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A review of specifications for lateritic materials for low volume roads

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ABSTRACT

Most laterite or lateritic soils do not comply with traditional specifications for road layers. This is a particular problem when materials are required for low volume roads. However, experience with many lateritic materials has shown that they can be successfully used with specifications that are outside traditional requirements. A review of various specifications concluded that the specifications used in Brazil are probably those based on the most pertinent and detailed research. This paper discusses the wide range of specifications suggested internationally for lateritic materials and compares the properties of a number of lateritic materials successfully used in roads in various sub-Saharan countries with the Brazilian specifications suggested for interim use in southern Africa.

Introduction

A significant increase in the use of laterites and lateritic materials, particularly for structural layers in low volume roads, is required to ensure the provision of an appropriate paved road network in many tropical and sub-tropical countries. In order to achieve this, it is essential that appropriate specifications for the use of laterites be developed and implemented. The traditional specifications employed (e.g. CBR of 80% and Plasticity Index of 6%) generally exclude many potentially useful laterites from use as structural layers in roads based on the incorrect test results obtained using conventional test methods (AFCAP, 2014). It is also known that other inherent properties of laterites result in good performance, even when the material properties are outside traditional specifications.

The high volume main road between Lilongwe and the Zambian border at Mchinji was constructed in about 1977 with a laterite base according to the 1974 Brazilian national specifications and recent inspections have shown that the road is still providing excellent service (Fig. 1).

In order to implement specifications developed uniquely for laterites and lateritic materials, it is essential that a simple definition of such materials accompany the specification. The unique properties of laterites that allow their use with widened specifications will not be mobilized if the specification is applied to materials that are not laterites and premature failure of the pavements can be expected.

This paper reviews research on specifications for lateritic materials and highlights some of the properties of laterites that make them conducive to use, despite their poor conformance to traditional specifications. Comparisons of the properties of successful roads with the current Brazilian specifications for laterite bases was carried out to see

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Fig. 1. Lilongwe–Mchinji road, Malawi as at February, 2014.

whether the Brazilian specifications could be applied directly in southern Africa.

Specifications

Laterites have certain unique properties that make them different from other road construction materials (AFCAP, 2014). This is one of the reasons that often results in their test results not conforming to conventional specification requirements and the materials being rejected for use, despite performing well when used in roads. Gidigasu and Dogbey (1980) note for instance that the lateritic gravels in Ghana have much poorer gradings than the local residual granitic gravels but, nonetheless, have performed satisfactorily.

Apart from the naturally poor gradings, the particle size distributions of laterites are affected significantly by the material preparation techniques used prior to testing. Ackroyd (1967) indicates that the aggregations of silt and clay caused by iron oxides are broken down during normal laboratory testing, but not during construction, giving results that are not directly related to the as-built condition.

Where the materials have weak aggregate particles in the gravel sized range, a good particle size distribution is necessary to ensure that the gravel particles have as many grain to grain contacts as possible with minimal voids. This improves the "support" for the aggregate particles and reduces the internal stresses allowing them to bear larger loads without fracturing. An alternative method of protecting the coarse aggregate is for it to float in the fines, but such a grading is normally inferior to the continuously graded material. It is important that the grading and plasticity allow the materials to be stable under traffic. Most limits for the fine material have been derived in temperate climates and have been based on the need to avoid frost damage, rare in countries with extensive deposits of lateritic materials as well as other criteria such as providing stability under temperate conditions.

Review of existing specifications

Typical specifications

Traditional materials specifications mostly developed in North America (e.g. AASHTO M147-65, 2011) and generally used internationally, which include specific grading envelopes, a maximum PI of 6% and a minimum CBR of 80% have typically been found to be too conservative for pedogenic materials in terms of their strict grading and plasticity requirements, while they do not control certain other particularly important constituents of pedogenic materials such as salts.

Numerous specifications for laterites have thus been proposed in the literature emanating from a variety of authorities. Not surprisingly, these have differing requirements, based on local experience. It has therefore been necessary to derive empirical specifications for these materials locally for which some examples are given in Tables 1 and 2.

Tables 1 and 2 show relaxations in a number of properties, particularly the plasticity and CBR strength requirements. It is interesting to note that Charmans (1988) requirements link the plasticity to the grading (Plasticity Modulus), a parameter subsequently used in a number of specifications.

Krinitsky et al. (1976) discuss various "relaxations" of specifications for laterite bases from selected countries. The main relaxations are for plasticity, but in the case of Thailand, PI× percentage passing 0.075 mm limits are proposed with values of 15–20 depending on traffic. This effectively is much stricter than most conventional specifications. Ghana had at that stage developed specifications for laterite bases for 3 different traffic categories, class I to III. These included slight relaxations of the grading envelopes over the AASHTO requirements, a move away from the LAA specification preferred by many countries towards the ACV (values between 35% and 50%), CBR requirements of 100%, 70% and 50% for Class I, II and III