MICROSTRUCTURAL INVESTIGATION ON LATERITE SOILS
ÉTUDE DE LA MICROSTRUCTURE DE SOIS LATÉRITIQUES

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Abstract

Considerable researches have been carried out to demonstrate the importance of microstructure in the interpretation of engineering behaviour of soils. Instances where the investigations are on laterite soils are however scanty in literature.

The microstructure of laterite soils obtained from Eastern Nigeria and North-East Brazil, have been examined with the aid of optical and scanning electron microscopes.

Investigations reveal the development of the well-known concretionary structure in laterite as a stage by stage process involving the accumulation of sesquioxides. The sesquioxides are accumulated initially as amorphous implantations in the pore spaces, the crystallisation of which leads to bonding of soil elements and formation of concretionary structure. The nature of cementation in the concretionary structure determines the resistance to degradation of the soils grains. The resistance to degradation would in turn influence the engineering behaviour.

Resume

De nombreuses études ont été entreprises pour mettre en évidence l'importance de la microstructure pour l'interprétation du comportement géotechnique des sols. Les exemples concernant les latérites sont cependant peu répandus dans la littérature.

La microstructure de sols latéritiques provenant de l'Est du Nigeria et du Nord-Est du Brésil a été étudiée à l'aide des microscopes optique et à balayage.

Les études ont mis en évidence le développement de la structure concrétionnée bien connue dans les latérites, processus progressant par étapes et comportant l'accumulation de sesquioxydes. Ces derniers s'accumulent d'abord en amas amorphes de remplissage de pores, et leur cristallisation conduit à former des liaisons entre les éléments du sol et à mettre en place la structure concrétionnée. La nature de la cimentation dans cette structure détermine la résistance des sols à la dégradation, et donc leur comportement géotechnique global.

Introduction

Modern ideas on the engineering characteristics of soils accept the concept that the values obtained from the measurement of physical parameters reflect the properties that operates on lower levels (microscopic and sub-microscopic). The failure of physical observations to provide the whole picture of soil behaviour has made the examination of the intrinsic properties of soils imperative in the engineering analyses of soils.

The control exercised by the microstructure on the engineering properties of soils has been widely demonstrated, particularly for soils in the regions of temperate climates in the world. This is however not the case for the tropics and paucity of investigations of microstructure with reference to engineering exist.

Lohnes and Demirel (1973) observed that the behaviour of laterite soils could not be adequately explained on the basis of physical observations alone. Additional emphasis has to be placed on the intrinsic properties and physico-chemical factors that make for the genesis of the soils (Gidigasu 1971, 1976).

A number of particle arrangements has been postulated or discerned in natural soils and sediments. (Lambe 1958, Alymore and Quirk 1970, Tan 1957, Smalley and Cabrera 1969). An important contribution by Collins and McGown (1974) has established that no particular singular arrangement of particle assemblage is characteristics of any type of soils and that a great number of soils and sediment types have a lot of arrangements in common, though certain types tend to prevail in certain soils than others.

Osipov and Sokolov (1978) however maintain that the microfabric of clay soils is determined by genesis. And that the microstructure is strongly related to its environment of formation and consequent transformation during the course of compaction. These authors have extensively investigated the microstructure of clay soils and have used the terminologies of an earlier study Sergevey et al. (1978) to describe the microstructural types associated with different environments of clay deposition.

The present work involves the use of the optical and the scanning electron microscope to investigate the

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microstructure of laterite soils obtained from Eastern Nigeria and North-east Brazil.

Materials and methods

Materials

Eastern Nigerian Samples:

Six samples were studied. The samples were developed from three geological units:
(a) False — bedded sandstones
(b) Shale
(c) A group consisting of shales, clays and sandstones.

The samples correspond to those in which the results of an investigation into the geotechnical properties had been previously described (Madu 1977). The level of sampling was the B-horizon or below.

Brazilian Samples

The Brazilian samples were collected from vertical road cuts near the cities of Sape, Cuite, and Nova Floresta all in the state of Paraiba in North-east Brazil. They are developed from the following geological units: Sape (shale), Cuite (sandstones), Nova Floresta (sandstones). Sampling sites are same as those described in Malomo (1983).

Methods

Optical microscopy employed a swift polarising microscope with a Bertrand lens and facilities for light filtering. Samples were impregnated with Araldite (resin) and Versamid (hardner) mixed at a ratio of 1:1 to give a refractive index of 1.54 (same as Canada Balsam). Thin sections were prepared following Brewer (1964, p. 403). Cut sample cementation to slide cover was done with Canada balsam.

Scanning electron microscopy (SEM) employed a 'Cambridge Instrument' Stereoscans 600. Fractured surfaces of samples to be examined were treated with 60 applications and removals of adhesive tape as suggested by Barden and Sides (1971). The surfaces were then coated with about 100 Å of silver in a vacuum evaporating chamber prior to examination.

Results

Optical Microscopy

All the specimens examined show a strong cementation of clay mineral particles, coating of the cemented clays (by iron oxides) and concentration of iron oxides in different parts (Figure 1). The concentration leads to the segregation of parts that are rich in iron oxide from part that are relatively poor, Figure 2.

The Brazilian soils, were seen as rounded to sub-rounded cemented bodies of various sizes, under the optical microscope. The bodies are the products of the cementation of elementary soil particles (clay minerals, quartz grains, iron oxide grains etc.). In addition to the coating role, iron oxides also provide a continuous link between the different bodies, Figure 3. The link is made up of goethite and secondary haematite.

Usually, a thin section could be divided into two regions.