Cameroon lava flow configurations and their use as building materials in civil engineering

Configuration des coulées volcaniques du Cameroun et leur utilisation comme matériaux de construction

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ABSTRACT
Soils of the South West region of Cameroon are partly made up of volcanic basalts from lava flows. The flows are successive and alternate thus forming deposits that are difficult to sample. This article presents results obtained from several wireline core drilling campaigns at 20 to 30 m depths on the right flank of the flow. There is a superposition of volcanic ash layers in-between consolidated basalt deposits. Rock materials of average shear strength of 50 Mpa and densities between 2.8 and 3.1 are presently used as ripraps for the 680 m breakwater in the "Limbe Shipyard Project" more to it, the Los Angeles values obtained show that they are suitable materials for road sub-base course.

RÉSUMÉ
Les sols de la région du Sud ouest du Cameroun sont en partie constitués de coulées volcaniques de nature basaltique, dont la succession et l'alternance des dépôts rend l'échantillonnage difficile. Cet article présente les résultats obtenus dans plusieurs campagnes de carottage grâce au système wireline sur 20 à 30m au droit de ces coulées. Il met en relief la superposition des couches de cendres volcaniques entre les dépôts de basaltes consolidés. Les matériaux rocheux de résistance moyenne 50 Mpa; de densité comprise entre 2.8 et 3.1, servent actuellement à l'enrochement du brise-lame de 680m dans le cadre du «Limbé Shipyard Project ». Il est aussi observé que les valeurs de Los Angeles obtenues rendent ces matériaux aptes à une utilisation dans les couches de fondations de certains types de routes.

Mots clés : système wireline, carottage, cendres volcaniques, routes

Key words: wire line coring; rock quality designation; compression shear strength.

1 INTRODUCTION

The on going construction projects in south west province, Cameroon (MUEA-KUMBA Road, LIMBE Ship Yard, MOUNGO bridge), have resulted to the search of materials for fills, pavement sub grade or as crushed stones for concrete by enterprises.

The most important parameters are density, Los Angeles coefficient of volcanic flow; characterized by a distinct heterogeneity such as the alternating beds of loose and compact rock masses that make exploitation difficult.

We shall thus present the configuration of the soils of this region based on the study of three sites: LIMBE, BAKINGUILI and EKONA. Core drilling campaigns of 20 m deep carried out on these sites have enabled us to obtain their physicochemical characteristics (Rock Quality Designation, Los Angeles coefficient, Simple compression shear strength, Unit weight...).

2 LOCATION OF SITES

2.1 *Limbe*

This site is at the northern boarder of SONORA. Drilling points are averagely -12 m below at the three quay and the 680 m breakwaters (a program of the ''Limbe Shipyard Project'').

2.2 *Bakinguili*

It is situated at 6 km from the first site on the LIMBE – IDENAU road at about +30 m in altitude. This study was carried out in a project on the determination of physico mechanical characteristics of rock masses to serve as borrows for breakwaters.

2.3 *Ekona*

It is at a higher altitude; +1700 m near BUEA and will be the borrow site for quarry materials for the MUEA-KUMBA road.

3 SAMPLING EQUIPMENT

The equipment used is a ''NIENZI drill rig'' comprising rods and double wall core barrels of NQ or HQ diameters.

Coring is by wireline such that the casing is left in the ground and only the inner tube is retrieved to the surface by a 1.5 m run via a cable.

4 VOLCANIC SOIL CONFIGURATIONS IN CAMEROON

Report sheets (table 1 and 2) on logs, stratigraphic description, and advancement of the core barrel as well as RQD of cores are representatives of each site.

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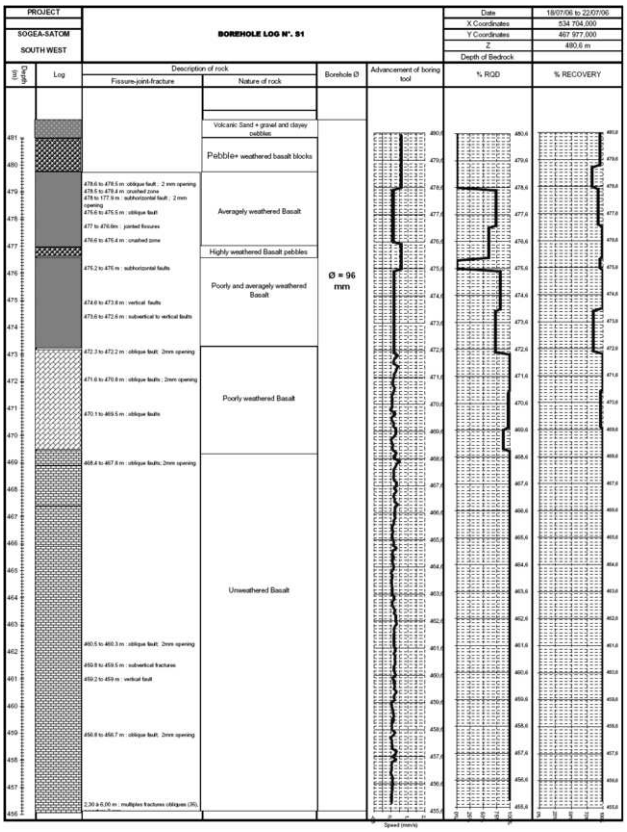
The EKONA site has a thin loose deposit (1 to 2 m) comprising pyroclastic blocks and volcanic ash followed by a transition zone (2 to 5 m) of weathered basaltic blocks of RQD less than 50%.

Table 1: Summary of parameters at EKONA.



The massive basalt has strength of 25 M and an RQD greater than 70% (AFTES 1993). This configuration is identical to the single flow type on this slope of Mt Cameroon.

LIMBE and BAKINGUILI have highly dispersed RQD (0 to 70%) which is characteristic of a heterogeneous massive formation constituted of a succession of several flows with loose layers trapped in-between lava flows. The highly compressible nature of these interlayer loose soils is not suitable for a stable foundation of the quay at these drilling points (AFTES 1993)

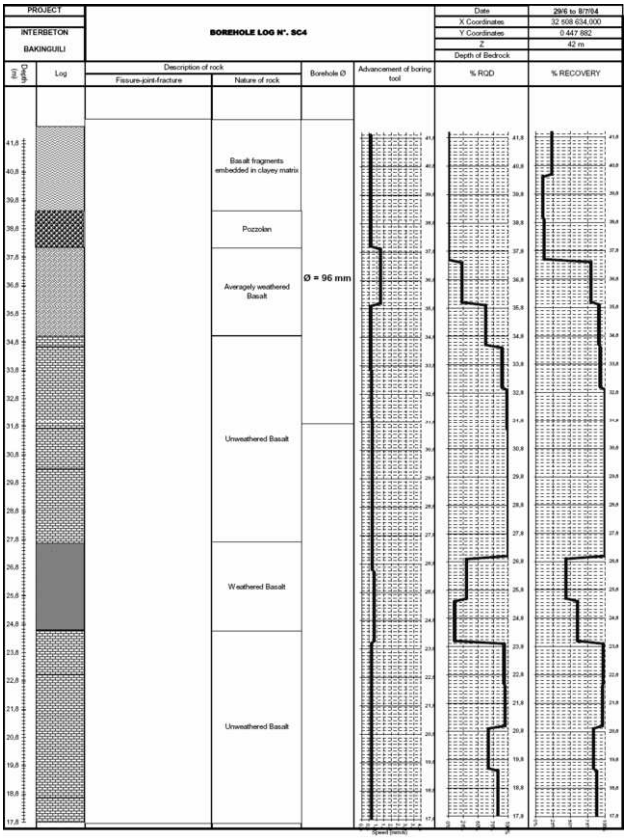
The use of these materials for the ongoing project of the region requires knowledge of the intrinsic properties of rock core samples. It is for this reason that measurements of dry and humid densities, Simple compression shear strength and Los Angeles coefficient were carried out.

Samples with RQD greater than 50% were obtained from some segments (KIM & GAO 1995), and simple compression shear tests were conducted on basalts with slenderness ratio equals 2 to obtain compression shear strength

5 EXAMPLES OF REPRESENTATIVE RESULT CURVES

Figure 1 shows results obtained from compression shear strength during crushing of rock sections. Results from more than 20 crushed cores are highly dispersed ranging from 34.6 Mpa to 73.6 Mpa thus a dispersion of about 52%. This value is nearer the 43% obtained by KIM & GAO (1995) on 58 tests carried out on massive basaltic rocks, USA.

Table 2: Summary parameters at BAKINGUILI.



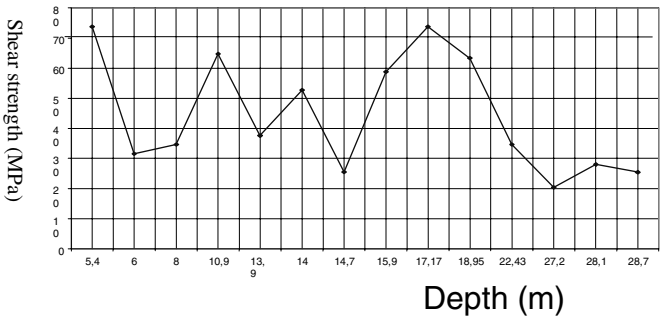


Figure 1: Trend of simple compression shear strength with core depth at EKONA.

More so, values of 300 Mpa have been obtained on these massive basaltic rocks with porosities less than 15% and densities ranging from 2.4 to 2.6t/m^3.

In spite of low compression shear strength values, dry densities ranging between 2.5 and 2.93 t/m^3 can be obtained on these basalt materials (fig 2 and 3).

The very dense portions (above 2.8 t/m^3) are found at depths greater than 20 m with respect to landscape.

A large opening in the BAKINGUILI quarry has made it possible for these materials to be used as rock fills for the 680 m breakwaters of the LIMBE Ship Yard.

The pavement structuring requires a foundation and/or basement materials of higher quality since it is the principal element to ensure duration of the pavement.

The LOS ANGELES coefficient corresponds to the fragmentation and abrasion shear strength of grains in the presence or absence of water.

Los values for present day pavements (ROCQUES 1977), should be between 25 and 35.

South West Cameroon basalts have Los values that range between 19 and 29 for materials of caliber of 16 /31.5 used in foundation layers. The others with calibers of 4/6 and 10/25 have values between 18 and 30 and these make it fit for use in pavement layers, however all these values are less than 35 and this also makes them suitable for used in concrete.

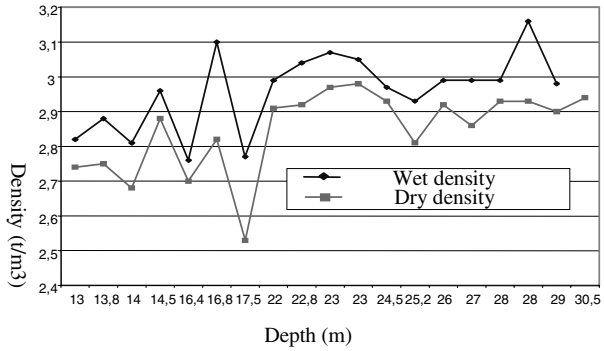


Figure 2. Trend of dry and wet densities with core depth at LIMBE

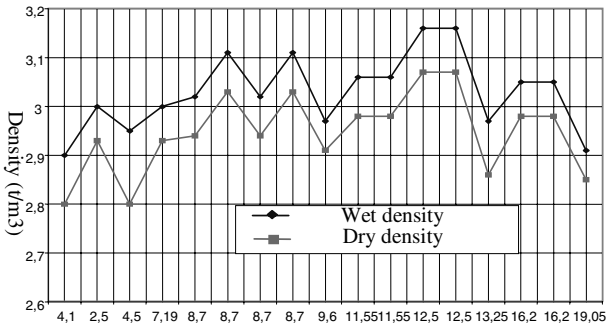


Figure 3. Trend of dry and wet densities with core depth at BAKINGUILI.

6 CONCLUSION

Volcanic flows of south west Cameroon, in spite of their special sampling technique (wireline coring) and their high heterogeneity, have mechanical properties that are suitable as building materials.

They have high dry densities (between 2.8 and 3 t/m^3) which guaranties the stability of the breakwater fill of the LIMBE Ship Yard.

The Los Angeles coefficient that ranges between 25 and 35 make them suitable for use in sub-base course.

The mechanical shear strength, the RQD as well as the Los Angeles values obtained have convinced the company, SATOM SOGEA to open a quarry at the EKONA site and its materials of different strengths shall be used in the on going construction of the MUEA-KUMBA road.

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