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Contribution in the Physical Characterization of Two River Sands from the South-mifi River of the Mifi Basin in Cameroon

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Abstract

The valorization and the use of natural resources as building materials require a meticulous study of its geotechnical properties. Thus the goal of our research is the physical characterization of two river sands from the south-Mifi river of the Mifi basin carried out with an aim of promoting its rational use in Civil Engineering constructions. After the fieldwork, laboratory studies have concerned the petrography, the physical identification of the Sands samples such as: water content, unit weight, density, sand equivalent, granulometrical analysis, sedimentation, and granularity. The study concludes that the representative samples of the analyzed aggregates have geometrical and physical properties which differed from the upper side of the South-Mifi River to the lower side of the river. From the upper side, the specific mass is 2.85 g/cm^3 and to the lower side between 25 and 35 km the specific mass is 2.61 g/cm^3, there is a variation of 8.42 %. The sand equivalent from the upper side is 76.4 % and to the lower side 70.5 %. The fineness modulus to the upper side is 3 and to the lower side 2. 8.

Key Words: Characterization; Physical; Geotechnical; Crushed stones; Sand grain size; Civil engineering.

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1. Introduction

We call aggregate a whole of grains of mineral origin with size ranging between 0,08 mm and 80 mm, coming from movable rocks, massive, ores or from the thermal transformation of industrial sub products. Sands are natural aggregates coming from the rivers (sea-bed, Reads River) and consist of one or more minerals thus quartz (SiO_2), with an alluvial texture. There are also artificial aggregates which results from the thermal transformation of the rocks, sub products, and waste or from the recycling process of old damaged structures. Sands have intrinsic characteristics which are related in general to the quality of the rocks exploited and just as of the extrinsic characteristics resulting from the conditions of formation such as the granularity, flatness, angularity... They must answer some criteria or specifications to be able to be used in a concrete, a mortar or in other Civil Engineering works. Moreover, sands are classified in several categories with particular specifications for each one of them. The standard distinguishes the aggregates according to the use, the medium and the nature of the work such as:

Aggregate for layer of fitted (sub-base, base course and wearing course)

Aggregate for different qualities of concrete and mortar

2. Literature/theoretical underpinning

Various studies have been done (various analysis on the sand usage) for the formulation of concrete and mortar. Granite are stones having a good reputation for their durability, strength and exceptional resistance in the construction buildings. However, no research (analysis) has been realize on South-Mifi river sand where this aggregate abundantly exist and is mostly use in Civil engineering constructions. Moreover, crushed stones as Granite have already done an object of meticulous studies such as:

Reference [1] who has studied the alteration of stones calco-alcaline and of granodiorites in the wild area of the Ivory Coast Republic. Many publications have been done on the longevity character, physical and mechanical of constructions materials. Reference [2] in the restriction of his third cycle thesis worked on the alteration of volcanics rocks. Reference [3] has proced to the geotechnical characterization of the products of the alteration of rhyolitics in Bafou area limiting himself on intrinsic parameters of the material. Reference [4] during the study of earth distortion in the Bana massive, has contribute in the geotechnical characterization of Granite stones. Reference [5] has sommary studied the physical properties of sand resulting the alteration of stones and rock of Batie (west Cameroon) and has done suggestion in other to improve the quality in the formulation of concrete. Reference [6] made studies on the sands of some carreers of Nord West region of Cameroon (in particular sands of Ndop, Woum, Mbattu) particularly saking on sand equivalent; and the analyse of their consequences in concretes formulation.

3. Materials and methods

For better characterization of West Cameroon aggregates for a suitable use in civil engineering, an adapted methodology must be applied in other to efficiently conduct fieldwork, laboratory analysis and the calculation of

different parameters of a structure we expect to build.

4. Fieldwork

Materials

The principal materials are represented here by the rocks, the grounds and the aggregates on which we take our various sand samples. For that we used the following equipment and tools:

- Polystyrene bags being used to take the samples;

- one decameter being used for the catches of measurements of various alternatives;

- Pens and memo pads for the catch of the data on site.

Localization of the site of study

In West Cameroon locality, several sand pits are open. An inventory of these last during many descents on the ground made it possible to operate a choice related with the geotechnical studies of the aggregates resulting from these various sites located between the parallels 5°25' and 5°28'00'' of Northern Latitude and the meridians 10° 20' and 10°25'00''.

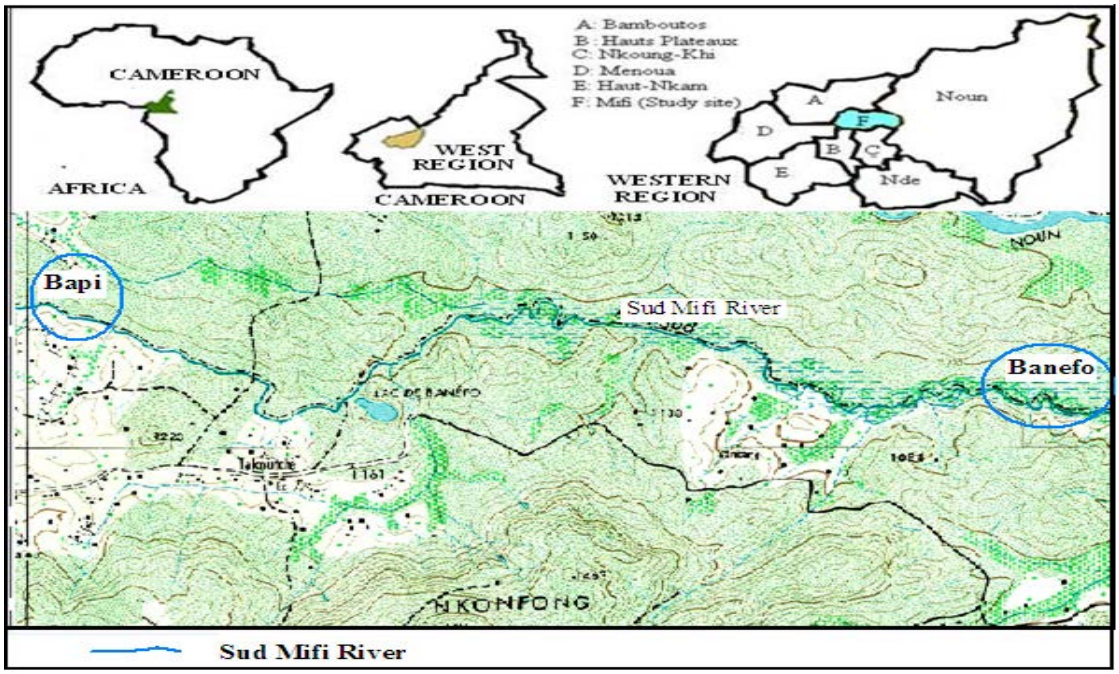

Figure 1: Localization of the sector of study

Sampling

With the aim of having the most representative samples, the approach of < shovel in hillock > was necessary, it

should have been mixed materials that one made fall from a bleeding on all the height of the coal face. Then the method of taking away by quartering made it possible to determine our operation by retaining the quantities necessary for work in laboratory. The resulted samples, taken on each alternative were packed in polystyrene bags and labeled for an identification of each one of these sands (granulometric analysis, the determination of the water content, the sand equivalent, the absolute voluminal weight …).

5. Work in laboratory

Work in laboratory was carried out on the various sand samples at the Laboratory of Engineering and the Industrial Systems and Environmental (LISIE) of the University Institute of Technology FOTSO Victor of Bandjoun associated with the Laboratory of Mechanics and Modeling Physical Systems (L2MSP).

Methods of experimentation

In this part, the methods of experimentation for the determination of different characteristics will be presented:

- Physical characteristics: Water content, density, specific mass, expansion of sand, absorption coefficient, the degree of surface cleanliness or equivalent of sand, the loss of mass.

- Geometrical characteristics: The granular composition, the fineness modulus, and the coefficient D flatness

Water content

The water content of studied materials was determined by the method by stoving according to the regulation of standard [7].

$$W\ (\%) = \frac{M_W}{M_s} * 100 = \frac{M_h - M_s}{M_s} * 100$$

With: M_W = Mass of water; Ms = Mass of the dry ground and M_h = Mass of the wet ground

Density (apparent bulk density)

The measurement of the density was taken according to standard [8].

$$\rho_{app} = \frac{M_{sch}}{M_{liq}} * \rho_{liq}$$

With: Mech: Mass sample gram (g) and Mliq: Mass liquid (water) gram and ρliq: Density of the liquid in (g/cm^3)

Specific mass (absolute or real density)

The determination of the specific mass of studied materials was carried out with the use of the method of the pycnometer with water according to the regulations of standard [9]. The sought absolute density is:

$$\rho_s = \rho_w * \frac{M_2 - M_1}{M_4 + M_2 - M_1 - M_3}$$

With ρw: Density of water taken conventionally equal to 1 g/cm^3.

Measure cleanliness of sands: sand equivalent

The cleanliness of sands is usually evaluated using the test of the sand equivalent. It is carried out on the fraction of sand passing to the sieve of 5mm, while following the regulations of standards [10]. The value of the equivalent of required sand is obtained using the expression

$$ES = \frac{ES_V + ES_P}{2}$$

Where ES_V and ES_P are respectively the visual sand equivalent and the equivalent sand measured with the piston

Expansion of sand

The expansion of materials was studied on the basis of principle describes by standard [11]. This test consists starting from and the state fineness modulus of the material (water content) through the abacus to determine the coincidence factor

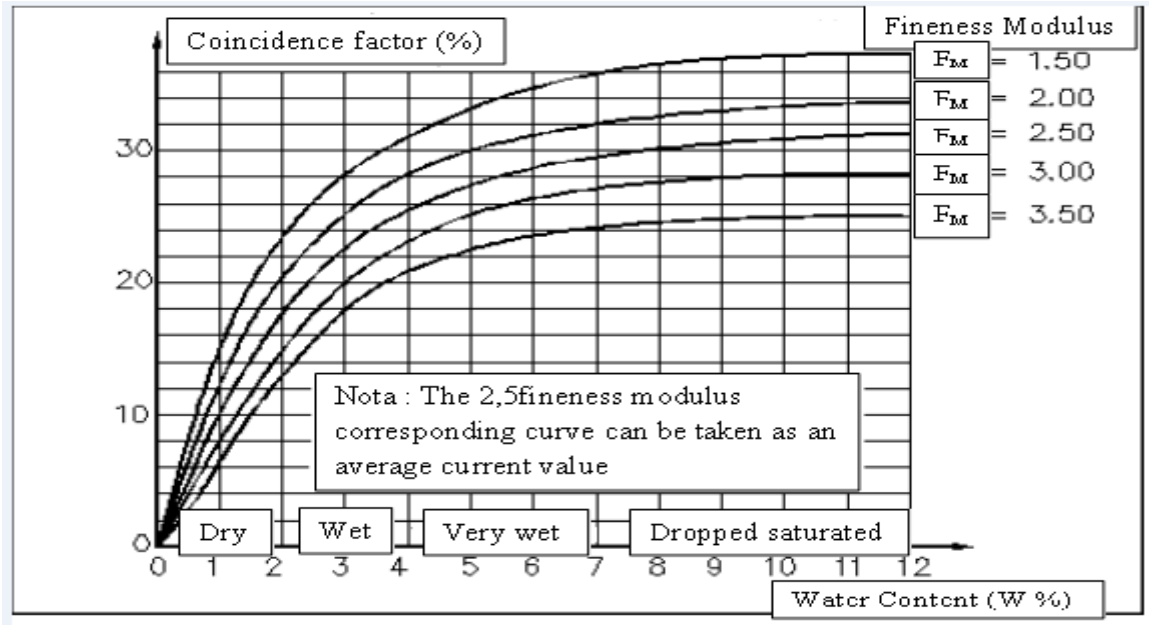

Figure 2: Determination of the coincidence factor

Source : Materials of construction course by Mehrez KHEMAKHEM

Absorption coefficient

The absorption coefficient of studied materials was evaluated by the method described in standard [8].

The absorption coefficient of water (in %) sand was determined by the formula

$$A_b = \frac{M_h - M_s}{M_s} * 100$$

With Mh the mass dries final and Ms the initial dry mass of the sample submitted for testing.

Test of control of loss of mass ([12])

The loss of mass of materials was studied on the basis of principle and of the procedure by. Standard the latter describes stipulates that the loss ratio of mass is defined by

$$C_p = \frac{M_0 - M_f}{M_0} * 100$$

With: M_O is the initial mass of the sample and MF is the final mass after execution of the test.

Granulometric analysis by dry sifting ([12])

The granulometric analysis of various materials was carried out by dry way. It makes it possible to determine the size and respective percentages by weight of various families of grains constituting the grounds.

The fineness modulus, quantifying the more or less fine character of sands corresponds to the sum of the percentages of the refusal cumulated brought back to the unit for the sieve of the modules 23. 26. 29. 32.35 and 38. It is given by the following expression:

$$M_f = \frac{(\%R_5 + \%R_{2.5} + \%R_{1.25} + \%R_{0.63} + \%R_{0.315} + \%R_{0.160})}{100}$$

With: M_O is the initial mass of the sample and MF is the final mass after execution of the test.

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{d_{30}^2}{d_{10}\ x\ d_{60}}$$

Dy: dimension of the sieve corresponding to y% of passerby.

Granulometric analysis by Sedimentation *([13])*

The test aims to develop the distribution in weight of the particles of a ground whose greatest dimension is equal to 80 µm and smallest higher than 1 µm. This test supplements the granulometric analysis by sifting.

Law of Stokes:

$V = \frac{(\gamma_s - \gamma_w).g.D^2}{18\eta}$ With η the viscosity of the liquid

6. Results

It comes out of this study that the values of physical parameters of the river sands from South-Mifi River of the Mifi basin in the west region have specifically reached for each tested sand to the following results:

Table 1: Physical characteristics of different aggregates

Characteristics	Sand 1	Sand 2	Ecart (%)
Nature	Rolled	Rolled	
Water content (W %)	**22.53**	**14.32**	**36.44**
Apparent bulk density g/cm^3	**1.2**	**1.78**	**32.58**
Sand equivalent %	**70.5**	**76.4**	**7.72**
Specific density g/cm^3	**2.61**	**2.82**	**7.44**

Water content

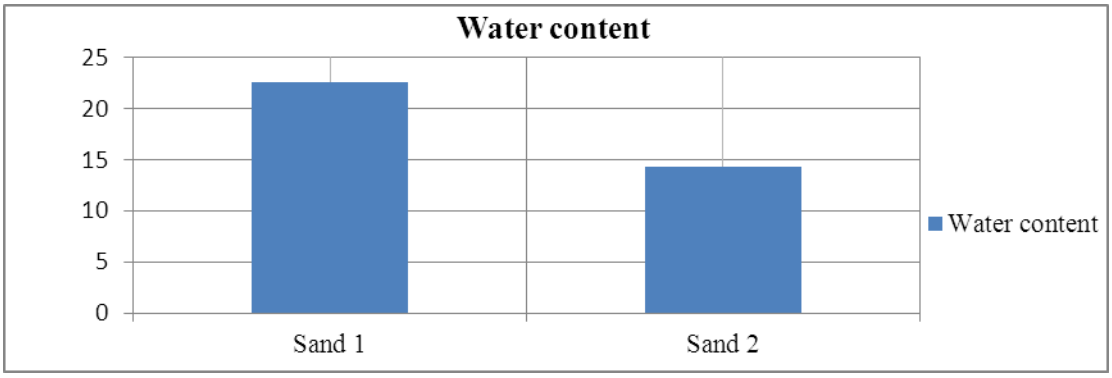

Figure 3: Histogram of the water contents of the various sand sample

Apparent and absolute bulk density

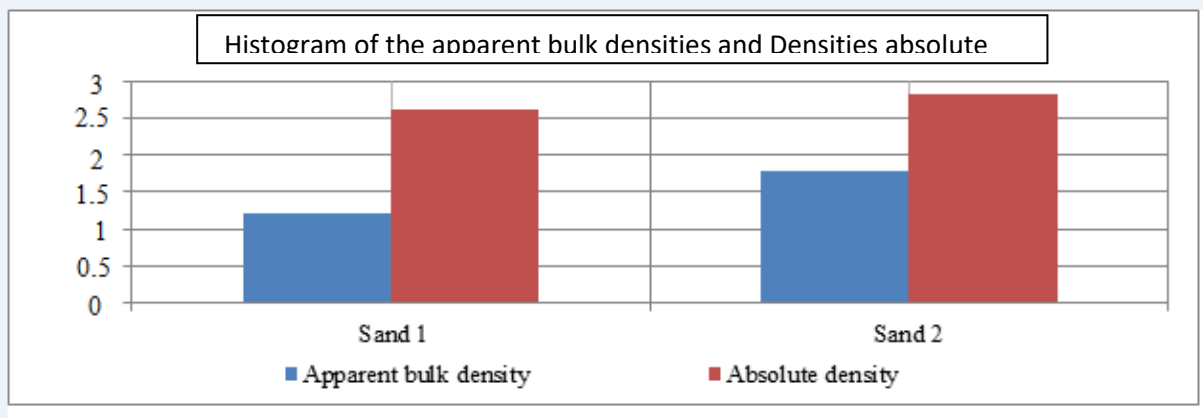

Figure 4: Histogram of the apparent bulk densities and Densities absolute

Sand equivalent

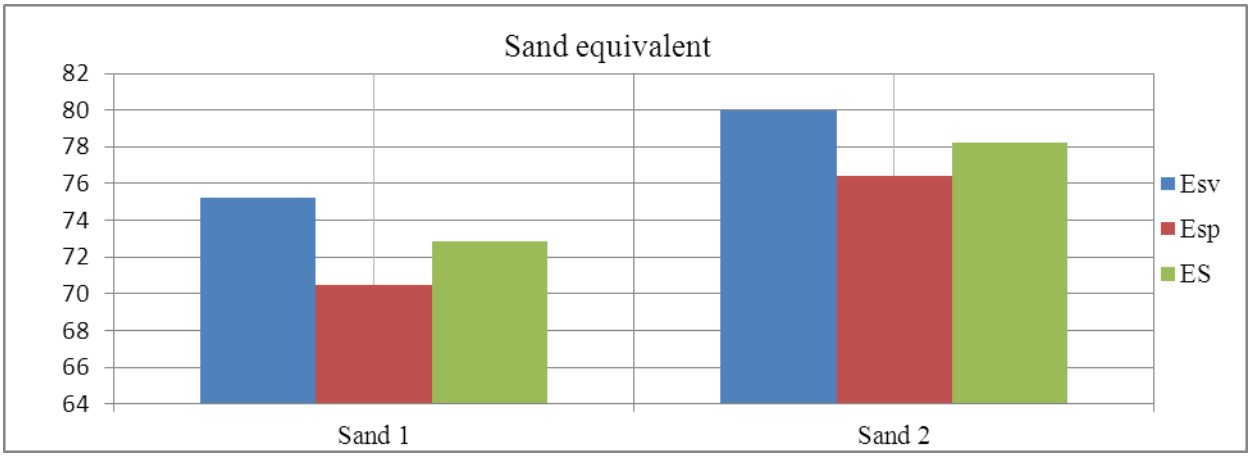

Figure 5: Histogram of the sand equivalents of the various sand samples

Grain-size distribution

Table 2: Data resulting from the granulometric analysis

Parameters	**« Sand 1 »**	**« Sand 2 »**
Fineness modulus Mf	2.8	3
Coefficient of curve C_c	0.67	0.79
Coefficient of uniformity C_u	3.07	3.65
Content of Fines (%)	5	3
Content of Sand (%)	80	77
Content of Fine Gravel (%)	15	20
Content of Stones (%)	0	0

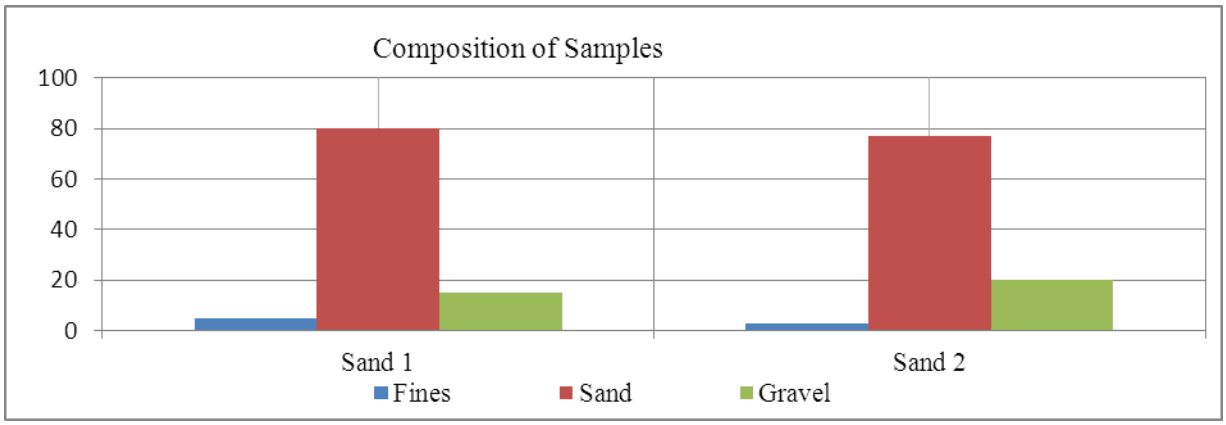

Figure 6: Histogram of the composition of the various samples

The materials resulting from the various careers are made up mainly of sand.

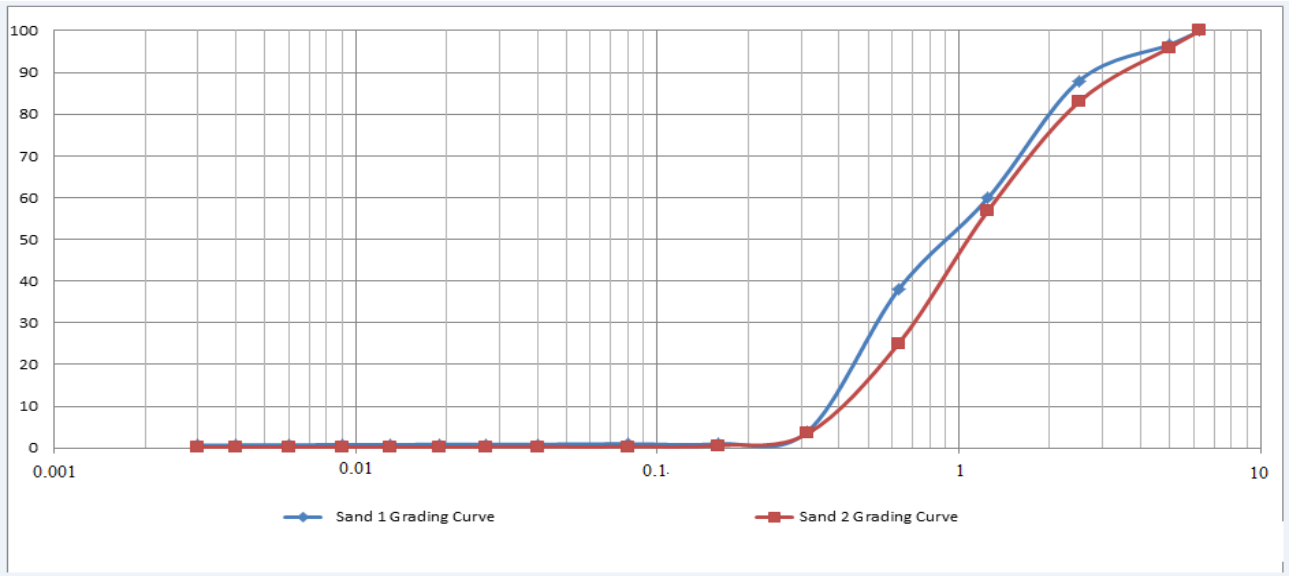

Figure 7: Grading curves of different sands

7. Discussions

After having carried out the various laboratory tests, it comes out that:

- The density of material "Sands 2" is higher than 1.4 g/cm^3 this attests that, the studied materials are aggregates. The density of "Sand 1" lies between 1 g/cm^3 and 1.4 g/cm by consequence it shows the characteristics of a ground.
- The sand equivalent of "Sand 1" and "Sands 2" are included / understood in the interval from 70% to 80% this attests that these materials are recommended for the realization of the concretes of good quality.
- "Sand 1" presents the strongest water content (22.53 %), which is explained by the strong presence of

the fine particles which retain water by absorption on their surface and thus reduce the permeability. This strong water content enables us to conclude that the "Sand1" is a fine grained soil in loose state and consequently its index of vacuum (e) is high. Other sands have a water content ranging between 10.84% and 14.32%. These low values of the water content attest low content of fine particles, which makes it possible to affirm that these grounds are in a compact or dense state and consequently their indices of vacuum are less high.

- The various materials "Sands 1" and "Sands 2" with a coefficient of curve Cc < 1 and the coefficient of uniformity Cu < 4 this indicates that we are in the presence of a serious evil graduated. According to the values of the fineness modulus "Sand 1" and "Sands 2" are standard sands. In addition according to the particle size, we obtained for each sand the various size ranges (fine, sands, and fine gravels).

8. Implication of the model to research and practice

“Sand1” is used like a laying material for garden ground blocs.

“Sand1” and “Sand2” are mainly constituted of sand.

Specific mass values differed from 2 g/cm^3 to 3 g/cm^3 which means that we here have usual types aggregates.

9. Conclusion

At the end of our study, it was a question for us to carry out a physical characterization of the aggregates of the South-Mifi river for their use in Civil Engineering. We for that, focus on the physical characterization of parameters which were presented and interpreted. From that it results from one hand the names, the compositions, the sizes particles, and on the other hand the physical properties of various materials taken on the site. With the aim of promoting and valorizing these materials resulting from the sedimentary rocks and metamorphic, we also carried out, a comparison of the results obtained of the career of "Sand 1" with those obtained on the aggregates of the career of "Sand 2".What enabled us to note that there is a variation between the different physical parameters of both sands due to the distance difference between both sand sites and also in relation with the river speed. At the end, the results obtained during this study pose the constitutive stakes of a physical base data of the aggregates of the careers of “Sand1” and that of “sand2”.

10. Pespectives

The improvement of the physical characteristics of “Sand 1” and “sand2” in other to obtain high quality concretes in structures constructions.

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