Geomaterials, 2016, 6, 1-17
Published Online January 2016 in SciRes. http://www.scirp.org/journal/gm
http://dx.doi.org/10.4236/gm.2016.61001

Soil Subgrade's Characterization and Classification of Thies (Senegal, West Africa) on a Radius of 2.5 Kilometers along Five Roads

El Hadji Bala Moussa Niakhate[1], Séni Tamba[2], Makhaly Ba[1], Adama Dione[1], Issa Ndoye[1]

[1]Laboratoire de Mécanique et Modélisation-UFR Sciences de l'Ingénieur, Université de Thies, Thies, Sénégal
[2]Ecole Polytechnique de Thies (EPT/Thies), Thies, Sénégal
Email: niakhatebala@univ-thies.sn

Received 9 September 2015; accepted 21 December 2015; published 24 December 2015

Abstract

This article explains the results of a study conducted on the characterizations of subgrade soils in the region of Thies. The road platforms are mainly composed of a background soil, which is generally overlapped by a surface layer that plays two roles. Firstly, it protects the soil structure, ensures the leveling, and facilitates the movement of vehicles. Secondly, it brings harmony in the mechanistic characteristics of the materials that compose the soil while improving the long-term life force. The methodology consisted in taking samples of subgrade soil along the roads all over the region of Thies in a 5 km diameter span. The identification tests allowed the Thies-Tivaoune, Thies-Khombole and Thies-Noto axes are characterized by tight sands, poorly graded size. While Thies Pout-axis is characteristic of severe solid particle size and spread well graded and serious to spread and well graded particle size. Finally the Thies-Montrolland axis is characterized by severe to very tight particle size and graduated to spread and serious and well graded particle size. The specific gravity values found Proctor test shows the presence of sand, sandy laterite and laterite. In the target area, polished soils of the A-3 type according to the AASHTO classification system are the most represented with 60%, followed by the A-2-6 type 25%, and the A-2-4 type with 9%, which are typical of gravel, clay, and silty sands. Soils of the A-1-b type (2%) typical of roc fragments, sands and clay are also represented. Polished sands of the A-3 type have a better efficiency on road infrastructures than other types of soil listed above. Finally, we've also noted the presence of soils of the A-2-7 and A-4 types with the low percentage of 2%. Subgrade soils of class S4 are the most represented with 58%, followed by those of class S5 with 42%. Samples of the Thies-Montrolland road have a claylike plasticity (CL or CH group), while those of the Thies-Pout road belong to the ML or OL and CL or OL groups with a tendency mostly directed to the CL or OL group.

How to cite this paper: Niakhate, E.H.B.M., Tamba, S., Ba, M., Dione, A. and Ndoye, I. (2016) Soil Subgrade's Characterization and Classification of Thies (Senegal, West Africa) on a Radius of 2.5 Kilometers along Five Roads. *Geomaterials*, **6**, 1-17.
http://dx.doi.org/10.4236/gm.2016.61001

All these results confirm the very nature of soils on the two roads and put the light on the presence of lateritic materials with certain plasticity.

Keywords

Subgrade Soil, Mechanistic Pavement Design, Arc GIS, AASHTO, CBR, Resilient Modulus

1. Introduction

Road infrastructures are among the key criteria currently used to measure the development of countries in general; that's why their construction is of paramount importance. They are vital to the transportation of people and goods; hence, developing countries are investing in roads that contribute to boosting their economy by facilitating movement to and from their most isolated areas. A road is a structure that has three main layers: 1) the platform, 2) the intermediate layer, and 3) the surface layer, each of which plays a precise role. This study targets the platform, which is the background of the road. It is established nowadays that road structures deteriorate very early and very easily. Therefore, the study aims at studying the characterization of platform soils for the sake of a mechanistic dimensioning. To achieve that goal, samples of subgrade soil were taken over a diameter of 5 km on both sides of roads going through Thies. Identification tests were then conducted on all the samples and the results presented and commented. Knowledge of the identification parameters and the classification of soils based on the AASHTO system made it easy to deal with the mechanistic pavement design.

2. Literature Review

The background platform of a road has various functions. Its first function is to protect the base layer against weathers hazards, support the vehicle's movement during the construction phase. It also has to supply enough and long-life roughness; which is also called life force so that a satisfactory mechanical motion of the structure can be obtained while ensuing a life cycle that is appropriate it its dimensioning. The environment largely conditions the life force of the background platform of a road [1]. The pair PST-base layer determines the long-term life force of the background platform of the road. Before any work should be undertaken, a laboratory should analyze and classify the soils composing the platform. **Figure 1** below could be a representation of a road structure.

Top-down, the structure is composed of three layers: the upper layer, the modeling layer, and the adjustment layer. The platform must meet the following requirements: guarantee, not only a short term life force that exceeds 50 MPa necessary to having good quality compacting or materials densification; but also a long term life force that could allow for the traffic of vehicles to happen correctly during the construction phase, while protecting the PST against weather hazards. The life force of the platform corresponds to the capacity of interrelated layers to resist the constraints and deformations applied to them during the traffic. The life force of the platform refers, in the short term, to the values estimated or measured in the construction site; in the long term, it refers to the values used for the dimensioning and targeted during the conception phase (Babilotte *et al.*, 1994) [3].

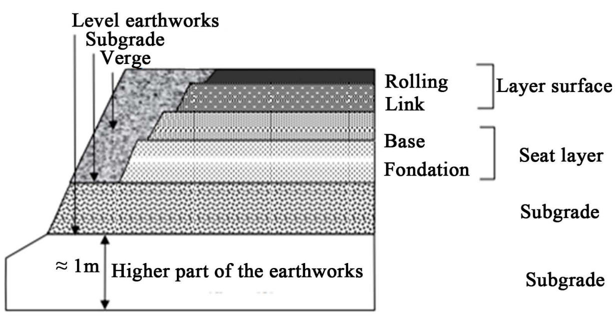


Figure 1. The elements of a roadway (LCPC, 1994) [2].

3. Methodology

This study aims at focusing first on the Thies region where samples of soil are taken from the local platform.

At first, it consists in considering the following:

- A circle of diameter 2.5 km is identified and samples are taken all along the roads going through it.

Figure 2 determines the limits of the field of action.

In **Figure 2** below the central area defines the spaces occupied dwellings and which justifies the non sampling of this area.

To carry out this study we ask the following basic assumptions:

- Samples are taken every 500 m.
- For each sampling point was made 02 samples on either side of the highway that is to say 01 samples on either side of the main road (left bank, right bank).
- An interval of 50 m is observed between testing sites.
- Samples are done on depths of between 70 cm and 1 m.
- Stripping of topsoil to a depth of 10 to 20 cm before collection.
- A GPS is used to localize each testing site.

Therefore, samples are taken from five roads inside the identified circle. There are two types of roads:

- Highways: Thies-Tivaoune, Thies Pout, Thies-Khombole.
- Secondary roads: Thies-Montrolland, Thies-Notto.

4. Results

4.1. Altitude Variation

The sampling points are marked with their GPS coordinates x, y and z, the distance between the sampling points is measured using a pedometer. Using the GPS coordinates we represented the curve elevations in **Figure 3** below.

Figure 3 shows that the highest altitudes are noted on the axes Thies-Montrolland and Thies-Pout with values

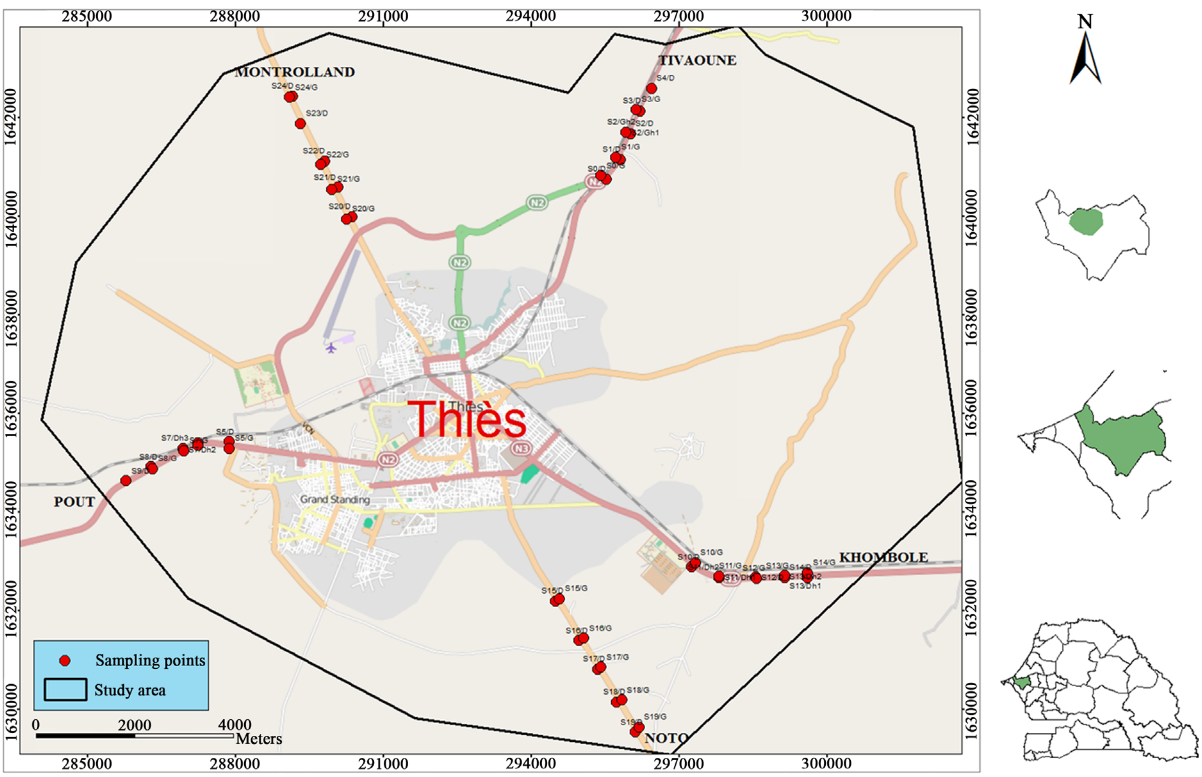


Figure 2. Delimitation of the scope of the study.

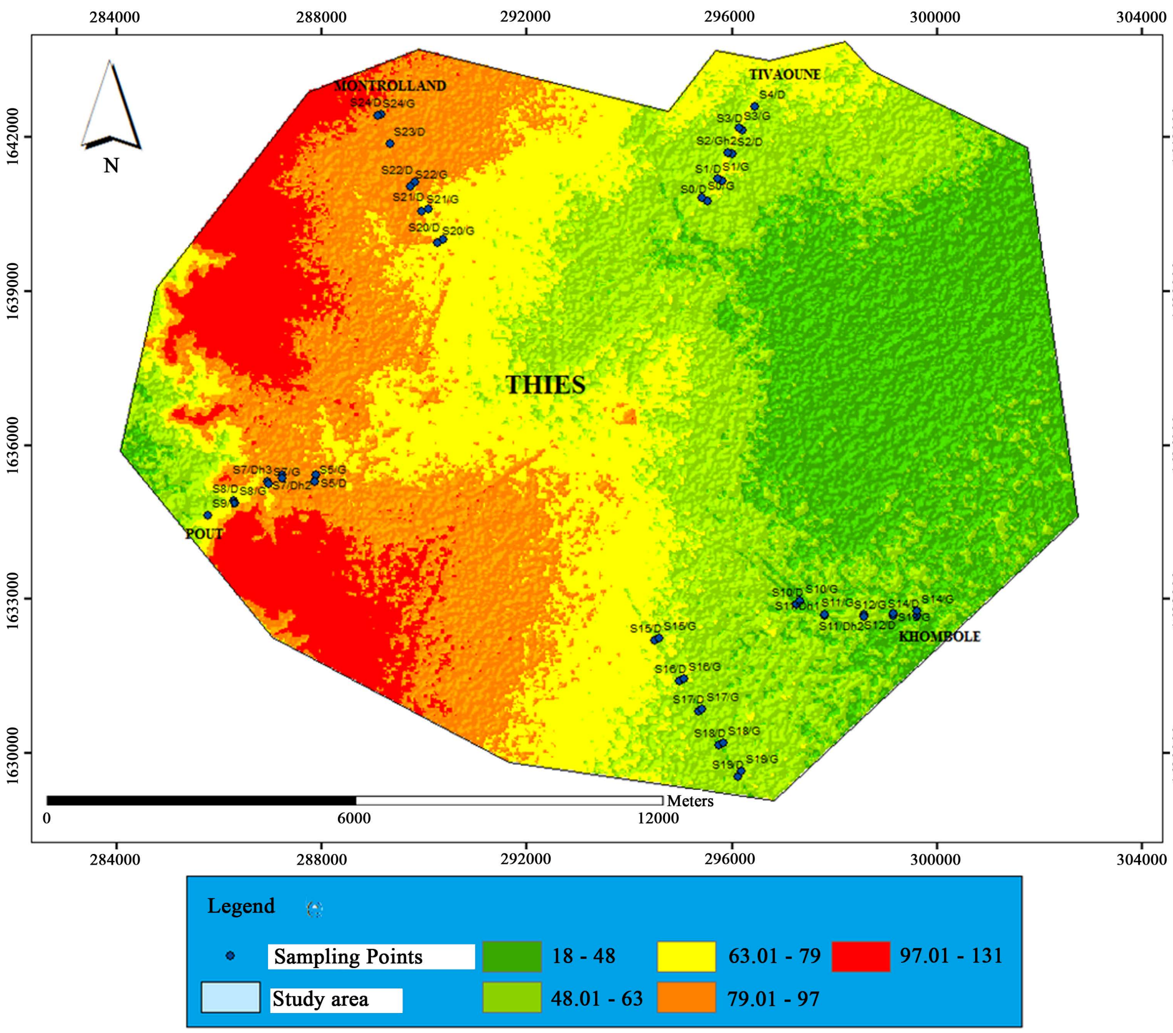


Figure 3. Altitude variation on five-axis characteristics of the study.

between 79 and 97 m. This is explained by the fact that these two areas are located on the cliff of Thies. Then come the Thies-Tivaoune axes, Thies-Khombole and Thies-Noto with values between 48 and 63 m.

4.2. Laboratory Test Results

Particle size analysis on the samples is carried out according to the procedure of the French standard NF P 94-056 (1996) [4], and the results are shown in **Figure 4**.

Examination of grading curves makes it possible to establish the particle size characteristics of **Table 1** corresponding to the uniformity coefficients and coefficients of curvature platform sampled soils.

For the analysis of these data we propose to make the graph to try to identify coéfficientd'uniformié variation range and curvature coefficient following the axes below.

Figure 5 shows that the values of the uniformity coefficient Cu on axis 1; 3 and 4 will vary over a range of maximum variation between 2 and 5. What is characteristic of a tight particle size. While on the axis 5 uniformity coefficients varies over a range within the interval 20 - 200 and 5 - 20 which corresponds respectively to the profile of a ground semiconductor particle size spread and spread size. Similarly on the axis 5 of the uniformity coefficient varies over a range belonging to the interval 20 - 200 and 2 - 5. Corresponding respectively to a ground profile to tight particle size and particle size spread. Referring to the French standard XP P 94-011 August 1999 [5], called, Soils: recognition and testing Description-Identification-Name soils. We can also do the following analyzes, on Thies-Tivaoune, Thies-Khombole and Thies-Noto axes the uniformity coefficient C_u is below 6 and

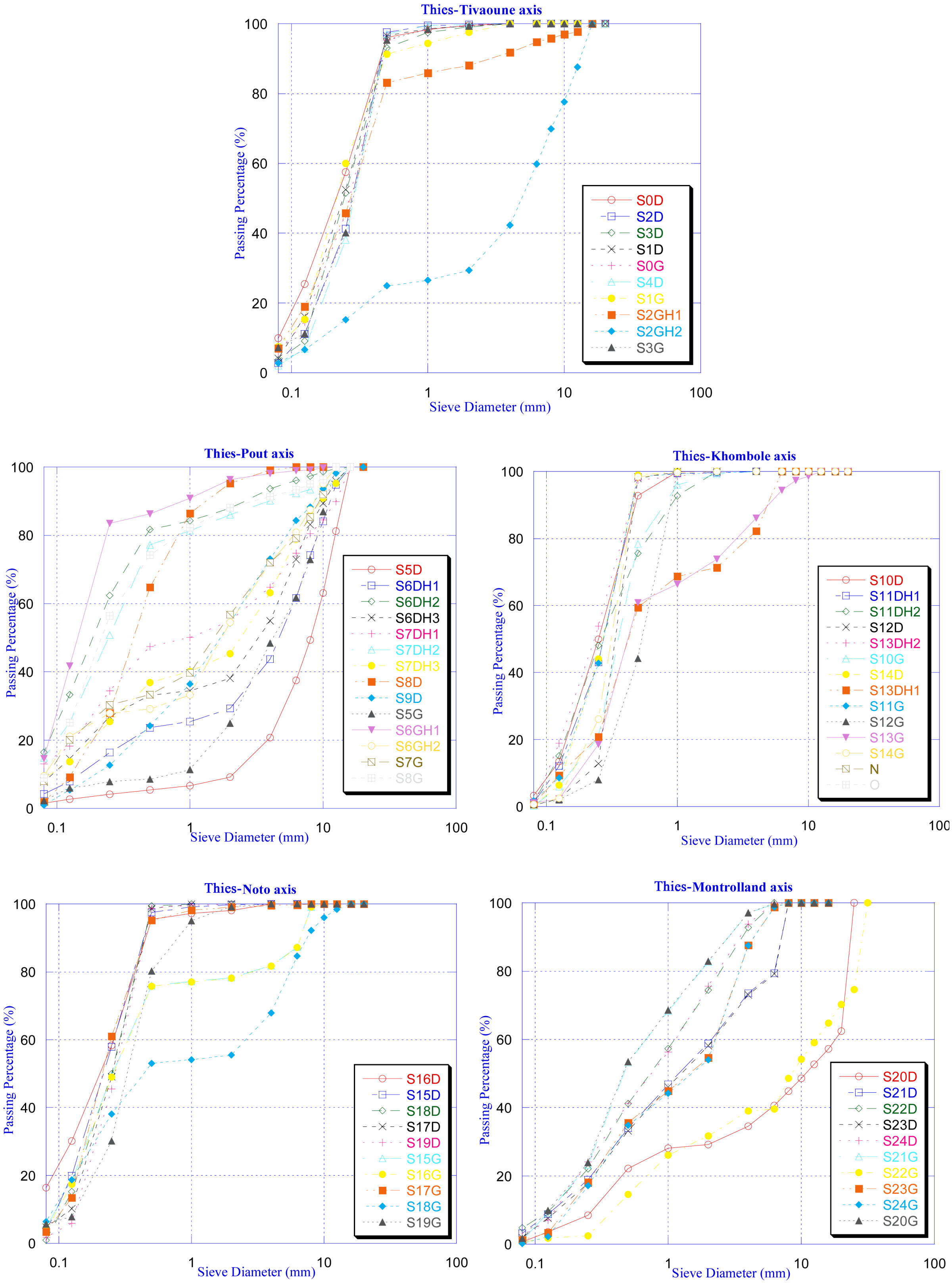


Figure 4. Particle size curves subgrade soil samples on five axes features of Thies (Thies-Tivaoune axis; Thies-Pout axis; Thies-Khombole axis; Thies-Noto axis and Thies-Montrolland axis.

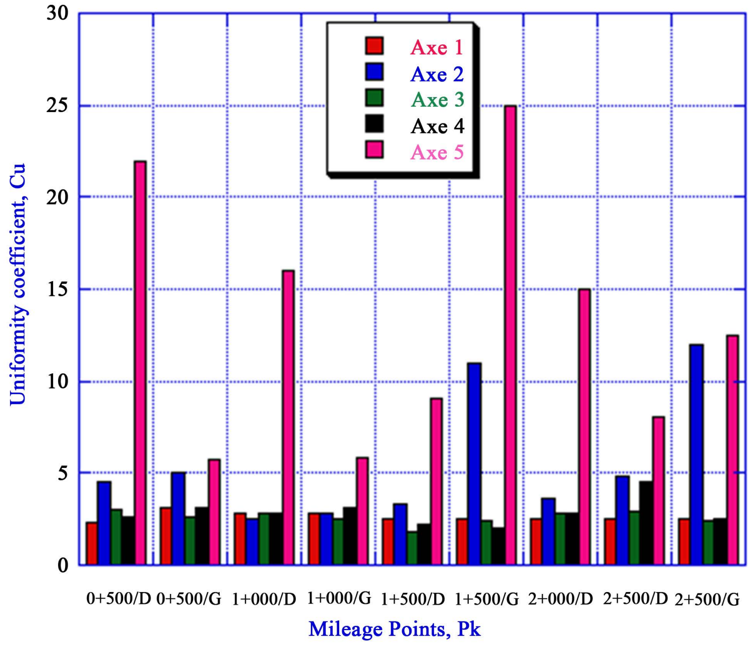


Figure 5. Variation of coefficient of uniformity along five roads.

Table 1. Subgrade soils size characteristics in the region of Thies.

Thiès-Pout axis (Axis 2)											
Samples			**S5/D**	**S5/G**	**S6/Dh1**	**S6/Dh2**	**S6/Dh3**	**S6/Gh1**	**S6/Gh2**		
Cu			4.5	5	49.6	2.5	42.85	2.8	35.71		
Cc			1.39	1.58	4.53	0.62	0.061	0.91	2.23		
Samples			S7/Dh1	S7/Dh2	S7/Dh3	S7/G	S8/D	S8/G	S9/D		
Cu			31.2	3.31	31.82	31.58	3.6	4.88	12		
Cc			0.13	0.53	0.28	0.39	1.1	1.03	1.07		
Thiès-Tivaoune axis (Axis 1)											
Samples	**S0/D**	**S0/G**	**S1/D**	**S1/G**	**S2/D**	**S2/Gh1**	**S2/Gh2**	**S3/D**	**S3/G**	**S4/D**	
Cu	2.36	3.13	2.8	2.78	2.52	2.52	39.38	2.24	2.52	2.48	
Cc	0.97	1.04	0.91	1.07	1.02	0.82	3.97	0.83	1.02	1.10	
Thiès-Khombole axis (Axis 3)											
Samples	**S10/D**	**S10/G**	**S11/Dh1**	**S11/Dh2**	**S11/G**	**S12/D**	**S12/G**	**S13/Dh1**	**S13/Dh2**	**S13/G**	**S14/D**
Cu	3.06	2.67	4	2.8	2.5	1.8	2.44	4	2.8	2.94	2.4
Cc	0.91	1.31	0.71	0.8	1.03	1.09	0.8	1.56	0.91	0.92	0.89
Thiès-Noto axis (Axis 4)											
Samples	**S15/D**	**S15/G**	**S16/D**	**S16/G**	**S17/D**	**S17/G**	**S18/D**	**S18/G**	**S19/D**	**S19/G**	
Cu	2.63	3.15	2.78	3.16	2.26	2.0	2.83	27.8	2.48	3.04	
Cc	0.86	0.81	0.90	0.81	0.92	0.82	0.91	0.16	0.92	1.32	
Thiès-Montrolland axis (Axis 5)											
Samples		**S20/D**	**S20/G**	**S21/D**	**S21/G**	**S22/D**	**S22/G**	**S23/D**	**S24/D**	**S24/G**	
Cu		69.23	5.76	16	5.84	9.04	25	15	8.07	12.5	
Cc		0.94	1.08	0.64	1.07	0.92	0.64	0.69	0.63	0.42	

the three axes are characterized by sands. So we are in the presence of poorly graded sands. While on the Thies-Pout and Thies-Montrolland axes Cu uniformity coefficient is greater than 4. **Figure 6** shows that the coefficient of curvature Cc is between 1 and 3. These two axes are characterized by gravelly therefore one is in the presence of well-graded gravel soils.

The Proctor modified test on sampled soils platform is performed according to the procedure of the French standard NF EN 13286-2 (February 2005) [6], and the results are presented in **Figure 7**.

The review of Proctor curves allow to establish **Table 2** showing the optimum water content and maximum dry volumetric weight.

Figure 8 and **Figure 9** show the variation of the optimum moisture content and maximum dry weight density following the five axis characteristics of the study.

Analysis of **Figure 8** and **Figure 9** shows that on the axle 1, the natural water content varies according to a maximum variation range ΔWn = 7.44%. With a maximum equal to 9.92%, these materials are sand and have a draining behavior resulting in a very low water holding capacity. While on the axis 2, the natural water content varies according to a maximum variation range ΔWn = 7.7%. With a maximum equal to 15.06%, these materials are gritty in nature. Therefore possess pores which can retain water. Note that on the axis 3 the maximum variation range is ΔWn = 1.76%. With a maximum equal to 2.12%, these low values of contents in natural water can be explained by the sandy nature of the samples on this axis and thus have a draining conduct. About the axis 4, the maximum change range is ΔWn = 4.69%. With a maximum equal to 5.36%, these low values of contents in natural water are related to the presence of sand having a draining conduct. And finally on the axis 5, there is as beach ΔWn = 13.49%. With a maximum equal to 15.59%, the natural water content values are explained by gritty nature of the samples. What made these samples be able to retain some moisture.

The CBR test is performed on the platform soils collected during the sampling campaign following the procedure of the NF P 94-078 standard. [7]. **Table 3** gives the CBR 95% of the Proctor optimum platform and corresponding class according to (CEBTP, 1984) for all the samples *in situ*.

Table 3 shows that on the axle 1, the CBR varies ΔCBR maximum variation range equal to 5.5%. With a maximum equal to 23%, the CBR values are explained by the presence of sand samples and not plastic. While on the shaft 2 there is a variation range between 9%, with a maximum equal to 41%. It is in the presence of laterite containing iron minerals, which results in an increase in the volume maximum dry weight and therefore the CBR. Note that the laterite is rich in iron minerals. Samples of axis 4 vary an 8% variation range with a maximum of 23 or less justified by the sandy nature of the samples on this axis. On the axis 5 the range of variation is 9% with a maximum equal to 54%. These materials are of gritty nature and little plastic; this plasticity may explain these CBR values. Note that the CBR values are greater on Thies-Montrolland and Thies Pout-axes. It is noted the presence of laterite samples from these two axes. Laterite has high mechanical properties compared to sand, while in the other three axes samples are composed mainly of sand guide CEBTP [8] defines the traffic classes and platform soils described in **Table 4**.

The Thies-Montrolland axis is not overstretched in terms of traffic can be classified into low traffic T_4 so the CBR values found allow the use of this material foundation layer and base layer of road structures on this axis. While Thies Pout-axis being very busy in circulation can be classified into T_1 heavy traffic, forcing the improvement of laterite for Montrolland to reach 98% to 100% of compactness using foundation layer and layer Base on this axis. When the Khombole-Thies axis with the presence of factory so opportunity truck output can be classified T_2 and the Thies-Tivaoune axis T_3 traffic. **Figure 10** shows the variation of the natural water content in the following five-axis characteristics of the study. **Figure 11** shows the variation of the optimum water content according to the five-axis characteristics of the study.

From **Figure 10** it is noted that the highest levels of natural water are observed in Thies-Montrolland and Thies-Pout axes. This is explained by the nature of laterite samples from these two axes, knowing that the laterite having pores can then maintain certain humidity. While samples are on—Thies Tivaoune axes; Thies-Noto and Thies-Khombole have lower water contents. This is explained by the sandy nature of the soil samples platform. When the optimum water content the opposite behavior is observed which is linked to the fact the materials that can retain some moisture will be absorbed water to achieve the optimum water content. **Figure 12** shows the weight of each type of soil encountered along the five axes characteristic of the study. As for **Figure 13**, it shows the different platform classes encountered the following five areas of study characteristics.

Note that the fine soil types A-3 are the most experienced (60%). Then come the A-2-6 type soils (25%) characterizing gravel and silty or clayey sands. It is the same as A-2-4 type soils (9%). Soil type A-1-b (2%),

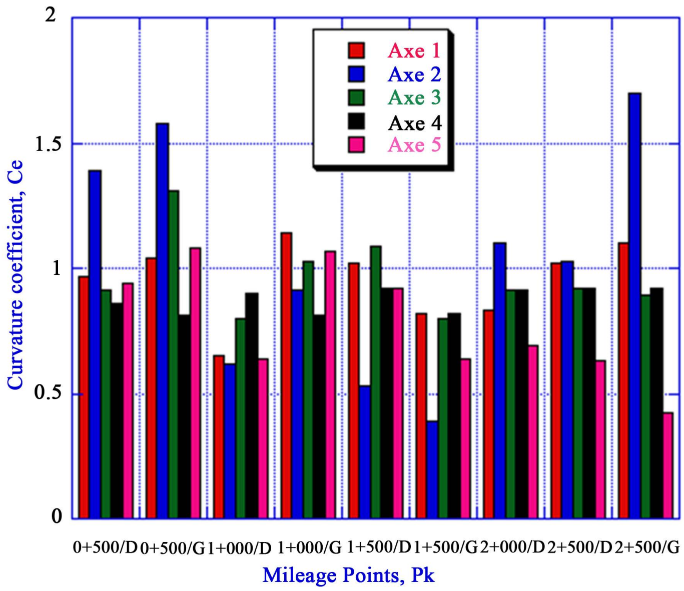


Figure 6. Variation of curvature coefficient along five roads.

Table 2. Maximum dry unit weight and water content of natural Platform soils in the region of Thies.

Thiès-Pout axis (Axis 2)											
Samples			**S5/D**	**S5/G**	**S6/Dh1**	**S6/Dh2**	**S6/Dh3**	**S6/Gh1**	**S6/Gh2**		
Wopt (%)			8.46	10.3	14.14	13.25	9.87	12.11	12.33		
γdmax (kN/m^3)			20.1	21	19	20.2	20.0	19.8	19.4		
Wn (%)			5.4	7.73	2.9	8.19	6.45	8.66	7.42		
Samples			**S7/Dh1**	**S7/Dh2**	**S7/Dh3**	**S7/G**	**S8/D**	**S8/G**	**S9/D**		
Wopt (%)			9.58	10.06	11.56	13.90	12.28	12.11	10.13		
γdmax (kN/m^3)			20.04	20.3	19.3	20.7	19.1	19.2	19.6		
Wn (%)			2.55	7.93	8.67	7	5.06	5.94	10.2		
Thiès-Tivaoune axis (Axis 1)											
Samples	**S0/D**	**S0/G**	**S1/D**	**S1/G**	**S2/D**	**S2/Gh1**	**S2/Gh2**	**S3/D**	**S3/G**	**S4/D**	
Wopt (%)	13.64	14.68	13.9	12.49	12.36	14.16	13.64	12.61	13.12	12.87	
γdmax (kN/m^3)	16.9	16.2	16.6	16.9	16.9	17.3	17.78	17	16.1	17.20	
Wn (%)	4.08	8.19	6.87	9.92	2.48	2.87	7.31	6.91	7.24	3.84	
Thiès-Khombole axis (Axis 3)											
Samples	**S10/D**	**S10/G**	**S11/Dh1**	**S11/Dh2**	**S11/G**	**S12/D**	**S12/G**	**S13/Dh1**	**S13/Dh2**	**S13/G**	**S14/D**
Wopt (%)	13.38	12.61	14.16	14.16	13.12	13.90	13.33	14.31	13.38	13.82	11.86
γdmax (kN/m^3)	17.42	16.20	17.1	17.2	16.70	17	17.2	17	17.4	16.40	17.36
Wn (%)	2.12	1.35	0.36	0.42	0.69	0.45	0.65	1.19	0.75	0.67	0.38
Thiès-Noto axis (Axis 4)											
Samples	**S15/D**	**S15/G**	**S16/D**	**S16/G**	**S17/D**	**S17/G**	**S18/D**	**S18/G**	**S19/D**	**S19/G**	
Wopt (%)	13.90	13.38	14.42	13.9	13.90	12.11	14.94	11.36	13.12	14.16	
γdmax (kN/m^3)	16.9	17.20	17.30	17.70	17.20	17	17	17.69	17.5	16.40	
Wn (%)	5.36	3.4	1.84	1.84	3.84	4.84	0.81	0.67	0.76	0.86	
Thiès-Montrolland axis (Axis 5)											
Samples		**S20/D**	**S20/G**	**S21/D**	**S21/G**	**S22/D**	**S22/G**	**S23/D**	**S24/D**	**S24/G**	
Wopt (%)		10.38	11.82	11.11	11.61	9.65	9.89	10.38	9.41	8.70	
γdmax (kN/m^3)		21.78	21.4	20.5	20.10	21.92	20.70	22.05	21.97	20.10	
Wn (%)		3.13	5.59	2.13	9.21	6.55	3.36	2.75	4.19	10	

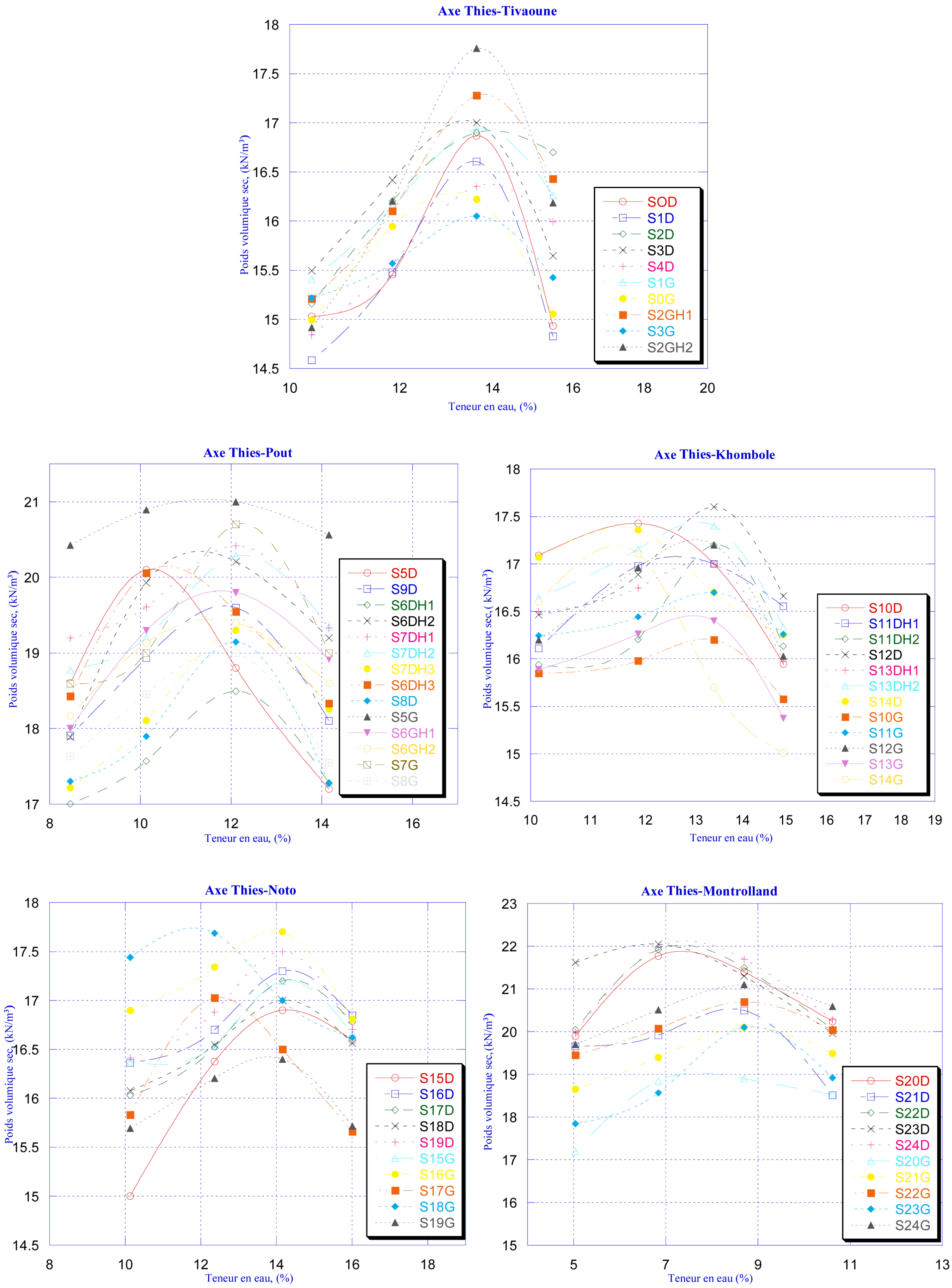


Figure 7. Proctor curves subgrade soil samples on five axes features of Thies (Thies-Tivaoune axis; Thies-Pout axis; Thies-Khombole axis; Thies-Noto axis et Thies-Montrolland axis).

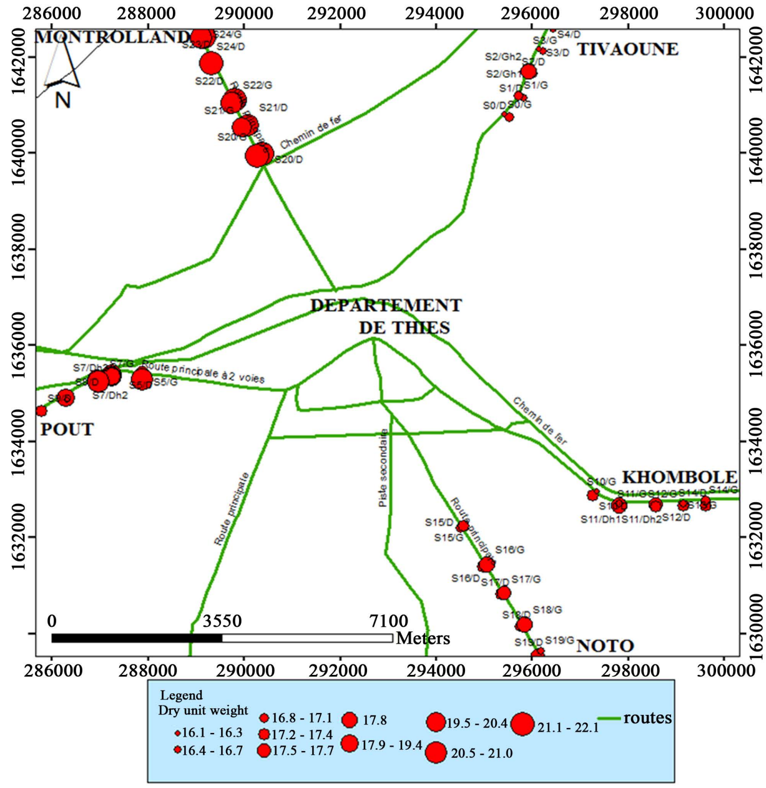


Figure 8. Dry unit weight variation after the five axes features on left bank and right.

Table 3. CBR and soil class platform in the region of Thies.

Thiès-Pout axis (Axis 2)											
Samples			S5/D	S5/G	S6/Dh1	S6/Dh2	S6/Dh3	S6/Gh1	S6/Gh2		
CBR			33	39	32	34	39	38	36		
Class platform			S5	S5	S5	S4	S5	S5	S5		
Samples			S7/Dh1	S7/Dh2	S7/Dh3	S7/G	S8/D	S8/G	S9/D		
CBR			42	37	36	41	34	40	37		
Class platform			S5	S5	S5	S5	S4	S5	S5		
Thiès-Tivaoune axis (Axis 1)											
Samples	**S0/D**	**S0/G**	**S1/D**	**S1/G**	**S2/D**	**S2/Gh1**	**S2/Gh2**	**S3/D**	**S3/G**	**S4/D**	
CBR	21	19	23	21	23	20	23,5	22	18	22	
Class platform	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	
Thiès-Khombole axis (Axis 3)											
Samples	**S10/D**	**S10/G**	**S11/Dh1**	**S11/Dh2**	**S11/G**	**S12/D**	**S12/G**	**S13/Dh1**	**S13/Dh2**	**S13/G**	**S14/D**
CBR	22	17	19	21	19	22	22	23	24	17	24
Class platform	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4
Thiès-Noto axis (Axis 4)											
Samples	**S15/D**	**S15/G**	**S16/D**	**S16/G**	**S17/D**	**S17/G**	**S18/D**	**S18/G**	**S19/D**	**S19/G**	
CBR	20	23	25	27	19	21	22	24	22,5	19	
Class platform	S4	S4	S4	S4	S4	S4	S4	S4	S4	S4	
Thiès-Montrolland axis (Axis 5)											
Samples		**S20/D**	**S20/G**	**S21/D**	**S21/G**	**S22/D**	**S22/G**	**S23/D**	**S24/D**	**S24/G**	
CBR		53	39	52	37	36	58	36	41	40,5	
Class platform		S5	S5	S5	S5	S5	S5	S5	S5	S5	

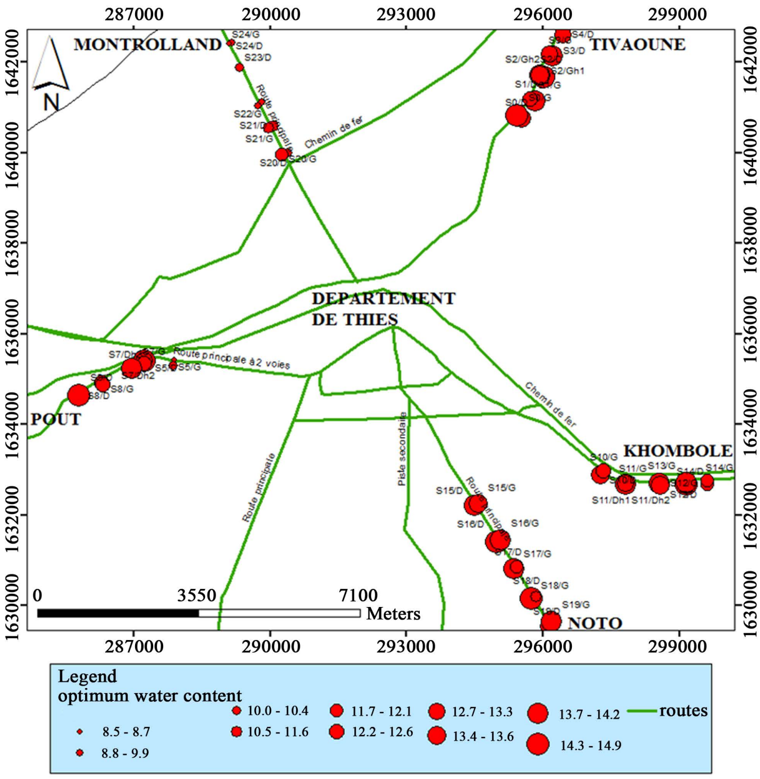


Figure 9. Change in optimum water content according to the five-axis features on left bank and right.

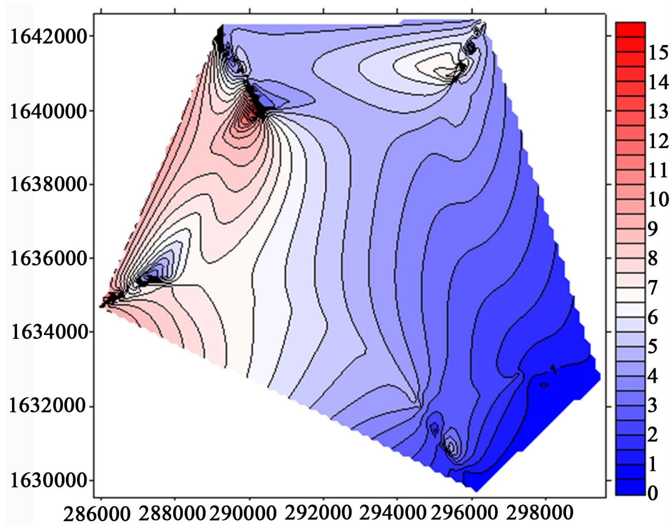


Figure 10. Variation of the natural water content Wn for the five characteristics axes.

Table 4. Classes' traffic and platform (CEBTP, 1982, in Ba, 2008) [9].

Traffic class	N équivalant PL CEBTP	Equivalent Traffic véhicule/jour	Subgrade class CEBTP	
T_0	$<5 \times 10^5$	<300	CBR < 5	S_1
T_1	De 5 10^5 à 1.5×10^6	de 300 à 1000	5 < CBR < 10	S_2
T_2	de 1,5 10^6 à 4×10^6	de 1000 à 3000	10 < CBR < 15	S_3
T_3	de 4 10^6 à 10^7	de 3000 à 6000	15 < CBR < 30	S_4
T_4	de 10^7 à 2×10^7	de 6000 à 12000	CBR > 30	S_5

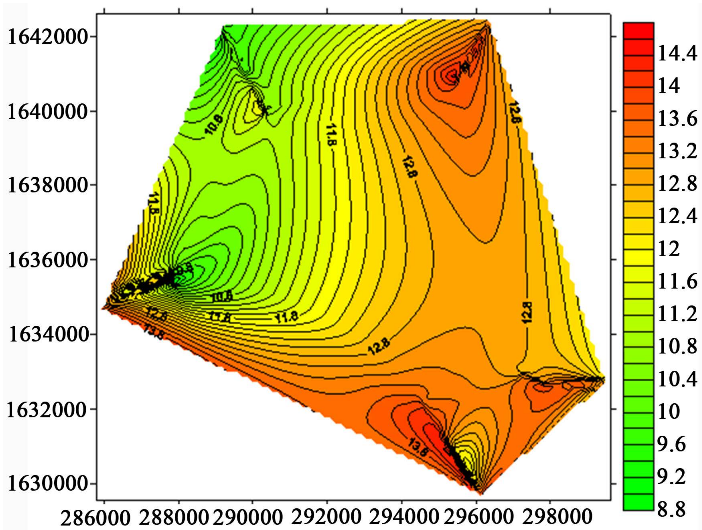


Figure 11. Variation of the optimum water content Wopt, for all five axes.

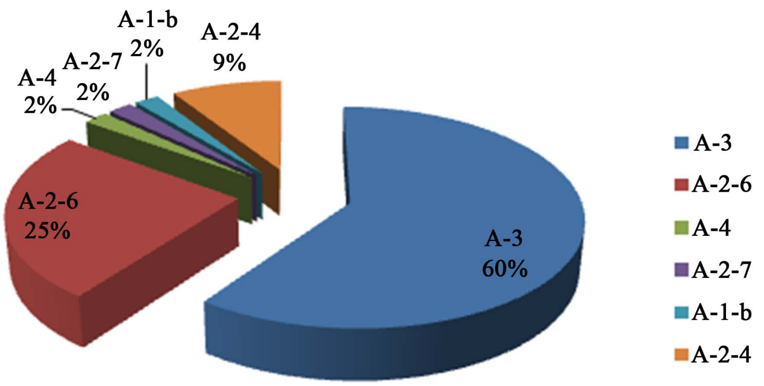


Figure 12. Distribution by type of subgrade in AASHTO system on five axes.

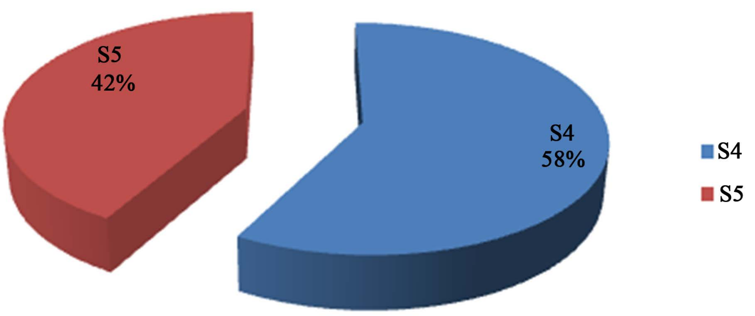


Figure 13. Distribution of subgrade class on five axes.

features fragments of rock, sand and gravel, are also present. Their performance is better in road infrastructure as other types of soils mentioned above. And, finally, soils encountered types A-2-7 and A-4 with lower percentages, of the order of 2%. It is noticed that for the most different roads of the study, soils are in place platform class S4 (58%), followed by soil class S5 (42%). Sampled platform floors are mostly made up of SP soil type (51%) then comes the SP-SC soils (20%). **Figure 14** shows the sampled subgrade soils are mostly made up of SP soil type (51%) then come the SP-SC soils (20%).

Atterberg limits on the samples are performed according to the procedure of the French standard NF P 94-051 (March, 1993) [10], and the results are shown in **Figure 15**.

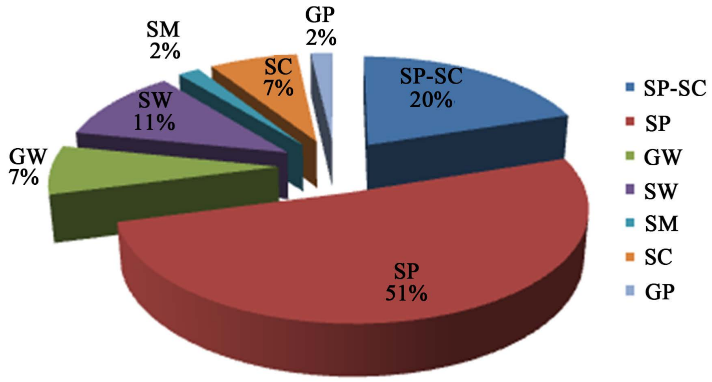


Figure 14. Distribution by type of subgrade in USCS system on five axes.

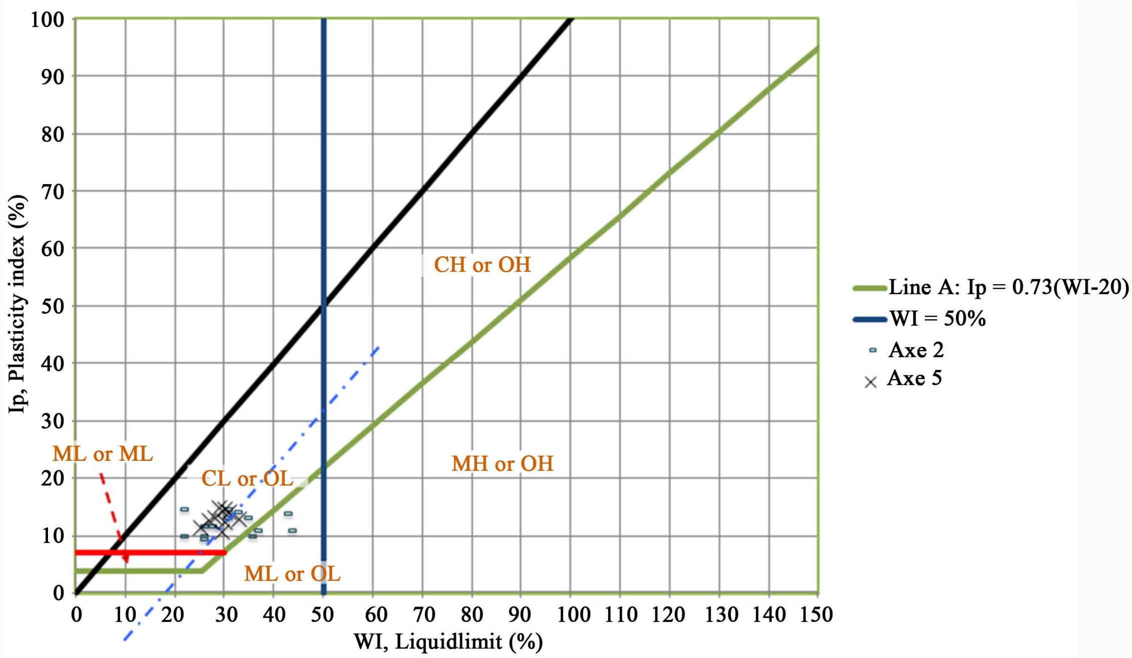


Figure 15. Land positions in place in the diagram Casagrande.

Figure 13 shows that the samples Thies-Montrolland axis lie above line A, the plasticity is of clay origin (CL or CH group), while the soil samples of Thies-Pout axis are shared by side of line A thus belong to ML or OL and CL or OL groups but the trend is particularly facing CL or OL group. All this confirms the nature of the soil Thies-Pout and Thies-Montrolland axes, highlighting the presence of laterite materials with high plasticity.

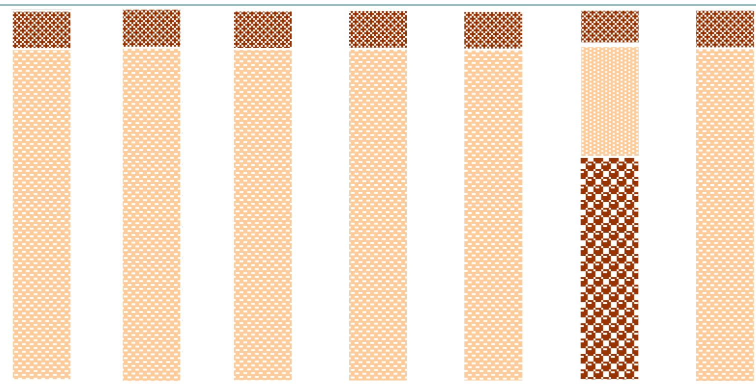
Table 5 gives the GPS coordinates, and the geotechnical profiles for all investigated axes.

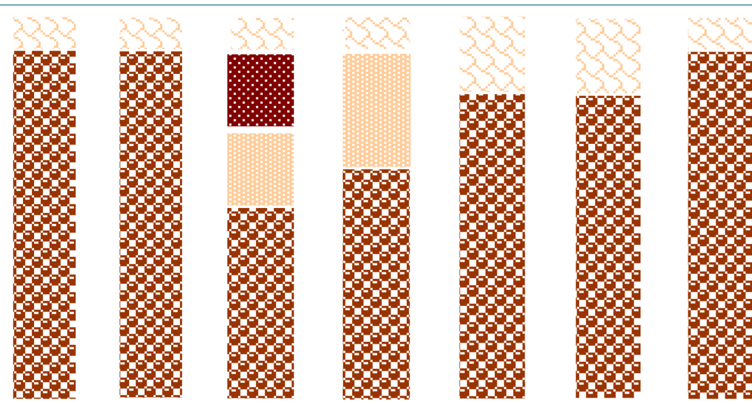
4.3. Log Stratigraphic and Classification in AASHTO System of Subgrade Soil

The study of soils cuts represent different sampling points in the tables below. After conducting laboratory tests, we used the results of the test particle size analysis and Atterberg limits to classify soil samples in the classification system (AASHTO, 1929, in Robitaille *et al.*, 1997) [11]. The following tables provided soils cuts at the different sampling point.

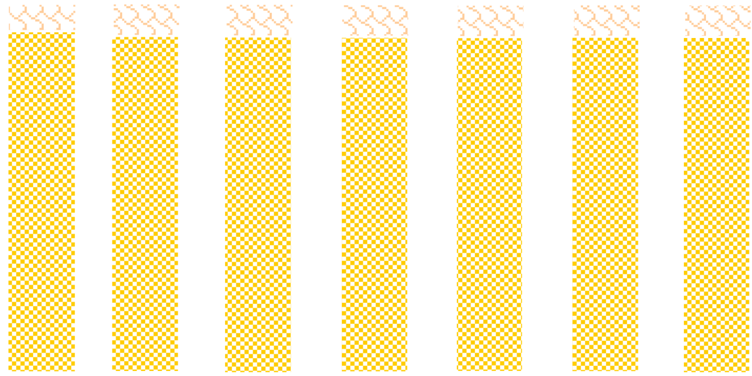
It may be observed on these soils cuts that Thies-Tivaoune, Thies Khombole and Thies-Noto axes consist mainly of sand while Thies Pout-axis is composed of laterite and lateritic sand, finally the Thies-Khombole axis laterite which confirms the results of preliminary studies drawn from maps (morpho soil, surface and geotechnical formations).

Table 5. Log stratigraphic of subgrade soil.

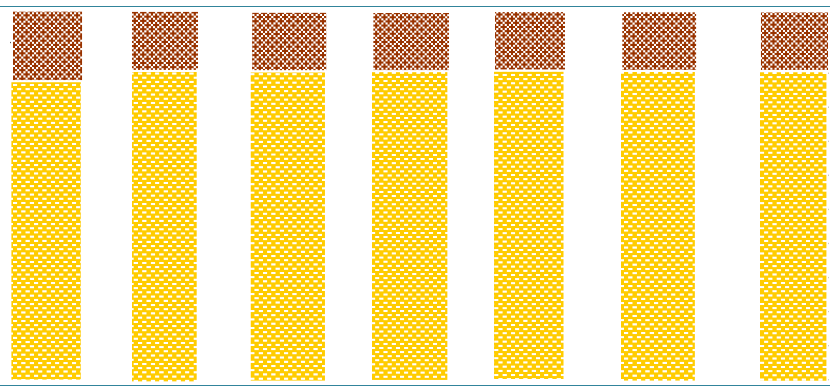
	Pk	S0	S0	S1	S1	S2	S2	S3
Designation	**N^0**	500 + 50/G	500 + 50/D	1000 + 50/G	1000 + 50/D	1500 + 50/D	1500 + 50/G	2000 + 50/D
	X	0295531	0295426	0295824	0295717	0296018	0295929	0296215
	Y	1640754	1640825	1641153	1641196	1641675	1641707	1642132
Log stratigraphic 	**0.10**							
	0.20							
	0.30							
	0.40							
	0.50							
	0.60							
	0.70							
	0.80							
	0.90							
	1.00							
Geotechnical profile	**% < 80 µm**	5.9	0.4	7.5	4.1	2.8	0.2	3.7
	Ip (%)	< 6	< 6	< 6	< 6	< 6	< 6	< 6
	AASTHO Classification	A-3	A-3	A-3	A-3	A-3	A-3	A-3
	γ_{dOPM}	16.20	16.90	16.90	16.6	16.9	17.3	17
	W_{OPM} (%)	14.68	13.64	12.49	13.90	12.36	14.16	12.61
	CBR 95% of OPM	19	21	21	23	23	20	22
	Classe platform	S4	S4	S4	S4	S4	S4	S4

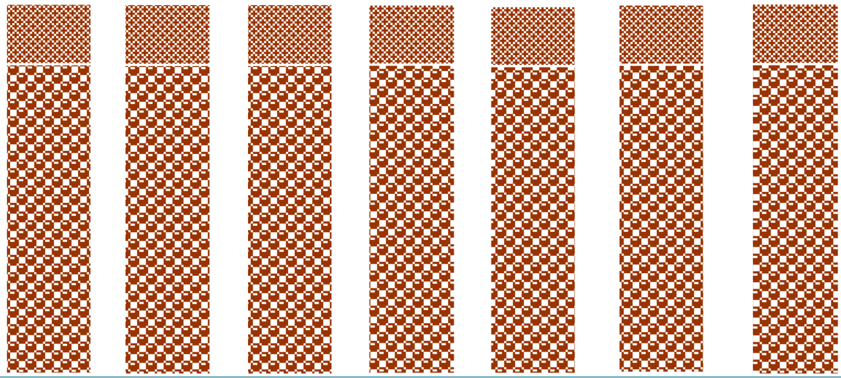
	Pk	S5	S5	S6	S6	S7	S7	S8
Designation	**N^0**	500 + 30/D	500 + 30/G	1000 + 20/D	1000 + 20/G	1500 + 20/D	1500 + 20/G	2000 + 20/D
	X	0287886	0287874	0287236	0287240	0286940	0286965	0286299
	Y	1635428	1635295	1635409	1635352	1635292	1635244	1634921
Log stratigraphic 	**0.10**							
	0.20							
	0.30							
	0.40							
	0.50							
	0.60							
	0.70							
	0.80							
	0.90							
	1.00							
Geotechnical profile	**% < 80 µm**	7.2	7.2	4.2	0.5	1.8	0.5	1.9
	Ip (%)	14.77	10.3	9.7	11.9	13.2	14.70	11
	AASTHO Classification	A-3	A-2-7	A-2-4	A-2-6	A-2-6	A-2-6	A-3
	γ_{dOPM}	20.1	21	19	19.8	20.3	20.7	19.1
	W_{OPM} (%)	8.46	10.13	14.14	12.11	10.06	13.90	12.28
	CBR 95% of OPM	33	39	32	34	37	41	34
	Class platform	S5	S5	S5	S5	S5	S5	S5

Designation	**Pk**	**S10**	**S10**	**S11**	**S11**	**S12**	**S12**	**S13**
	N⁰	500 + 50/D	500 + 50/G	1000 + 50/D	1000 + 50/G	1500 + 10/D	1500 + 10/G	2000 + 9/D
	X	0297261	0297336	0297812	0297818	0298571	0298576	0299147
	Y	1632888	1632970	1632673	1632704	1632653	1632688	1632678
Log stratigraphic	**0.10**							
	0.20							
	0.30							
	0.40							
	0.50							
	0.60							
	0.70							
	0.80							
	0.90							
	1.00							
Geotechnical profile	**% < 80 µm**	3.3	0.2	1.2	1.8	0.5	0.6	0.5
	Ip (%)	<6	<6	<6	<6	<6	<6	<6
	AASTHO Classification	A-3	A-3	A-3	A-3	A-2-4	A-3	A-3
	γ_{dOPM}	17.42	16.20	17.1	16.7	17	17.20	17
	W_{OPM} (%)	13.38	12.61	14.16	13.12	13.90	13.33	14.31
	CBR 95% of OPM	22	17	19	19	22	22	23
	Class platform	S4	S4	S4	S4	S4	S4	S4



Designation	**Pk**	S15	S15	S16	S16	S17	S17	S18
	N⁰	500 + 40/D	500 + 40/G	1000 + 50/D	1000 + 50/G	1500 + 50/D	1500 + 50/G	2000 + 50/D
	X	0294505	0294581	0294972	0295067	0295357	0295424	0295743
	Y	1632199	1632247	1631395	1631444	1630817	1630855	1630150
Log stratigraphic	**0.10**							
	0.20							
	0.30							
	0.40							
	0.50							
	0.60							
	0.70							
	0.80							
	0.90							
	1.00							
Geotechnical profile	**% < 80 µm**	3.5	4.6	5.6	3.9	4.8	0.5	0.9
	Ip (%)	<6	<6	<6	<6	<6	<6	<6
	AASTHO Classification	A-3	A-3	A-3	A-3	A-3	A-3	A-3
	γ_{dOPM}	16.9	17.20	17.3	17.7	17.2	17	17
	W_{OPM} (%)	13.9	13.38	14.42	13.9	13.90	12.11	14.94
	CBR 95% of OPM	20	23	25	27	19	21	22
	Classe platform	S4	S4	S4	S4	S4	S4	S4



Designation	**Pk**	**S20**	**S20**	**S21**	**S21**	**S22**	**S22**	**S23**
	N^0	500 + 50/D	500 + 50/G	1000 + 50/D	1000 + 50/G	1500 + 50/D	1500 + 50/G	1500 + 50/D
	X	0290378	0290265	0290080	0289958	0289814	0289741	0289741
	Y	1639997	1639948	1640590	160548	1641120	1641047	1641047
Log stratigraphic	**0.10**							
	0.20							
	0.30							
	0.40							
	0.50							
	0.60							
	0.70							
	0.80							
	0.90							
	1.00							
Geotechnical profile	**% < 80 µm**	0.7	1.8	3.2	1.1	4.8	0.6	1.9
	Wl (%)	31	29.5	29	25	28	27	33
	Ip (%)	14.2	10.7	14.99	11.5	13.2	12.7	14.80
	AASTHO Classification	A-2-6	A-3	A-2-6	A-3	A-2-6	A-2-6	A-2-6
	γ_{dOPM}	21.78	21.4	20.5	20.10	21.92	20.7	22.05
	W_{OPM} (%)	10.38	11.82	11.11	11.61	9.65	9.89	10.38
	CBR 95% of OPM	53	39	52	37	36	58	36
	Class platform	S5	S5	S5	S5	S3	S5	S5

Legend: : Topsoil; : Sand; : Laterite; : Sable; : Sand; : Topsoil.

5. Conclusion

The results for all tests on five (05) axes reveal the following important points: The highest altitudes are noted on the Thies-Pout and Thies-Montrolland axes and three axes show the lowest altitudes. From the viewpoint of particle size allowed, the Thies-Tivaoune, Thies-Khombole and Thies-Noto axes are characterized by tight sands, poorly graded size. While Thies Pout-axis is characteristic of severe solid particle size and spread well graded and serious to spread and well graded particle size. At last the Thies-Montrolland axis is characterized by severe to very tight particle size and graduated to spread and serious and well graded particle size. Soils in place are mostly lateritic or similar materials and it corroborates initial information from maps (morpho soil, surface and geotechnical formations). The Thies-Montrolland axis lies above line A, and the plasticity is of clay origin (CL or CH group), while the soil samples of Thies Pout-axis are divided on either side of A line so belong to the ML or OL and CL or OL groups. Also, lateritic materials sampled on the axis Thies-Montrolland show CBR and maximum volume and dry weight (max γd) highest and best water contents (Wopt.) Lower. The Thies-Montrolland axis is not overstretched in terms of traffic that may be classified into low traffic T_4 so the CBR values found allow the use of this material foundation layer and base layer of road structures on this axis. While Thies Pout-axis being very busy in circulation can be classified into T_1 heavy traffic, forcing the improvement of laterite Montrolland to reach 98% to 100% of compactness using foundation layer and layer base on this axis. When the Thies-Khombole axis with the presence of factory so opportunity for truck output can be classified T_2 and lastly, the Thies-Tivaoune axis T3 traffic. This recognition of the soil up allowed the classification of soils in the AASHTO system subject to the standard (ASTM, 1992). And so, it is noted that the platform soils covering our fields of study consist of 60% of fine soils (A-3), 25% gravel and silty or clayey sands A-2-6, 9% soil types A-2-4 (characterizing gravel and silty or clayey sands). In sum considering the same wave length of 2% of soil type A-2-7, A-1-b and A-4, fine soils types A-3 that are most predominantly met, have a better performance in road infrastructure (Robitaille *et al.*, 1997). We also meet 58% of S_4 platform floors class, 42% of S_5 class soils.

References

[1] SETRA (2009) Apport du drainage dans la conception des plateformes supports de chaussées. Ministère de l'Écologie, de l'Énergie, du Développement Durable et de l'Aménagement du Territoire, 10 p.

[2] LCPC-SETRA (1994) Conception et dimensionnement des structures de chaussées: Guide technique.

[3] Babilotte, C. and de Lyon, C.S.C. (1994) Dimensionnement des structures de chaussées communautaires du Grand LYON: Guide technique communautaire. Parution initiale en, 85 p.

[4] Norme Française NF P 94-056 (1996) Sol: Reconnaissance et essais Analyse Granulométrique Méthode par tamisage à sec après lavage. Norme Française, 16.

[5] Norme Française XP P 94-011 (1999) Sols: Reconnaissance et essais, Description-Identification-Dénomination des sols, 24 p.

[6] Norme Française NF P 94-093 (1999) Sol: Reconnaissance et essais Détermination des références de compactage d'un matériau. Norme Française, 18 p.

[7] Norme Française NF P 94-078 (1997) Sol: Reconnaissance et essais CBR après immersion-indice CBR Immédiat-Indice portant immédiat. Norme Française, 12.

[8] CEBTP (1984) Guide Pratique de Dimensionnement des chaussées pour les pays Tropicaux, 155 p.

[9] Ba, M. (2012) Comportement Mécanique sous Sollicitations Cycliques de Granulats Quartzitiques de Backel-Comparaison avec des Matériaux de Référence du Sénégal et d'Amérique (USA): Application au Dimensionnement Mécanistique des Chaussées Souples. Thèse de Doctorat Université Cheikh Anta Diop de Dakar, 239.

[10] Norme Française NF P 94-051 (1993) Détermination des limites d'Atterberg: Limite de liquidité à la coupelle, limite de plasticité au rouleau, 16 p.

[11] Robitaille, *et al.* (1997) Mécanique des sols théorie et pratique. 647 p.