

Physico-Chemical and Mechanical Characterization of Dam Sediments in Burkina Faso for Application in Road Geotechnics: Case of Three Hydraulically Connected Sites

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How to cite this paper: Ouedraogo, A.A.T., Kabore, W.I.E., Namouniara, K., Ouedraogo, S. and Naon, B. (2026) Physico-Chemical and Mechanical Characterization of Dam Sediments in Burkina Faso for Application in Road Geotechnics: Case of Three Hydraulically Connected Sites. *Open Journal of Applied Sciences*, **16**, 2336-2360.

<https://doi.org/10.4236/ojapps.2026.167133>

Received: June 2, 2026

Accepted: July 10, 2026

Published: July 13, 2026

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Abstract

This study falls within the framework of promoting alternative materials in road geotechnics. Its objective is to characterize dam sediments, identified as alternative materials in terms of their physico-chemical and mechanical properties, for road applications. To this end, a sample collection campaign was conducted at three hydraulically connected sites in the city of Ouagadougou, Burkina Faso. The results of the analyses show varying physico-chemical characteristics depending on the sampling points. The sediments generally consist of clay, sand, and silt in their particle size distribution, with a small and variable gravel fraction depending on the excavation points. The maximum diameter reaches 25 mm in excavation pits A7 and C4 of the stream and dam No. 2, respectively. In these sites, the sediments are “non-plastic or slightly plastic”, with a pH ranging from acidic to alkaline. From a mechanical standpoint, the excavation pits from the stream (A5, A7) and dam No. 1 and 2 (B4 and C4) show favorable bearing capacity at 98% compaction ($I.CBR \geq 25$), for use both as a subgrade layer and as a foundation layer of pavement. Their low linear swelling reflects the insensitivity of the constituent layers of these excavation pits to water. Those with an $I.CBR$ between 5 and 15 (A3, A9, A1, A2, A4, A6, B1, B5, B6, B7, B8, B9, C1, C5, C6, and C9) are suitable only for subgrade layers, with any necessary correction of the fine fraction before implementation, according to CEBTP recommendations. Similarly, excavation pits A8, B2, B3, C2 and C3 ($I.CBR < 5$) also require possible improvement in order to meet CEBTP requirements.

Keywords

Physico-Chemical and Mechanical Properties, Dam Sediments, Alternative Materials, Road Geotechnics

1. Introduction

The accumulation of sediment at the bottom of hydraulic structures [1] [2], such as dams, is a current national and international issue for the efficient management of water resources. In addition to the effects of erosion, this problem is also exacerbated by human activities [1] [2], carried out on the banks of these structures during the dry season. Faced with this problem, dredging operations are often essential to mitigate the risk of flooding and promote the sustainable management of water infrastructure. This issue remains particularly relevant in Burkina Faso [3]-[8], where recent dam dredging initiatives demonstrate the importance placed on restoring the water storage capacity of dams to contribute to strengthening agricultural, pastoral, and fishing activities.

From a sustainable development and environmental protection perspective, in the face of climate change, sediment management cannot be limited to its extraction. It is also necessary to consider its potential uses. Thus, faced with the high consumption of natural materials in civil engineering and the difficulty of accessing these resources in certain areas, public stakeholders and the scientific community are increasingly focusing on research into alternative materials that can meet the growing needs of the construction sector.

Several research studies have been dedicated to the valorization of sediments in various civil engineering applications [2] [9] [10]-[12]. One of the most advanced applications from an experimental standpoint concerns road construction [1] [13]-[21]. Related applications include aggregates [12] [22] [23], brickmaking [24]-[27], cement-based materials [2] [28]-[32], and so on. Despite advances in research in this field, knowledge regarding the characteristics of dam sediments in Burkina Faso remains limited. Available data are still insufficient to assess their suitability for use in road construction, particularly in the case of dams originating from the same hydraulic system. The study of hydraulically interconnected sites is of particular interest, however, as hydrological interactions and sediment transport processes can influence the nature and properties of the deposits accumulated in these reservoirs.

This work focuses on three hydraulically connected sites located in the city of Ouagadougou, Burkina Faso. The objective of the study is to characterize the physico-chemical and mechanical properties of the sediments sampled from these three hydraulically interconnected sites in order to assess their suitability for use in road geotechnics. Thus, this research aims to answer the following question: do the collected sediments possess sufficient characteristics for use in road construction? The hypothesis is that these extracted materials possess acceptable proper-

ties allowing their use in pavement layers, in accordance with current regulations. The results of this research will contribute to a better understanding of dam sediments in Burkina Faso and to the identification of new alternative resources for road construction.

2. Materials and Methods

The study carried out is intended to be experimental for an evaluation of the physico-chemical and mechanical properties of sediments for use in road geotechnics. The framework of the study is as shown in **Figure 1** below:

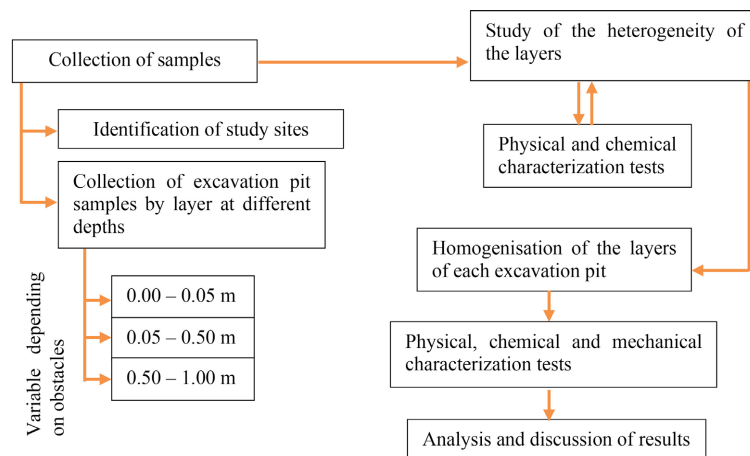


Figure 1. Study framework.

2.1. Materials Used

2.1.1. Sediments

The sedimentary materials used in this study come from three (03) sites in Burkina Faso, precisely in the province of Kadiogo. These are the sediments from:

- Stream, at the geographical coordinates 12°22'44.20" north latitude and 1°34'38.80" west longitude;
- dam No. 1, at the geographical coordinates 12°22'53.48" north latitude and 1°33'51.35" west longitude;
- dam No. 2, at geographic coordinates 12°23'21.35" north latitude and 1°32'4.97" west longitude.

These three sites are hydraulically interconnected and are located in the city of Ouagadougou. Thus, the sampling process was carried out according to the requirements of standard XP P 94-202 [33], through the execution of excavations of 1 m² sections and at various depths. **Figure 2**, illustrates the execution of the excavations carried out in the study sites in order to take the samples. The depths of the sampling layers of the excavation pits are generally from 0 to 5 cm, 5 cm to 50 cm and 50 cm to 1 m, with the exception of excavations marked by certain observed constraints (the presence of rocks, water, grass, etc.).

The sampling campaigns were conducted during the dry season in April 2024. Only one sampling campaign was carried out at each site. This period was chosen

to ensure accessibility to the sampling areas and to obtain sediments representative of the depositional conditions. It should be noted, however, that certain properties of the sediments, particularly their water and organic matter content, can exhibit seasonal variations linked to hydrological conditions and human activities.



Figure 2. Process for collecting sediments from sites.

2.1.2. Auxiliary Materials and Reagents Used

As part of the experimental study, reagents are used for lab analyses. These include water (current and distilled) complying with standards NF EN 1008 [34] et NF EN ISO 3696 [35], as well as chemical reagents such as methylene blue and potassium dichromate, the manufacture of which is governed respectively by standard NF EN ISO 6353-2 [36] et NF P 94-055 [37].

2.2. Methods Used

2.2.1. Sample Preparation

The preparation of the samples before the analysis was carried out in several stages. **Figure 3** describes the process carried out. This first step consists of drying the wet sediments in the open air on polyethylene film in order to eliminate the water and remedy any deterioration in the characteristics of the samples during the storage phase. The dried samples are then stored in sampling bags, after reducing the aggregated clumps. The assembly is well labeled according to the provisions of standard XP P 94-202 [33], for quick and easy identification of samples during lab tests.



Figure 3. Preparation of sediment samples.

2.2.2. Characterization Method

a. Characterization of layer variability and homogenization

The sediments studied are subjected to physical and chemical characterization tests for an analysis of their properties for the constitution of the mixture representative of each excavation pit of the sites. This mixture also underwent secondary characterization to determine its physical and chemical properties before mechanical characterization tests. Thus, the characteristics evaluated include:

- the composition of the particle size fractions and the D_{max} by the particle size analysis test [38] [39];
- the natural water content in accordance with standard NF P 94-050 [40];
- the bulk and absolute density according to standard NF P 94-053 et NF P 94-054 [41] [42];
- the plasticity through the determination of Atterberg limits according to standard NF P 94-051 [43];
- the methylene blue adsorption capacity of sediments according to standard NF P 94-068 [44];
- the organic matter content in accordance with standard NF P 94-055 [37];
- the hydrogen potential following the requirements of standard NF ISO 10390 [45];

The identification parameters highlight a variability of sediment characteristics in the excavation layers. Thus, this approach makes it possible to identify the critical threshold of organic matter for use on roads according to the CEBTP (OM < 3% and 2%, respectively for platform and foundation layer) and the GTR (OM < 3%) [46]-[48], such as illustrated in **Table 1**. The organic matter content retained in the present study must not exceed 2% in accordance with the CEBTP in the local context.

Table 1. Organic matter content of the sites of the stream and dam No. 1 and No. 2.

Stream				Dam No. 1				Dam No. 2			
Excavation	1Co	2Co	3Co	Excavation	1Co	2Co	3Co	Excavation	1Co	2Co	3Co
A1	3.07	1.22	0.55	B1	3.15	0.87		C1	3.14	0.59	0.43
A2	3.01	0.80		B2	3.15	0.93	0.50	C2	3.57	0.39	0.27
A3	3.09	0.83	0.48	B3	3.20	0.22	0.24	C3	3.15	0.70	0.53
A4	3.08	1.36	1.13	B4	3.11	0.95	0.38	C4	3.01	0.84	
A5	3.02	0.95	0.50	B5	3.12	1.15	0.47	C5	3.02	0.94	0.77
A6	3.05	0.78	0.41	B6	3.14	0.81	0.55	C6	3.46	0.96	0.76
A7	3.08	0.65	0.52	B7	3.50	1.86	0.25	C7	3.52		
A8	3.03	1.82	1.17	B8	3.50	0.36	0.18	C8	3.55		
A9	3.11	0.90	0.67	B9	3.12	0.34		C9	3.10	0.87	0.44

Abbreviation: 1Co: first layer; 2Co: second layer; 3Co: third layer.

Table 1 highlights the fact that the surface layers of the sites of the stream and dam no. 1 and no. 2, contain quantities of organic matter exceeding the defined threshold. These sediment layers, which do not comply with the geotechnical requirements for organic matter according to the CEBTP, are excluded from the formulation of the mixture of the excavation pit layers for the mechanical characterization.

▪ **Composition of representative mixtures**

After excluding the first layers with an organic matter content exceeding 2%, the layers were homogenized. A representative mixture from each excavation was prepared, using equal proportions of the dry mass of each layer. **Table 2** shows the composition of the formulated mixtures from each site.

Table 2. Composition of representative mixtures from each site.

Stream		Dam No. 1		Dam No. 2	
Excavation	Mixing	Excavation	Mixing	Excavation	Mixing
A1	2Co + 3Co	B1	2Co	C1	2Co + 3Co
A2	2Co	B2	2Co + 3Co	C2	2Co + 3Co
A3	2Co + 3Co	B3	2Co + 3Co	C3	2Co + 3Co
A4	2Co + 3Co	B4	2Co + 3Co	C4	2Co
A5	2Co + 3Co	B5	2Co + 3Co	C5	2Co + 3Co
A6	2Co + 3Co	B6	2Co + 3Co	C6	2Co + 3Co
A7	2Co + 3Co	B7	2Co + 3Co	C7	Nothing
A8	2Co + 3Co	B8	2Co + 3Co	C8	Nothing
A9	2Co + 3Co	B9	2Co	C9	2Co + 3Co
Total mixture	9	Total mixture	9	Total mixture	7

Abbreviation: 2Co: second layer; 3Co: third layer.

In **Table 2**, the second layers of excavations A2, B1, B9, and C4 are used as representative samples. Indeed, two sampling layers were carried out at these excavations due to environmental constraints (presence of water, armor plating, etc.). Thus, with the first layer excluded, the second layers were used as a representative sample for these excavations. The absence of a representative mixture in excavations C7 and C8 is explained by the following reasons:

- the presence of water and waste in the environment during sampling, which did not facilitate their use (field observation);
- only one sampling layer was carried out to confirm the field observation (presence of organic matter) through lab testing;
- their high proportion of organic matter (greater than 2%) at the end of lab tests.

In the end, the physico-chemical and mechanical tests of the representative mixtures were carried out on:

- 9 samples for the stream;
- 9 samples for dam no. 1;
- 7 samples for dam no. 2.

b. Mechanical characterization

Mechanical characterization involves evaluating the compaction and bearing capacity properties of sediments. This determination was carried out in accordance with the requirements of standards NF P 94-078 [49] and NF 94-093 [50].

3. Results

The results presented in the following paragraphs concern the characteristics of representative mixtures from each site excavation. These are the mixtures of the sedimentary layers carried out after the identification of the critical threshold of organic matter. For better analysis of the results, the samples are labeled as follows:

- A1 to A9, for representative mixtures of the sedimentary layers from the excavations in the stream;
- B1 to B9, for representative mixtures of the sedimentary layers from the excavations at dam No. 1;
- C1 to C9, for representative mixtures of the sedimentary layers from the excavations at dam No. 2.

3.1. Physico-Chemical Properties

3.1.1. Physico-Chemical Properties of Excavations in the Stream

Table 3 presents the physico-chemical properties of the sediments evaluated after lab tests.

The results obtained show that the stream is characterized by a dominant proportion of clay, silt, and sand in its particle size distribution (**Table 3**). Relatively significant gravel fractions appear in excavation pits A3 (8.61%) and A7 (7.90%). The maximum diameter obtained for all excavations at the site is 25 mm. The sediments are mostly “non-plastic”, except for those in A4 (IP = 14.5%), which

exhibit low plasticity according to standard XP P 94-011 [51]. The stream is also distinguished by a low organic matter content ($OM < 2\%$), indicating inorganic sediments conforming to CEBTP requirements [46] [51], and a relatively high natural water content in excavation pit A8 ($W_n = 28.39\%$). Across the entire profile, a variable and relatively acidic-basic pH is observed. The methylene blue value is relatively high in excavation pit A6 ($V_{BS} = 2.17$) compared to the others, which are relatively low.

Table 3. Physico-chemical properties of sediments from excavations of the stream.

Designation		Particle Size Fractions					Other Characteristics						
		Cl	Si	Sa	Gr	D _{max}	Ip	Wn	OM	V _{BS}	PH	ρ_a	ρ_{app}
Excavation	A1	29	41	24.46	5.54	16	7.5	14.31	0.88	1.06	7.22	2.57	1.22
	A2	30	42	23.59	4.41	8	5	2.57	0.80	1.71	7.91	2.61	1.20
	A3	34	22	35.39	8.61	12.5	10	13	0.65	1.29	6.85	2.60	1.18
	A4	39.5	37.5	22.25	0.75	8	14.4	22.66	1.25	1.06	5.84	2.55	1.08
	A5	23	55	18.07	3.93	10	7	1.73	0.73	0.72	6.62	2.42	1.28
	A6	45	35	17.96	2.04	12.5	11	24.99	0.60	2.17	7.36	2.61	1.18
	A7	20.5	36	35.6	7.9	25	5	2.78	0.59	0.76	6.89	2.59	1.36
	A8	53.5	30.5	15.09	0.91	10	12	28.39	1.49	1.53	5.82	2.61	0.97
	A9	22	39	37.21	1.79	10	5	2.66	0.79	0.70	6.05	2.53	1.31
Statistical parameters	Mean	32.9	37.6	25.5	4.0	12.4	8.5	12.6	0.9	1.22	6.7	2.6	1.2
	SD	11.2	8.9	8.5	2.9	5.3	3.5	10.7	0.3	0.5	0.7	0.06	0.12
	Cv	34	24	33	73	43	41	85	33	41	10	2	10

Abbreviation: **Cl:** Clay fraction (%); **Si:** Silt fraction (%); **Sa:** Sand fraction (%); **Gr:** Gravel fraction (%); **D_{max}:** Maximum diameter (mm); **Ip:** Plasticity index; **Wn:** Natural water content (%); **OM:** Organic matter content (%); **V_{BS}:** Methylene blue value; **PH:** Hydrogen potential; **ρ_a :** Absolute density (g/cm^3); **ρ_{app} :** bulk density (g/cm^3); **Mean:** Mean; **SD** Standard Deviation; **Cv:** Coefficient of variation.

Thus, the evaluation of the standard deviations and coefficients of variation of the samples for each characteristic, allows to identify two groups of parameters. These are:

- Relatively homogeneous parameters (pH, absolute and bulk density, silt and sand fraction, organic matter content), indicating low dispersion across the entire site.
- Variable parameters (gravel fraction, natural water content, D_{max}, plasticity index, methylene blue value, clay fraction) reflecting significant spatial heterogeneity.

3.1.2. Physico-Chemical Properties of Excavations in the Dam No. 1

Table 4 illustrates the physico-chemical properties of the sediments obtained after lab tests.

Table 4. Physico-chemical properties of sediments from excavations of the dam No. 1.

Designation		Particle Size Fractions					Other Characteristics						
		Cl	Si	Sa	Gr	D _{max}	I _P	W _n	OM	V _{BS}	PH	ρ _a	ρ _{app}
Excavation	B1	25.5	32.5	40.61	1.39	12.5	5	0.90	0.87	0.60	6.96	2.63	1.24
	B2	36	41	20.54	2.46	8	10	16.73	0.71	1.70	7.31	2.63	1.20
	B3	37.5	36.5	23.47	2.53	8	11	15.80	0.23	1.64	7.11	2.63	1.23
	B4	17	31.5	44.93	6.57	20	4.5	13.03	0.67	0.55	7.27	2.57	1.43
	B5	32.5	35.5	30.15	1.85	6.3	8	19.40	0.81	1.35	7.11	2.61	1.18
	B6	34.5	34.5	28.67	2.33	10	10.2	22.70	0.68	1.30	7.02	2.60	1.20
	B7	38	45.5	12.44	4.06	10	11	28.78	1.06	1.05	6.60	2.55	1.01
	B8	45.5	38.5	15.03	0.97	10	17.5	32.92	0.92	1.63	6.29	2.50	0.93
	B9	28	33	28.24	10.76	12.5	19	6.78	0.34	0.78	7.36	2.62	1.12
Statistical parameters	Mean	32.7	36.5	27.1	3.7	10.8	10.8	17.4	0.7	1.2	7.0	2.6	1.2
	SD	8.3	4.5	10.8	3.1	4.0	4.9	10.1	0.3	0.5	0.35	0.05	0.1
	Cv	25	12	40	84	37	45	58	43	42	5	2	8

Abbreviation: **Cl:** Clay fraction (%); **Si:** Silt fraction (%); **Sa:** Sand fraction (%); **Gr:** Gravel fraction (%); **D_{max}:** Maximum diameter (mm); **Ip:** Plasticity index; **Wn:** Natural water content (%); **OM:** Organic matter content (%); **V_{BS}:** Methylene blue value; **PH:** Hydrogen potential; **ρ_a :** Absolute density (g/cm³); **ρ_{app} :** bulk density (g/cm³); **Mean:** Mean; **SD** Standard Deviation; **Cv:** Coefficient of variation.

In dam no. 1, the results in **Table 4** highlight a predominance of clay, silt, and sand in the particle size distribution of the sediments. The gravel fraction is relatively low and varies depending on the excavations. The maximum diameter recorded at the site, for all excavations, is 20 mm. The sediments are generally “non-plastic”, with the exception of those in B8 ($I_p = 17.5$) and B9 ($I_p = 19$), which are slightly plastic according to standard XP P 94-011 [51]. At this site too, the organic matter content is low and complies with the requirements of the CEBTP ($OM < 2\%$) [46]. The natural water content fluctuates depending on the excavations, with the highest value obtained being 32.92% (excavation B8). Furthermore, the results show that the excavations are predominantly alkaline, according to the pH test [45]. Indeed, excavations B2, B3, B4, B5, B6 and B9 are characterized by a predominance of alkaline sediments compared to those of B1, B7, and B8, which are acidic. The methylene blue values are relatively lower ($V_{BS} < 2.5$), indicating slightly clayey sediments according to standard NF P 11-300 [47].

Thus, the evaluation of the standard deviations and coefficients of variation of the samples for each characteristic, allows to identify two groups of parameters. These are:

- Relatively homogeneous parameters (pH, absolute and bulk density, silt and clay fractions), indicating low dispersion across the entire site.
- Variable parameters (gravel and sand fraction, natural water content, D_{max}, plasticity index, methylene blue value, organic matter content) reflecting sig-

nificant spatial heterogeneity.

3.1.3. Physico-Chemical Properties of Excavations in the Dam No. 2

Table 5 presents the physico-chemical properties of the sediments obtained after lab tests.

Table 5. Physico-chemical properties of sediments from excavations of the dam No. 2.

		Particle Size Fractions					Other Characteristics							
		Cl	Si	Sa	Gr	D _{max}	I _p	W _n	OM	V _{BS}	PH	ρ _a	ρ _{app}	
Excavation	C1	33	30	34.20	2.80	8	10	23.58	0.51	0.97	6.58	2.63	1.10	
	C2	20.5	51.5	24.08	3.92	16	6	20.54	0.33	1.20	7.65	2.57	1.08	
	C3	27.5	50.5	21.12	0.88	8	8	1.80	0.61	1.47	7.21	2.60	1.27	
	C4	8.5	19	22.02	50.48	25	4.5	12.54	0.84	0.34	6.47	2.80	1.25	
	C5	40	43	16.64	0.36	8	12	31.08	0.85	1.34	6.02	2.47	1.11	
	C6	42	31	25.56	1.44	8	9	24.20	0.86	1.42	6.48	2.49	1.12	
	C9	29	43	24.16	3.84	20	11	3.40	0.65	0.77	7.15	2.56	1.26	
Statistical parameters	Mean	28.6	38.3	24	9.1	13.3	8.7	16.7	0.7	1.1	6.8	2.6	1.2	
	SD	11.5	12.0	5.4	18.3	7.1	2.6	11.1	0.2	0.4	0.56	0.1	0.1	
	Cv	40	31	23	201	53	30	66	29	36	8	4	8	

Abbreviation: **Cl:** Clay fraction (%); **Si:** Silt fraction (%); **Sa:** Sand fraction (%); **Gr:** Gravel fraction (%); **D_{max}:** Maximum diameter (mm); **Ip:** Plasticity index; **Wn:** Natural water content (%); **OM:** Organic matter content (%); **V_{BS}:** Methylene blue value; **PH:** Hydrogen potential; ρ_a : Absolute density (g/cm³); ρ_{app} : bulk density (g/cm³); **Mean:** Mean; **SD** Standard Deviation; **Cv:** Coefficient of variation.

In dam no. 2, the results in **Table 5** show a significant percentage of clay, silt, and sand in the particle size distribution. The gravel fraction is relatively low in excavations C1, C2, C3, C5, C6 and C9 compared to excavation C4, which shows a high gravel proportion (50.48%) across the entire studied profile. The maximum diameter obtained for all excavations, is 25 mm. The sediments are characterized by a “non-plastic” state according to the evaluated plasticity index [51], with a low proportion of organic matter (OM < 2%), conforming to CEBTP requirements [46]. Within the site, the natural water content varies according to the excavations and is higher at excavation C5 (31.08%). Furthermore, **Table 5** shows a large majority of excavations with acidic characteristics across the entire study section, according to the pH test [45]. Indeed, the C1, C4, C5 and C6 excavations are characterized by a predominance of sediments with acidic properties compared to those of C2, C3 and C9 which are basic. The methylene blue values are relatively lower (V_{BS} < 2.5), illustrating sediments with low clay content according to standard NF P 11-300 [47].

Thus, the determination of the standard deviations and coefficients of variation of the samples for each characteristic, allows to identify two groups of parameters. These are:

- Relatively homogeneous parameters (pH, absolute and bulk density, silt and

sand fraction, plasticity index, organic matter content), revealing low dispersion across the entire studied profile.

- Variable parameters (gravel and clay fraction, natural water content, D_{max} , methylene blue value) reflecting significant spatial heterogeneity.

3.2. Mechanical Properties

3.2.1. Compaction Characteristics of Excavations

The results of the modified Proctor tests carried out, in accordance with the requirements of NF P 94-093 [50], are shown in **Figures 4-6**.

The graphs generally illustrate the bell-shaped curve, reflecting the evolution of dry density as a function of water content. They indicate the existence of a Modified Proctor Optimum (MPO), corresponding to the optimal water content at which maximum dry density is reached.

Figure 4 presents the Modified Proctor curves of the excavations in the stream. At this site, excavations A4 (17.1%; 1.83 g/cm³) and A8 (17.2%; 1.72 g/cm³) exhibit the lowest characteristics at the MPO. Their high optimal water content may suggest a significant sensitivity to water in these constituent layers. In comparison, excavations A1 (12.9%; 1.955 g/cm³), A2 (10.1%; 1.96 g/cm³), A3 (12.4%; 2.03 g/cm³), A5 (10.9%; 2.005 g/cm³), A6 (11.0%; 2.00 g/cm³), and A9 (11.7%; 2.035 g/cm³) exhibit average characteristics at the MPO, while excavation A7 (9.4%; 2.165 g/cm³) contains the highest MPO compaction reference value on the site.

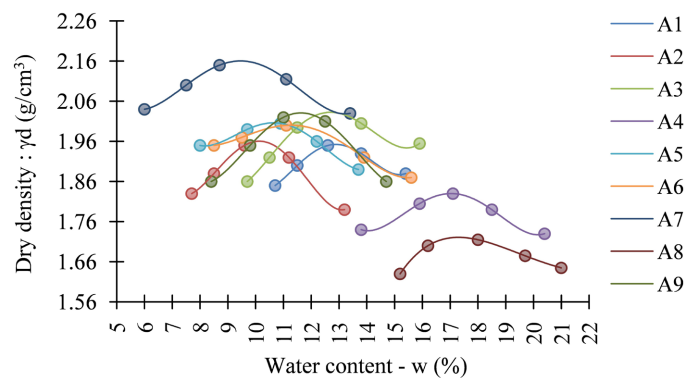


Figure 4. Modified Proctor curves of excavations in the stream.

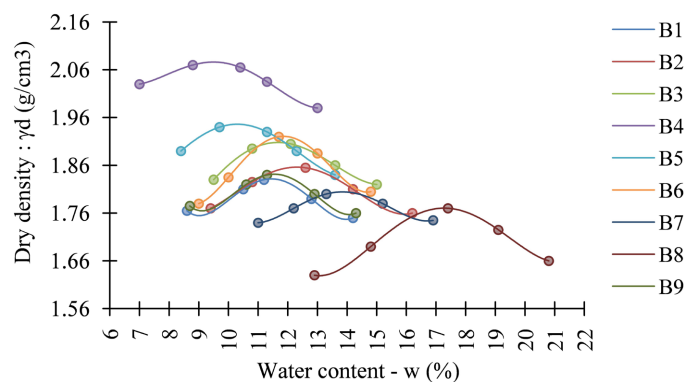


Figure 5. Modified Proctor curves of excavations in the dam No. 1.

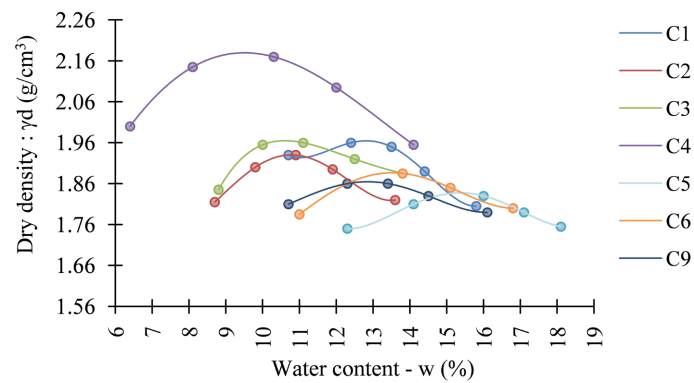


Figure 6. Modified Proctor curves of excavations in the dam No.2.

In **Figure 5**, the curve for excavation B1 (11.5%; 1.83 g/cm³) shows the lowest reference to the MPO of dam No.1, compared to the average compaction references observed on the curves for excavations B2 (12.2%; 1.86 g/cm³), B3 (11.6%; 1.91 g/cm³), B5 (10.4%; 1.95 g/cm³), B6 (11.9%; 1.92 g/cm³), B7 (13.7%; 1.805 g/cm³), B8 (17.4%; 1.77 g/cm³), and B9 (11.4%; 1.84 g/cm³). Thus, the highest compaction curve at the site is obtained in excavation B4 (9.5%; 2.08 g/cm³).

At the site of Dam No. 2 (**Figure 6**), the lowest compaction curve was recorded in excavation C5 (15.3%; 1.84 g/cm³) compared to the average curve found in excavations C1 (12.8%; 1.965 g/cm³), C2 (10.7%; 1.93 g/cm³), C3 (10.6%; 1.97 g/cm³), C6 (13.3%; 1.89 g/cm³), and C9 (12.8%; 1.87 g/cm³). Thus, the highest MPO compaction reference value at the site is identified on the curve for excavation C4 (9.5%; 2.18 g/cm³).

Thus, the variations of the MPO compaction references of the sediments explain by various factors, including the nature of the constituent layers of the excavations, their particle size distribution, their organic matter content, and the heterogeneity of the sedimentary deposits. These parameters contribute to influencing the maximum dry density and the optimal water content.

3.2.2. Bearing Capacity Characteristics of the Excavation Samples

a. Bearing capacity characteristics of the excavations in the stream

The bearing capacity characteristics obtained from the tests carried out in accordance with the requirements of standard NF P 94-078 [49], are presented in **Figure 7** and **Figure 8**. They highlight soaked CBR indexes (I.CBR), linear swellings and variable water contents depending on the excavation points.

In **Figure 7**, excavation A8 exhibits the lowest I.CBR values compared to the other excavation pits. Its I.CBR at 98% compaction of the MPO (4.20), is strictly lower than the minimum value acceptable by the CEBTP at 95% compaction (CBR = 5) [46], for the construction of pavement subgrade layers. It is characterized by a relatively high sensitivity to water ($W_{max} = 28.40\%$). To mitigate any potential problems, its use for a subgrade layer requires improvement of its bearing capacity characteristics (treatment with lime, cement, etc.). Furthermore, excavation A4 exhibits a satisfactory I.CBR at 98% of the MPO ($7.50 > 5$) for the subgrade layer

according to the CEBTP guide, compared to excavations A1, A2, A3, and A9, which reveal oneself at 95% of the MPO compaction.

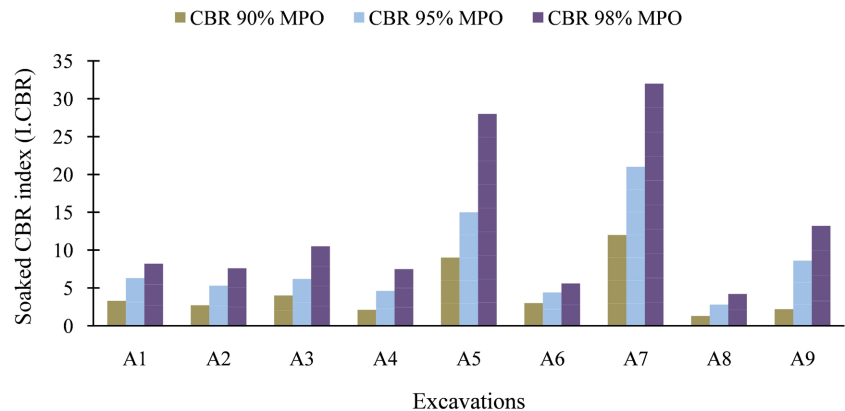


Figure 7. Soaked CBR performance of stream excavations.

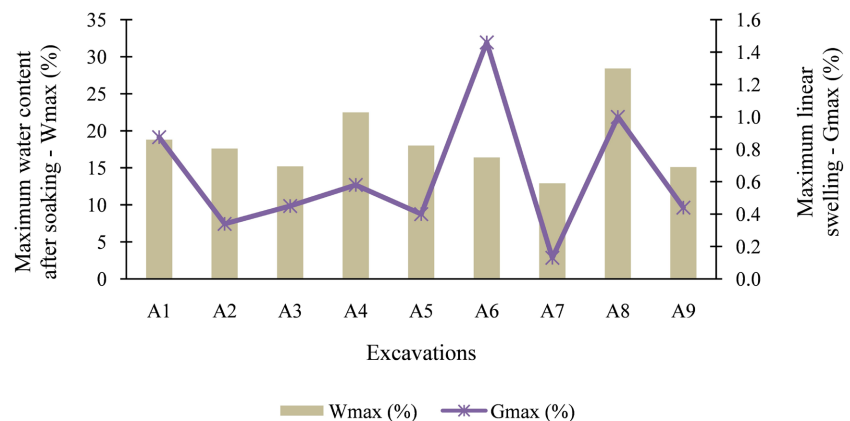


Figure 8. Maximum water content after soaking and maximum linear swell of stream excavations.

On this site, excavations A5 and A7 record high I.CBR values at the MPO (**Figure 7**), with acceptable values for the pavement layer according to the CEBTP manual [46]. Their low linear swelling reflects the insensitivity of the constituent layers of these excavations to water.

Finally, **Figure 8** shows a linear swelling in the different excavations that is strictly less than the maximum value defined by the CEBTP guide (2%) [46]. The maximum proportion of linear swelling is identified in excavation A6 (1.46%), and the maximum saturation water content in excavation A8 (28.40%).

b. Bearing capacity characteristics of the excavations in the dam No. 1

The bearing characteristics in dam no. 1, evaluated from standard NF P 94-078 [49], are illustrated in **Figure 9** and **Figure 10**.

At the site of Dam No. 1, the results obtained (**Figure 9** and **Figure 10**) show variability in I.CBR indexes, linear swellings, and water contents depending on the different excavations. **Figure 9** indicates that excavations B2 and B3 have the lowest I.CBR values compared to the other excavations. Their I.CBR at 98% compac-

tion of the MPO (4.10 and 3.60) are strictly lower than the minimum value recommended by CEBTP at 95% compaction (CBR = 5) for the implementation of pavement subgrade layers. Their application for subgrade layers therefore requires prior treatment to remedy any problems that may arise during implementation. In comparison, excavations B5, B8, and B9 only show I.CBR values at 98% compaction of the MPO of 6.00, 6.10 and 5.90 respectively, all exceeding 5 (according to CEBTP). Furthermore, for excavations B1, B6, and B7, the I.CBR values are only acceptable at 95% compaction of the MPO.

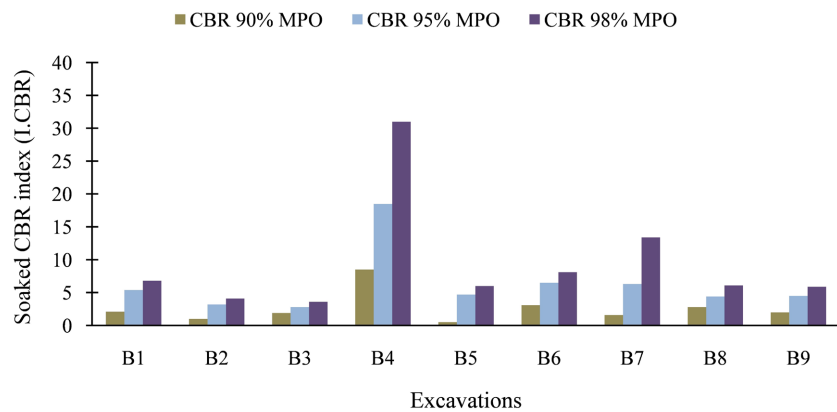


Figure 9. Soaked CBR performance of dam no. 1 excavations.

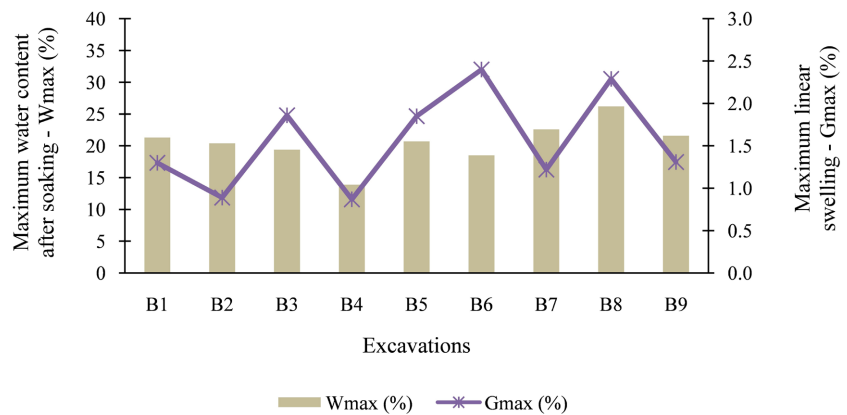


Figure 10. Maximum water content after soaking and maximum linear swell of dam no. 1 excavations.

In **Figure 9**, excavation B4 exhibits the highest I.CBR values of the site. Its low proportion of linear swelling (0.87%) and water content (13.90%), indicates an insensitivity to water of the constituent layers of this excavation.

Finally, the results also illustrate that the measured linear swelling and water content are quite significant in some excavations on the site (**Figure 10**). Indeed, excavations B6 and B8 show high linear swelling values (2.40% and 2.29%, respectively), exceeding the CEBTP requirements (2%). For potential road use, the constituent layers of these excavations must be treated to reduce their high sensitivity to water. For excavations B3 and B5, where linear swelling is less than 2%, precau-

tions (treatments) should also be considered for potential use.

c. Bearing capacity characteristics of the excavations in the dam No. 2

The results obtained are illustrated in **Figure 11** and **Figure 12**. They highlight CBR indices, linear swellings and water contents that vary depending on the excavations.

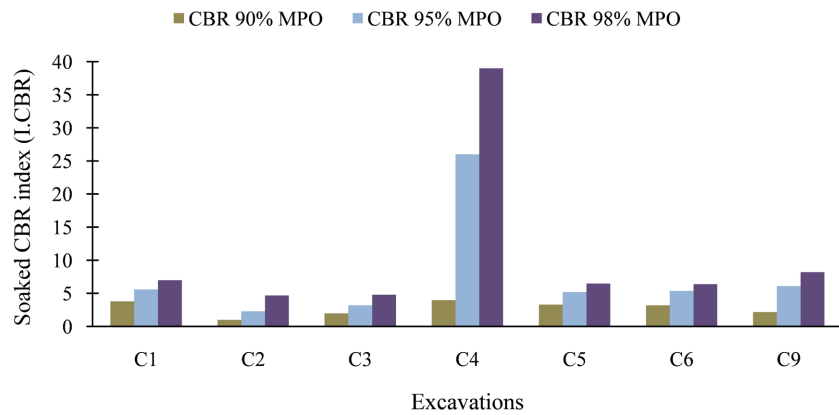


Figure 11. Soaked CBR performance of dam no. 2 excavations.

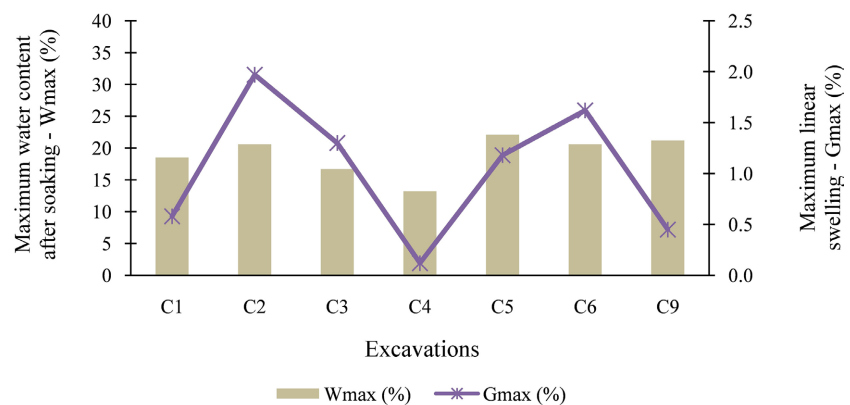


Figure 12. Maximum water content after soaking and maximum linear swell of dam no. 2 excavations.

In **Figure 11**, excavations C2 and C3 exhibit the lowest CBR values on the site (4.70 and 4.80 respectively at 98% of the OPM), which are below the minimum value (CBR = 5) recommended by CEBTP for subgrade application. Measurements of their swelling (presented in **Figure 12**), show proportions (1.97% and 1.30%) that are strictly less than 2% (according to CEBTP). In comparison, excavations C1, C4, C5, C6, and C9 show acceptable CBR values at 95% compaction of the MPO (greater than CBR = 5 according to CEBTP). Among the excavations at the site, excavation C4 exhibits high I.CBR values with a very low maximum linear swelling (0.12%), indicating a very negligible sensitivity to moisture in its constituent layers.

In **Figure 12**, linear swelling across all excavations remains below 2% (according to CEBTP), with fairly significant water contents observed after soaking in

excavations C1, C2, C3, C5, C6, and C9. Their varying degrees of sensitivity to water could lead to problems (rapid degradation) in road. Potential improvements could be implemented before any application.

4. Discussion

4.1. Factors Explaining the Observed Differences in Bearing Capacity

The comparative analysis of the three hydraulically connected sites reveals generally similar characteristics. They are composed of a predominance of clay, silt, and sand fractions, a low organic matter content, and low plasticity according to standard XP P 94-011 [51]. Despite this apparent similarity, differences are observed in mechanical performance, particularly in terms of bearing capacity as measured by the I.CBR.

The highest I.CBR values are recorded for excavations A5 and A7 of the stream (I.CBR = 28 and 32), B4 of dam no. 1 (I.CBR = 31), and C4 of dam no. 2 (I.CBR = 39). Examination of their particle size distribution shows that these materials have relatively high proportions of coarse particles (sands and gravels) associated with low plasticity and low clay activity.

At the level of the stream, excavations A5 and A7 have methylene blue values of 0.72 and 0.76, respectively, indicating low clay activity. Although A5 has a high proportion of silt (55%), its clay content remains moderate (23%), and its maximum diameter reaches 10 mm. Excavation A7 is more distinguished by a higher proportion of sand (35.6%) and gravel (7.9%), as well as a maximum diameter of 25 mm. Furthermore, observation of the constituent layers of excavations A5 and A7 during sampling reveals sediments of a sandy and non-plastic nature. Thus, the textural characteristics of the sediments from these excavations, marked by a relatively high proportion of gravel particles and low clay activity, appear to be the main factors contributing to the level of bearing capacity observed. Furthermore, the homogeneity of the constituent layers of the excavations (A5 and A7) also contributes to the consistency of the performance obtained.

Excavation B4 of dam no. 1, has a sand content of 44.93%, with only 17% clay and a plasticity index of 4.5. On-site observation reveals that excavation B4 has a sandy texture (with homogeneous underlying layers), compared to the other excavations (B1, B2, B3, B5, B6, B7, B8, and B9). Its particle size distribution reflects a decrease in the influence of cohesive fines in favor of granular particles. The reduction in the clay fraction limits water sensitivity and improves the internal friction of the material, thus promoting the development of higher bearing capacity (I.CBR = 31). Furthermore, the homogeneity of the layers constituting the observed excavation appears to contribute to the stability of the performance obtained in B4.

The best bearing capacity was observed for excavation C4 of dam no. 2, with a I.CBR of 39. This value appears directly linked to its particular grain size structure, characterized by a very high proportion of gravel (50.48%) and a maximum diam-

eter of 25 mm. The significant quantity of coarse elements recorded is explained by the geological nature of this excavation, observed during sampling (presence of lateritic crust). This geological feature promotes the production of coarse fragments, enriching the environment with gravelly elements. Thus, the significant presence of coarse elements allows the formation of a rigid granular skeleton capable of effectively resisting applied loads. Furthermore, the low clay content (8.5%) and the low plasticity index ($I_p = 4.5$) considerably reduce the deformation and water retention effects generally associated with fine materials. This combination of factors leads to a significant improvement in bearing capacity.

In general, the results obtained show that the bearing capacity of the studied sediments depends strongly on the texture and variability of the constituent layers of each excavation. Excavations exhibiting the highest I.CBR values generally correspond to those characterized by homogeneous underlying layers, reduced clay content, low plasticity, relatively large maximum diameters, and a higher proportion of sand and gravel.

4.2. Comparative Analysis with the Literature

The results highlight the variable physico-chemical and mechanical properties of the sediments. The sediments consist mainly of clay, silt, and sand, with a relatively small and divergent gravel fraction depending on the excavations. This observation differs significantly from those of [13]-[16], whose analyses indicate a complete absence of the gravel fraction in the particle size distribution. This observation can be explained by the difference in sampling conditions and the mineralogical nature of the sediments studied. The particle size characterization methodology also contributes to this divergence, particularly in the context of the grain size fraction assessment proposed by [15]. Furthermore [15] highlights a sediment characterized by an absolute density (2.63 g/cm^3) similar to that of excavations B1, B2, B3, and C3, and a bulk density (1.21 g/cm^3) close to the results obtained in excavations A1 (1.22 g/cm^3), A2 (1.20 g/cm^3), B2 (1.20 g/cm^3), and B6 (1.20 g/cm^3).

The sediments are characterized by variability in their natural water content depending on the excavation. Those from [16] [52] [53] exhibit very high natural water contents (ranging from 100% to 360%) compared to the results of the different excavations obtained, with the maximum percentage reaching 32.92% (B8). Conversely, [15] reports a relatively low natural water content in the raw sediment (8.91% and 9.46%), falling within the range of the results of the present study. In accordance with standard XP P 94-011 [51], the sediments are characterized by relatively low plasticity compared to those of [1] [14] [16], which are plastic or highly plastic depending on the sediment nature. Furthermore, the basic character observed in several excavations of our sediments is also confirmed in the work of [9] [14] [16].

Modified Proctor curves exhibit a bell shape, conforming to geotechnical requirements [50], and allow for the determination of compaction references. Thus,

the CBR bearing capacity characterization demonstrates the suitability of sediments for use in pavement layers. In the literature [1] [13] [15] [16] [54], the immediate bearing index (IBI) is commonly used to evaluate the bearing capacity of sediments before their improvement for road applications. This parameter differs from the soaked CBR index, used in this study to assess the behavior of the sediment (without treatment) in a state closer to the conditions of use in road structures. This parameter is directly linked to pavement structure design methods in West Africa (particularly Burkina Faso), notably the CEBTP guide [46]. For an $I.CBR \geq 25$ conforming to CEBTP [46] requirements, the sediments from excavations A5, A7, B4, and C4 exhibit a favorable bearing capacity at 98% compaction, suitable for use in both subgrade and pavement foundation layers, subject to possible correction of the fines percentage for excavations A5, A7, and B4 according to geotechnical requirements. When the soaked CBR index is between 5 and 15, the sediments from excavations A3, A9, A1, A2, A4, A6, B1, B5, B6, B7, B8, B9, C1, C5, C6, and C9 show acceptable CBR bearing capacity at 98% compaction, suitable for use in subgrade layers, with possible correction of the fines fraction before placement, according to CEBTP [46] recommendations. Excavations B6 and B8 also require additional treatment against swelling (2.40% and $2.29\% > 2\%$) by lime treatment to remedy any defects that may remain during their use, according to CEBTP [46] guidelines. Similarly, excavation sediments A8, B2, B3, C2, and C3, whose I.CBR at 98% compaction is less than 5, also require possible improvement (lime treatment, particle size correction) to meet CEBTP [46], requirements for applications in pavement layers.

4.3. Strengths and Limitations

This study highlights several important contributions:

- The production of new data on dam sediments in Burkina Faso: this research contributes to enriching the knowledge base on the properties of dam sediments in Burkina Faso, a field that remains poorly documented in the scientific literature;
- Understanding sediments from a hydraulically connected system: the study provides insights into the variability of sediment characteristics within the same hydraulic system;
- Assessing the potential for road construction: the study serves as a screening or prequalification tool for materials;
- Contributing to the circular economy: the study aligns with the principles of waste recovery, sustainable resource management, and reduced quarrying.
- Supporting decision-making for dredging operations: the study provides useful information for dam managers.

This study is far from perfect, but the results obtained constitute a substantial foundation for research and development of secondary resources in the construction sector. Sediments from hydraulically connected dams in Burkina Faso represent a relatively unstudied geomaterial resource whose physico-chemical and me-

chanical properties deserve consideration in geotechnical road engineering strategies. However, some limitations can be noted, such as:

- The limited number of sites studied: The results obtained only concern the three sites studied and do not allow for direct extrapolation of the conclusions to all dams in the country;
- The lack of temporal variability: The study corresponds to a single campaign and does not take into account seasonal and interannual variations;
- The absence of full-scale testing: The study relies primarily on lab tests and an analysis of potential suitability. It does not include the construction of test sections, test sections, or operational monitoring;
- Lack of sediment treatment: the materials are studied in their raw state, and the evaluation of various possible treatments (lime treatment, cement, hydraulic binders, etc.) to improve certain sediment characteristics remains to be explored;
- Incomplete environmental assessment.

5. Conclusions

This study focused on the physical, chemical, and mechanical characterization of dam sediments from three hydraulically connected sites, for application in road geotechnics. The objective of the analysis was to evaluate the characteristics of these alternative materials collected for potential use in road construction, in accordance with geotechnical specifications. The following results emerged from the analysis:

- The sediments at the different sites (stream, dams no. 1 and no. 2) are characterized by a predominance of clay, silt, and sand, with a relatively low and variable gravel fraction depending on the excavation;
- The excavations of the stream (A5, A7) of dam no. 1 and no. 2 (B4 and C4) show favorable bearing capacity at 98% compaction, suitable for use as both a subgrade and a pavement foundation layer. Their low linear swelling reflects the insensitivity to water of the constituent layers of these excavations;
- The excavation sediments A3, A9, A1, A2, A4, A6, B1, B5, B6, B7, B8, B9, C1, C5, C6, and C9 show a CBR bearing capacity at 98% compaction, acceptable for use as a subgrade layer. For implementation, potential treatment (fine fraction correction, lime stabilization, etc.) could be adopted to address swelling-related issues, according to CEBTP requirements;
- The excavation sediments A8, B2, B3, C2, and C3, with an I.CBR at 98% compaction below 5, may require improvement (lime treatment, particle size correction) before implementation to meet CEBTP requirements for applications in road construction layers.

Following this analysis, the results show interesting and favorable characteristics that allow for their use in road construction. For sustainable construction and the preservation of natural resources, the use of these materials represents an interesting alternative to consider in order to meet the growing need for roadworks.

Acknowledgements

This work was carried out as part of a collaboration between Nazi BONI University of Bobo Dioulasso, the National Lab for Building and Public Works (LNBTP) and the Institute of Environment and Agricultural Research (INERA) of Burkina Faso. It was made possible thanks to the financial support of the Community Project for Recovery and Stabilization of the Sahel-Burkina Faso (PCRSS-Burkina).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Tran, N.T. (2009) Valorization of Marine and River Sediments in Road Construction Technique. Ph.D. Thesis, School of Mines of Douai, p. 187.
https://www.academia.edu/download/107497494/TRAN_20NGOC_20THANH.pdf
- [2] Khezami, I. (2014) Experimental Approach to Valorizing Dredged Sediments in Civil Engineering Applications. Doctoral Thesis, University of Lille 1, p. 204.
<https://www.academia.edu/download/86550336/559a1d6f-2e27-4c99-8758-5b7eb0b014f0.pdf>
- [3] Burkina Faso News Agency (2026) Burkina Faso: The Government Launches a National Campaign to Dredge 100 Dams to Mobilize 50 Million Cubic Meters of Water.
<https://www.aib.media/?p=139107>
- [4] Diappa, D. (2026) Mobilization of Surface Water: The Prime Minister Launches Dredging and Reinforcement Work on 100 Dams, Ministry of Agriculture, Water, Animal and Fisheries Resources.
<https://www.agriculture.bf/2026/02/02/%f0%9d%90%8c%f0%9d%90%a8%f0%9d%90%9b%f0%9d%90%a2%f0%9d%90%a5%f0%9d%90%a2%f0%9d%90%ac%f0%9d%90%9a%f0%9d%90%ad%f0%9d%90%a2%f0%9d%90%a8%f0%9d%90%a7-%f0%9d%90%9d%f0%9d%90%9e%f0%9d%90%ac-%f0%9d%90%9e/>
- [5] BOUGOUM (2026) Burkina Faso: Prime Minister Launches Dredging and Reinforcement Work on 100 Dams. the newspaper WakatSéra.
<https://www.wakatsera.com/burkina-le-premier-ministre-lance-des-travaux-de-curage-et-de-confortation-de-100-barrages/>
- [6] Burkina Faso News Agency (2026) Burkina Faso: Minister Ismaël Sombié Launches Dredging Work on Dams No. 1, No. 2, No. 3 and Boulmiougou to Prevent Flood Risks.
<https://www.aib.media/?p=148065>
- [7] BOUGOUM (2026) Ouagadougou: Dredging Work Begins on Four Dams.
<https://www.wakatsera.com/ouagadougou-lancement-des-travaux-de-curage-de-quatre-barrages/>
- [8] Sagbe, W. (2026) Ouagadougou: Large-Scale Dam Dredging Operation to Strengthen Water Supply.
<https://burkina24.com/2026/05/01/ouagadougou-vaste-operation-de-curage-des-barrages-pour-renforcer-lapprovisionnement-en-eau/>
- [9] Miraoui, M. (2010) Pretreatment and Treatment of Dredged Sediments for Use in Civil Engineering. Doctoral Thesis, Mines of Douai, 210.
<https://www.academia.edu/download/110931291/abf20fdf-f4e4-433e-88b8-b5b050c8e307.pdf>
- [10] Lecomte, T. (2018) Évaluation environnementale des sédiments de dragage et de cur-

- age dans la perspective de leur valorisation dans le domaine du génie civil. Doctoral Thesis, University of Lille 1, p. 417.
https://www.researchgate.net/profile/TristanLecomte/publication/380596482_Evaluation_environnementale_des_sediments_de_dragage_et_de_curage_dans_la_perspective_de_leur_valorisation_dans_le_domaine_du_genie_civil/links/679b4936645ef274a4520ad8/Evaluation-environnementale-des-sediments-de-dragage-et-de-curage-dans-la-perspective-de-leur-valorisation-dans-le-domaine-du-genie-civil.pdf
- [11] Zeraoui, A. (2020) Operational Approach for the Sustainable Management of Dredged Sediments in Civil Engineering Projects. Ph.D. Thesis, National School of Mines-Telecom Lille Douai. France, p. 316.
<https://theses.hal.science/tel-03510243v1>
 - [12] Ouendi, F. (2022) Impacts of Preparation Methods and Influences of Granular Classes on the Physicochemical Properties and Mechanical Behavior of Fluvial and Marine Sediments for Use in Civil Engineering. Ph.D. Thesis, National School of Mines-Telecom Lille Douai. France, p. 166. <https://theses.hal.science/tel-05456956v1>
 - [13] Achour, R. (2013) Valorization and Characterization of the Durability of a Road Material and a Concrete Based on Dredged Sediments. Doctoral Thesis, University of Lille 1, p. 199.
<https://pepite-depot.univ-lille.fr/LIBRE/EDSPI/2013/50376-2013-Achour.pdf>
 - [14] Benaissa, A. (2017) Valorization of Silt for Use in Road Construction. Doctoral Thesis, Djillali Liabes University, p. 150.
<https://theses-algerie.com/2036751748524487/these-de-doctorat/universite-djillali-liabes---sidi-bel-abbes/valorisation-de-la-vase-pour-l-utilisation-dans-la-technique-routiere>
 - [15] Azrar, H. (2014) Contribution to the Valorization of Port Dredging Sediments: Road Construction Techniques, Concrete and Artificial Aggregates. Doctoral Thesis, University of Lille 1, p. 224.
<https://pepite-depot.univ-lille.fr/LIBRE/EDSPI/2014/50376-2014-Azrar.pdf>
 - [16] Dia, M. (2013) Treatment and Valorization of Phosphate Dredging Sediments in Road Construction. Doctoral Thesis, University of Artois, p. 169.
 - [17] Mkahal, Z. (2021) Co-Valorization of Alternative Materials in Road Construction: Technical and Environmental Feasibility of Their Use in Embankments and Hydraulic Road Binders. Ph.D. Thesis, National School of Mines-Telecom Lille Douai, p. 202
<https://theses.hal.science/tel-04403016v1>
 - [18] Cabrerizo, A. (2019) Characterization and Processing of Excavated Materials and Marine and Fluvial Sediments for Use in Road Construction and Civil Engineering. Ph.D. Thesis, National School of Mines-Telecom Lille Douai, p. 173.
<https://theses.hal.science/tel-04903168v1>
 - [19] Khattaoui, M., Boudlal, O., Hamza, A. and Ferri, N. (2015) Study of the Mechanical Behavior of the Silt from the Ain Zaouia Dam (Algeria) for Its Use in Road Construction. p. 8. <https://hal.science/hal-03446109v1>
 - [20] Benasla, M., Benamara, L. and Hadjel, M. (2015) Caractérisation de sédiments du barrage de l'Oued Fodda et leur valorisation comme un ajout artificiel dans le ciment. *Matériaux & Techniques*, **104**, 546-558.
 - [21] Bellara, S., Levacher, D., Mezazigh, S. and Hidjeb, M. (2020) Valorization of Sediments from the Zardezas Dam (Algeria): Characterization and Compaction Suitability of the Sediments. 571-580. <https://normandie-univ.hal.science/hal-03355189v1>
 - [22] Safhi, A.E.M. (2020) Valorization of Dredged Sediments in Self-Compacting Concrete: Formulation Optimization and Durability Study. Ph.D. Thesis, National Grad-

- uate School of Mines-Telecom Lille Douai; University of Sherbrooke, p. 170.
<https://theses.hal.science/tel-03161520v1>
- [23] Ennahal, I. (2019) Valorization of Dredged Sediments in Polymer Matrices. Ph.D. Thesis, National Graduate School of Mines-Telecom Lille Douai, p. 224.
<https://theses.hal.science/tel-02890657v1>
- [24] Hafida, M. (2018) Valorisation des sédiments issus du dragage du barrage de Bouhanifia et du port d'Oran. Doctoral Thesis, Abdelhamid Ibn Badis University of Mostaganem, p. 90.
<https://e-biblio.univ-mosta.dz/bitstreams/c619ec4e-86a3-422d-9f64-ae1a4c53514c/download>
- [25] Levacher, D., Ndahirwa, D., Suriray, A., Zmamou, H., Leblanc, N. and Hussain, M. (2024) Raw Earth Bricks Made from Sediments—The Upécomat Project. p. 12.
https://www.paralia.fr/jngcgc/18_80_levacher.pdf
- [26] Brahim, M. (2022) Valorization of Dredged Sediments in the Manufacture of Compressed Earth Blocks Stabilized by Geopolymer Binders. Doctoral Thesis, CY Cergy Paris University, p. 132. <https://theses.fr/api/v1/document/2022CYUN1135>
- [27] Nassar, S. (2024) Valorization of Dredged Sediments in Earthen Constructions. Ph.D. Thesis, University of Bordeaux, p. 220.
<https://theses.hal.science/tel-04890293v1>
- [28] Heidari, P. (2026) Development of Eco-Efficient Cementitious Systems through the Co-Valorization of Dredged Marine Sediments and Crustacean Residues. Doctoral Thesis, University of Sherbrooke, p. 280.
- [29] Kourtaa, S. (2022) Contribution to the Development of a New Lime-Marine Sediment Eco-Binder for Applications in Bio-Based Concretes. Ph.D. Thesis, National Graduate School of Mines-Telecom Lille Douai, p. 200.
<https://theses.hal.science/tel-04368448>
- [30] Laoufi, L., Senhadji, Y. and Benazzouk, A. (2016) Valorization of Mud from Fergoug Dam in Manufacturing Mortars. *Case Studies in Construction Materials*, **5**, 26-38.
<https://doi.org/10.1016/j.cscm.2016.06.002>
- [31] Benasla, M., Hadjel, M., Benamara, L. and Ouhba, K. (2016) Caractérisation de sédiments du barrage de l'Oued Fodda et leur valorisation comme un ajout artificiel dans le ciment. *Matériaux & Techniques*, **104**, Article No. 304.
<https://doi.org/10.1051/mattech/2016025>
- [32] Benamar, S., Mamoune, S.M.A., Cherif, R. and Cherif, W.N.E.H. (2025) Dredged Sediments as an Alternative Resource for a Durable Cementitious Mortar: Application of Sediments from the Sekkak Dam in Algeria. p. 8.
<https://revue.ummto.dz/index.php/JMES/article/view/4030>
- [33] XP P 94-202 (1995) Soils: Investigation and Testing—Soil and Rock Sampling—Methodology and Procedures. Association Française de Normalisation, p. 42.
- [34] NF EN 1008 (2003) Mixing Water for Concrete: Specifications for Sampling, Testing, and Evaluation of Suitability for Use, Including Process Waters in the Concrete Industry, such as Mixing Water for Concrete. Classification Index: P18-211.
- [35] NF EN ISO 3696 (1995) Water for Lab Analytical Use—Specification and Test method. Association Française de Normalisation, p. 9.
- [36] NF EN ISO 6353-2 (1983) Reagents for Chemical Analysis—Part 2: Specifications—First Series. Association Française de Normalisation, p. 57.
- [37] NF P 94-055 (1993) Soils: Investigation and Testing—Determination of the Organic Matter Content of a Soil by Weight—Chemical Method. Association Française de Normalisation, p. 7.

- [38] NF P 94-056 (1996) Soils: Investigation and Testing—Particle Size Analysis—Dry Sieving Method after Washing. Association Française de Normalisation, p. 15.
- [39] NF P 94-057 (1992) Soils: Investigation and Testing—Particle Size Analysis of Soils—Sedimentation Method. Association Française de Normalisation, p. 17.
- [40] NF P 94-050 (1995) Soils: Investigation and Testing—Determination of the Water Content by Weight of Materials—Oven Drying Method. Association Française de Normalisation, p. 7.
- [41] NF P 94-053 (1991) Soils: Investigation and Testing—Determination of the Density of Fine Soils in the Laboratory—Cutting Kit, Mold, and Water Immersion Methods. Association Française de Normalisation, p. 6.
- [42] NF P 94-054 (1991) Soils: Investigation and Testing—Determination of the Density of Solid Particles in Soils—Water Pycnometer Method. Association Française de Normalisation, p. 6.
- [43] NF P 94-051 (1993) Soils: Investigation and Testing—Determination of Atterberg Limits—Liquid Limit (Cup Test)—Plastic Limit (Roller Test). Association Française de Normalisation, p. 15.
- [44] NF P 94-068 (1998) Soils: Investigation and Testing—Measurement of the Methylene Blue Absorption Capacity of a Soil or Rock Material. Association Française de Normalisation, p. 7.
- [45] NF ISO 10390 (2005) Soil Quality—pH Determination. Association Française de Normalisation, p. 7.
- [46] CEBTP (1984) Practical Guide to Pavement Design for Tropical Countries. Ministry of Foreign Affairs-Cooperation and Development, p. 155.
https://www.francescomiceli.com/blog/Guide_pratique_dimensionnement.pdf
- [47] NF P 11-300 (1992) Earthworks—Classification of Materials Usable in the Construction of Embankments and Subgrade Layers for Road Infrastructure. Association Française de Normalisation, p. 21.
- [48] Technical Guide (2000) Realization of Embankments and Subgrade Layers (Booklets I and II). LCPC—SETRA, p. 211.
- [49] NF P 94-078 (1997) Soils: Investigation and Testing—Soaked CBR Index—Immediate CBR Index—Immediate Bearing Capacity Index—Measurement on a Sample Compacted in the CBR Mold. p. 12.
- [50] NF P 94-093 (1993) Soils: Investigation and Testing—Determination of Compaction References for a Material—Standard Proctor Test—Modified Proctor Test. Association Française de Normalisation, p. 18.
- [51] XP P 94-011 (1999) Soils: Investigation and Testing—Description—Identification—Soil Naming, Terminology—Classification Elements. Association Française de Normalisation, p. 15.
- [52] Boutouil, M. (1998) Treatment of Dredged Material by Stabilization/Solidification Using Cement and Additives. Doctoral Thesis, University of Havre, p. 245.
<https://theses.fr/1998LEHA0010>
- [53] Colin, D. (2003) Valorization of Fine Dredged Sediments in Road Construction Techniques. Doctoral Thesis, University of Caen, p. 180.
<https://theses.fr/2003CAEN2038>
- [54] Asmahane, B.M. (2012) Mechanical Behavior of Fine Soils—Application to the Valorization of Dam Sediments in Road Construction. Doctoral Thesis, Abou-Bekr-Belkaid-Tlemcen University, p. 227. <https://dspace.univ-tlemcen.dz/handle/112/1169>

Nomenclature

Acronyms and Abbreviations

1 Co	<i>First layer of sediment taken between 0 and 5 cm</i>
2 Co	<i>Second layer of sediment taken between 5 cm and 50 cm</i>
3 Co	<i>Third layer of sediment taken between 50 cm and 1 m</i>
AFNOR	<i>French Association for standardization</i>
A1 to A9	<i>correspond to the numbers assigned to each excavation of the stream, as well as to the representative mixtures of sedimentary layers obtained from these same excavations</i>
B1 to B9	<i>correspond to the numbers assigned to each excavation of dam no. 1 as well as to the representative mixtures of sedimentary layers obtained from these same excavations</i>
C1 to C9	<i>correspond to the numbers assigned to each excavation of dam no. 2 as well as to the representative mixtures of sedimentary layers obtained from these same excavations.</i>
CBR	<i>California Bearing Ratio</i>
CBR 90 % OPM	<i>Bearing capacity of the California Bearing Ratio at 90 % compaction of the modified Proctor optimum</i>
CBR 95 % OPM	<i>Bearing capacity of the California Bearing Ratio at 95 % compaction of the modified Proctor optimum</i>
CBR 98 % OPM	<i>Bearing capacity of the California Bearing Ratio at 98 % compaction of the modified Proctor optimum</i>
CEBTP	<i>Experimental Center for Research and Studies in Building and Public Works</i>
EN	<i>European Standard</i>
GTR	<i>Guide to Road Earthworks, Realization of Embankments and Subgrade Layers</i>
INERA	<i>Institute of Environment and Agricultural Research</i>
ISO	<i>International Standard Organization</i>
LNBTB	<i>National Lab for Building and Public Works</i>
NF	<i>French standardization</i>
NF EN	<i>French standard adopting a European standard</i>
NF P	<i>French standard applicable to building and civil engineering</i>
MPO	<i>Modified Proctor Optimum</i>
PCRSS	<i>Community Project for Recovery and Stabilization of the Sahel</i>

Symbols

ρ_a	Absolute density of sediment (g/cm ³)
ρ_{app}	Bulk density of sediment (g/cm ³)
γ_d	Dry density of the compacted sediment sample (g/cm ³)
Cl	Clay fraction (%)
Cv	Coefficient of variation
D_{max}	Maximum diameter (mm)
G_{max}	Maximum linear swelling (%)
Gr	Gravel fraction (%)
IBI	Immediate Bearing Index
$I.CBR$	Soaked California Bearing Ratio Index
Ip	Plasticity Index
$Mean$	Mean
OM	Organic matter content (%)
PH	Hydrogen potential
Sa	Sand fraction (%)
Si	Silt fraction (%)
SD	Standard Deviation
V_{BS}	Methylene Blue Value
W	Exact water content of the compacted sediment sample (%)
W_{max}	Maximum water content after four (04) days of soaking (%)
W_n	Natural water content (%)
