Impacts of organic matter on physical properties of dredged sediments: Comparison of organic matter characterization methods.

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ABSTRACT:

Dredged sediment listed as waste according to European classification and available in important quantities; generally consist of a mineral phase, an organic phase (in various forms) and a liquid phase generally water. The presence of organic matter (OM) in sediment, even in low amounts, can affect the physical, chemical and mechanical behavior.

The main objective of this study is to develop a methodology for characterization and identification of OM in the sediment and the effects on the physical properties and the mechanical behavior of sediments.

However, before observing this aspect of the study, as a first step, it is important to characterize the different types of OM in sediment using different standardized tests and non-standard methods.

The results of these tests will allow better understanding of which type of OM is measured with which tests and how about the value measured with ignition tests as known in different domain of civil engineering.

KEY WORDS: *Sediment, organics matters, influence, characterization methods*

1. Introduction:

The practice of dredging generates large volumes of sediments which in some cases may contain contaminants. In France each year about 50 million m^3 [1] of sediment are dredged. These dredged sediment volumes are traditionally dumped at sea, a few kilometers from the coast, in controlled areas. However, due to the harmful induced by dumping at sea, new management solutions are explored over the world [2].

The civil engineering uses over 400 million tons of material (aggregates, sand, cement) of which 96% are of natural origin [3]. The materials reserves are becoming unusable or inaccessible for various reasons: too expensive operation, risk of impact on the environment, integrated with urban areas or located in classified or protected sites. In this context, the dredged sediment, listed as waste according to European classification [3], could constitute a new resource in the context of sustainable development.

Dredged sediment generally consists of a mineral phase, an organic phase (in various forms) and a liquid phase (water). The presence of organic matter (OM) in sediment, even in small amounts, can affect its physical, chemical and mechanical behavior [4]. This is why it is imperative to identify and characterize the impacts of organic matter on the properties of dredged sediments.

The objective of this study is to investigate the influence of OM on the physical properties and mechanical behavior of the sediments. However before this objective, it's very important to select an adequate method to

characterize the organic matter in sediment. For this purpose, different methods of characterization will be compared.

2. Materials and Méthodes:

For the purpose of this study, three original materials are used. The first material is composed of fine minerals with a very small amount of organic matters (FM). The second material is marine sediment (MS) dredged from the south west of the North Sea. The third material is a highly organic material (HO) used generally for the nourishment of soils organically.

The preparation of the sample has followed the same procedure; the materials are first oven dried using a temperature between 40°C and 105°C. After drying, the samples are disaggregated then passed through a 400 µm sieve. This procedure is undertaken to homogenize the samples and to prepare the specimens for the different tests.

Before performing thermal and chemical tests on the different samples, an initial characterization following test standard are performed. The characterization include the measurement of initial water content, grains size distribution, specific density, specific area, methylen bleu test (Table 1).

Tests	Standards
Particle Analysis: Method using laser diffraction	[ISO 13320:2009]
absolute density of solid particles	[NF P 94-054]
Water content	[NF P 94-050]
BET specific surface	[NF EN ISO18757]
The Methylene Blue Value (MBV)	[NF P 94-040]

Table 1 : *standardized characterization tests*

In terms of tests performed to characterize the organic matters, 6 tests different by the procedure recommended, the level of ignition or the type of reagent used are selected for this study. These tests are undertaken according to test standard as mentioned in Table 2.

Thermal tests	Standards
Determination of the weight content of organic material by calcination	[XP P94-047]
Determination of loss on ignition of waste, sludge and sediments	[NF EN 15169]
Chemical tests	**Standards**
Method for determining the organic content	[NF P94- 055]
Determination of the content of fulvic acid	[NF EN 1744-1+A1]
Method of chemical oxidation of organic substances with hydrogen peroxide	[NBN 589-207-3]
Destruction of organic matter by etching with chlorine bleach	[NF U44-164]
Walkley-Black method	/

Table 2 : organic matter characterization methods

3. Results and discussion :

The physical properties of the materials studied in this work are listed in Table 3. According to these results the following conclusions could be drawn.

In terms of grains size distribution, the sediment and the fine material exhibit almost the same distribution even the marine sediment is coarser than the fine material. The high organic material is coarser than both materials. It's to note that for this later mater, its grain size distribution is mainly artificial in a sense that the material at the start of study was crushed. In terms of absolute density, it seems that the measured values are well correlated with the level of organic matter. Higher the amount of organic mater lower the value measured.

Properties	MS	FM	HO
Particle size analysis (%)			
Clay: grains < 2 µm	20.26 %	24.26 %	2.07 %
Limon : 2 µm < grains< 63 µm	63.16 %	71.73 %	29.37 %
Sand : 63 µm< grains	16.58 %	4.01 %	68.56 %
absolute density of solid particles (g/cm3)	2.55	2,7	1.62
Water content (%)	20.19	0.8	39.81
BET specific surface (m^2/g)	6,70	9,57	0.94
MBV (ml/g)	1,09	1,66	-

Table 3*: The physical properties of materials examined*

The water content measure on the different materials is the initial water content to characterize the material at the stage of the preparation procedure. In terms of specific surface, le sediment and fine material exhibit comparable value whereas the highly organic material exhibit lower value. In terms of Blue value both material (sediment and fine material) exhibit comparable value.

The results of tests to characterize the organic matter are presented on Table 4. From these results it appears that the result can change to threefold. This clearly demonstrates the difficulty to characterize the organic matter in a material. From the obtained results it appears also that the thermal method give the highest values whereas the chemical methods predict the lowest values.

Thermal tests	MS OM (%)	FM OM (%)	HO OM (%)
Determination of the weight content of organic material by calcination	8.01	1.27	42.24
Determination of loss on ignition of waste, sludge and sediments	11.58	2.80	73.02
Chemical tests	**OM (%)**	**FM OM (%)**	**HO OM (%)**
Method for determining the organic content	9.40	2.80	53.29
Method of chemical oxidation of organic substances with hydrogen peroxide	3.47	1.04	29.23
Destruction of organic matter by etching with chlorine bleach	5.45	2.24	48.16
Walkley-Black method	5.55	0.68	-

Table 4*: Results of tests to characterize the organic matter*

4. Conclusions

In this study the main concerns is to select three different materials with different amount of organic matters and compare on the basis of these materials different tests methods to characterize the amount of organic matter. From the different methods found in the literature 6 methods were chosen. The comparison of these methods clearly shows the difficulties to characterize the organic matters for the different materials. On the basis of the obtained results, the measured values can change substantially. In general, the chemical methods predict the lower values whereas the thermal methods predict the higher values. This trend is verified on moderately organic material and highly organic material.

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Standards

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