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Geoenvironmental characterization of dredged sediments as alternative materials for covers

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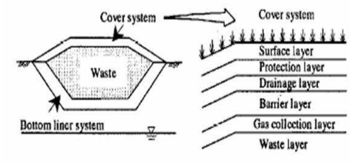
Introduction

Four naturally dried non-contaminated dredged materials (DM) from channels and rivers handled by Belgian Sludge Treatment Centres have been analised. Economically and environmentally management and handling of DM is important in Belgium as huge amounts of dredged material emerge from maintenance, construction and remedial works within water systems. Usually these materials after temporary upland disposal in lagoons are disposed in landfills. One of the purposes of this study is to analyse the possible re-use of these large available quantities of DM as a low-cost alternative material for covers. Unconventional cover materials refer to materials used for covers for waste containment systems that are used as alternatives to regulated or prescribed covers materials with equivalent performance. Consideration of alternative materials usually occurs when: (a) high costs are associated with prescriptive materials, (b) prescribed materials are not readily available, (c) alternative materials are available in large quantities

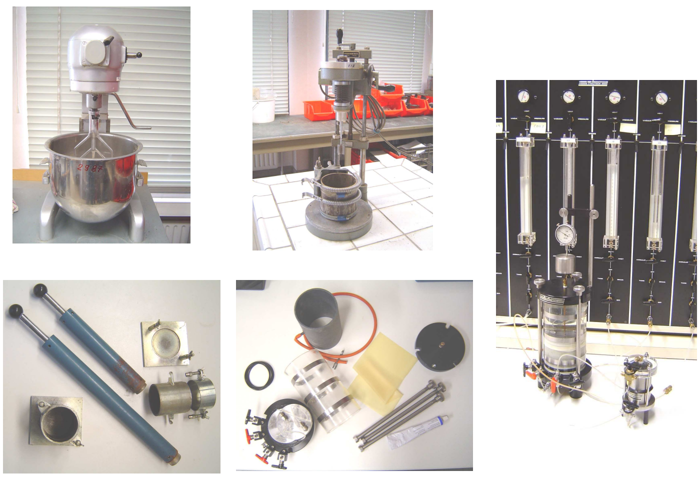


Test procedure

The Proctor compaction curve is evaluated plotting the dry unit weight of a compacted material vs. the water content by means of the compaction mould shown in picture 1. In this study compaction curves for reduce, standard and modified compaction effort have been determined (ASTM D698, ASTM D1557).
Constant-Head tests in flexible wall permeameters (picture 1) have been performed following the standard ASTM D5084 to determine the hydraulic conductivity on the four investigated materials varying the compaction water content of the samples and the compaction effort.
An effective pressure of 25 kPa has been used to represent the confining pressure expected in a cover liner.

Results and discussions

Figure 1 shows the particle size distribution of the four samples investigated obtained by sieving and sedimentation.
Table 1 shows a comparison between the minimum physical characteristics requirements recommended to achieve a hydraulic conductivity lower than a specified limited value for most soil liners materials and the physical characteristics of the materials examined.
Figure 2 shows the hydraulic conductivity values assessed on the samples varying the compaction water content and the compaction effort.



Picture1. Experimental setup

Table 1. Physical characteristics

recommended criteria	fines > 20-30 %	Ip > 7-10 %	gravel < 30 %	Φmax < 25-50 mm	w_L > 20 %	organic content	carbonate content
A	22.90%	24.10%	0%	≤ 2 mm	48.6%	2.4%	2.1%
B	39.40%	36.20%	0%	≤ 2 mm	67.2%	2.8%	3.5%
C	77.02%	24.00%	0%	≤ 2 mm	60.4%	6.4%	14.9%
D	29.10%	14.77%	0.40%	≤ 20 mm	34.0%	1.7%	1.2%

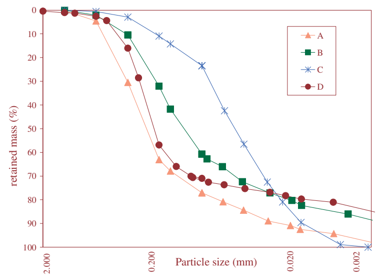


Figure 1. Particle size distribution of the four naturally dried non-contaminated dredged materials analysed

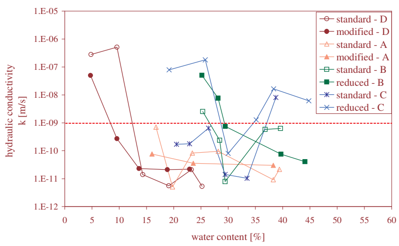


Figure 2. Hydraulic conductivity of the four investigated materials varying the compaction water content and the compaction effort.

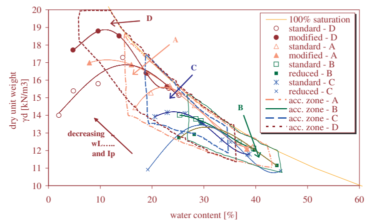


Figure 3. Proctor compaction curves and acceptable zone based on hydraulic conductivity for every alternative dredged materials

Acceptable zone

As a result an "acceptable zone" based on hydraulic conductivity as a function of dry unit weight and water content has been established (Fig. 3). Any compacted material with a dry unit weight and a water content falling into the acceptable zone has a hydraulic conductivity lower than a specified limiting value ($k < 10^{-9}$ m/s).

Conclusions

Test results confirm that the alternative dredged material investigated has shown geo-environmental characteristics respecting suitability criteria for containment applications. Therefore, the use of dredged materials for cover liners is very promising and represents an interesting opportunity for the future use of non-contaminated dredged materials.
It has been observed that the acceptable zones shift towards lower water contents and higher dry unit weights with decreasing wL and Ip. This phenomenon was more evident for two samples with very similar proctor curves. The acceptable zones of these two samples in fact show the same size in terms of range of water contents but shifted depending on their Atterberg limits.