Substitution of Sands by Geotextiles in the Small Dams and Hillside Reservoirs in Algeria

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***Abstract*:** *Algeria lives currently an unprecedented plunder of sands of the rivers beds destination of which is directed to building work including the dams building. The use of the sand for filters and drains creates dangerous situations when the standards and the requirements of design are not respected, because not corresponding sand technically engenders internal erosions and clogging of the filter misleading the ruin of the work. In the construction of dams with local materials, the role of sands remains in the realization of the filters of transition and drains. Contrary to natural sands resulting from beds of rivers, the artificial sands are the product of the crushing in the quarries. Two types who can be the object of a part of the organs of filtration are subjected has a hydrotechnical calculation. The extraction of natural sands raises serious problems to the ecology and the environment. Indeed, this extraction modifies the topography of the stream and a modification of the water flow, and this fact being able to lead natural disasters such as the floods of the waterside plots of land, the overflow near houses, dryings out are also obvious for certain places of the stream so disrupting the ecosystem. Today to avoid the use of sands in the realization of filters we make substitute the latter by a synthetic material: the geotextile. Certainly, the geotextile is a not biodegradable geosynthetic material, because the life expectancy of the work can last several of decades. In addition, this geosynthetic material is easy to set up in the body of the embankment to play its role of filter. Besides, the geotextile is less expensive than the sand in view of their unit price including the implementation. In this work, we shall highlight the places, which would occupy the geotextile in the massif of the embankment.*

Keywords: *geotextile, filter, embankment, sand, hillside reservoirs.*

1. Introduction

In the field of the construction of dams, the sand goes into several components of the water development.

Besides the composition of concretes, the sand constituted an essential element in the construction of drains and zones of transition in embankment using local materials. The origin of these sands is multiple. From streams being thought of by beaches as natural sands, up to the of quarry called artificial sand and the origin of which is rock one of the constituents of the environment. The need for this material taken in the nature deform the environment and modifies appreciably the landscape in particular the beds of rivers so causing the modification of the regimes of water flow so entailing inconveniences to the waterside populations by the inundations. The through local authorities always codified and regulated the exploitation of sands in the construction generally, thing never respected by a part of the operators, in particular the traders of building materials.

The sand intended for the filters of drains, and for the zones of transition is strictly governed by criteria, owing of the vital role that play the drain and the zones of transition in the stability of the work, because a malfunction of the latter can cause the ruin of the dam. The advent of geotextiles is perceived as a salute for the hydraulic constructions in particular.

In Algeria, the substitution of sands by geotextiles was made within the framework of the innovative techniques in the construction of dams for a functioning and much more reassuring certain elements of dams.

2. The Geotextiles of Dams

2.1. Definition

We mean by the geotextiles of dams, the range of this type of material the most adapted and more appreciated in the compacted embankment. They have to be besides filters of drains and the transitions of embankment in earth, as well as in the protection of the geomembrane against the tears, when the latter is defined for reasons technics and economics as solution of sealing of the dam. Under forms of tablecloths fibred these geosynthetic materials their big capacities of filtration and permeability, Resistance fighters in the tractions, in the indentation of the underlying material, and in the separation of the materials of various size gradings. The use of geotextiles in dams in earth tends to improve the yield and the durability of drains and zones of transition[9]. According to the calculations and the sizing realized by the engineer, the manufacturer will define the type of geotextile to apply to the dam in the point of view thickness, weight, resistance in the external loads width of the roller. This last condition can be evaded, because in dams it is recommended to use the biggest width existing on the market to reduce the number of covering surfaces and caulking.

2.2. Location of Geotextiles in Dams

In the body of the dam, geotextiles occupy the place where the sands is imperative in the interest of the survival of the work[10].

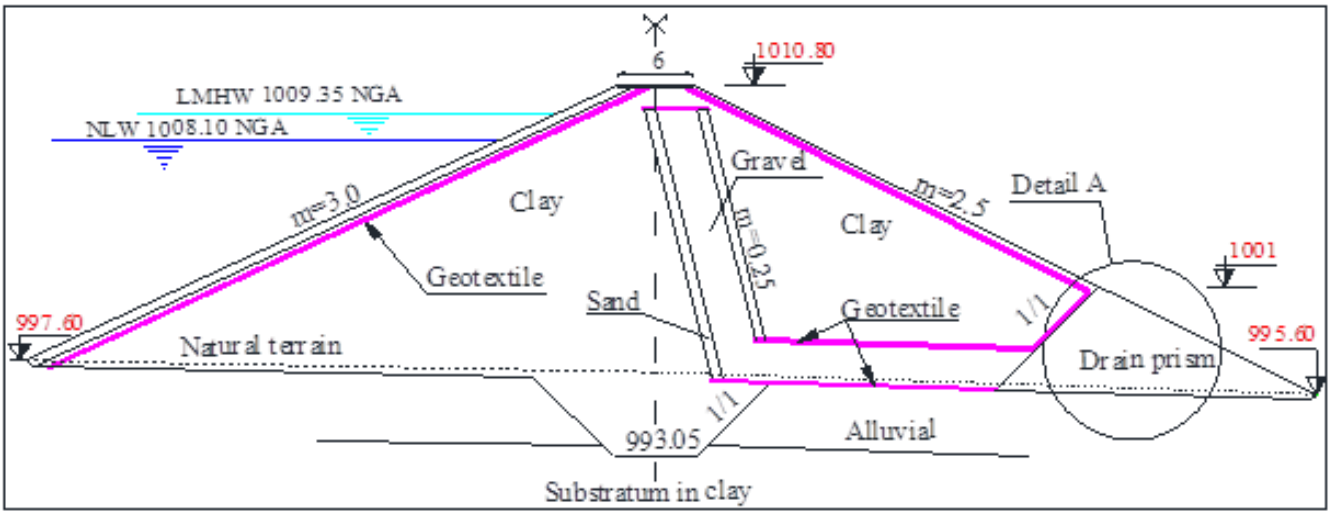

Fig. 1: Cross section of embankment of Taoura

Indeed, the sand in the various types of dams met:

- On the upstream slope between gravels and ground to be protected.
- Between the ground of foundation and the horizontal drain.
- Between the basic ground and the gravels of the drain prism.
- On the downstream slope between the basic material and the ripraps of protection[8].

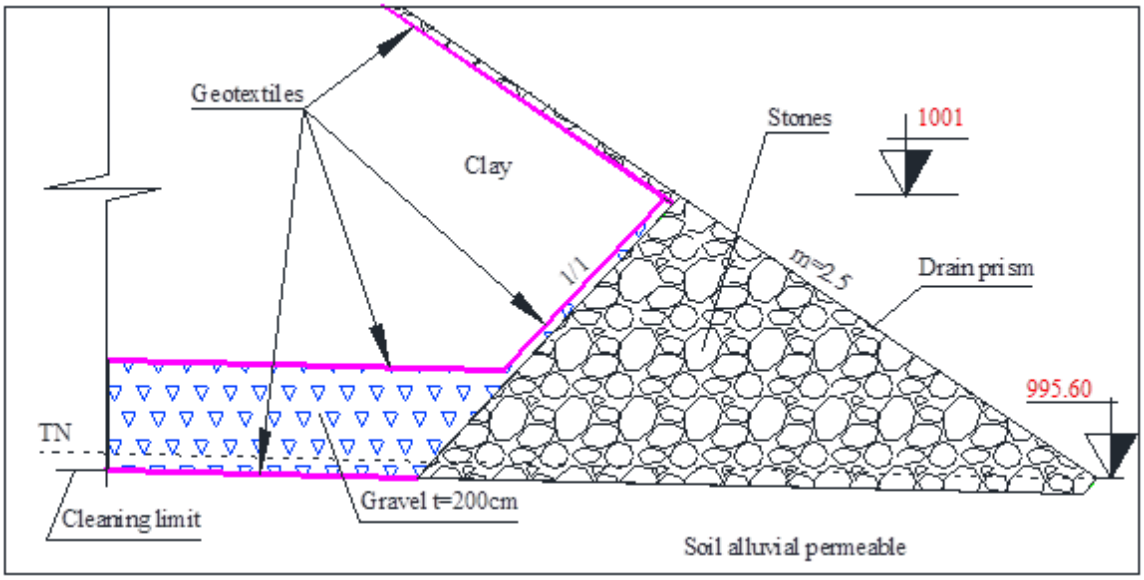

Fig. 2: Detail A-embankment of Taoura

2.3. Computation and Design

The design has for objective to define the permissible permeability of the geotextile to be including in the body of the work. Indeed the speed of flow between the interstices of the geotextile has to be the same that speed defined by the calculations for the layer of sand.

Thus, it is necessary to determine the grading beach, which will join the sand constituting the filter. A sample of this sand will undergo the test of Darcy to obtain the coefficient of permeability which is communicated to the supplier of the geotextile within the framework of the definition of the latter.

The computation is made by means of the criteria of Terzaghi (1922), perfected by the USBR, and improved by Sherard(1984)[7]:

$$\frac{D_{15}(filter)}{d_{85}(soil)} < 4 \div 5 \quad ; \quad \frac{D_{15}(filter)}{d_{15}(soil)} > 4 \div 5 \quad ; \quad \frac{D_{50}(filter)}{d_{50}(filter)} < 25$$

From these conditions are determined diameters D50, and D85 who will allow the construction of the grading beach.

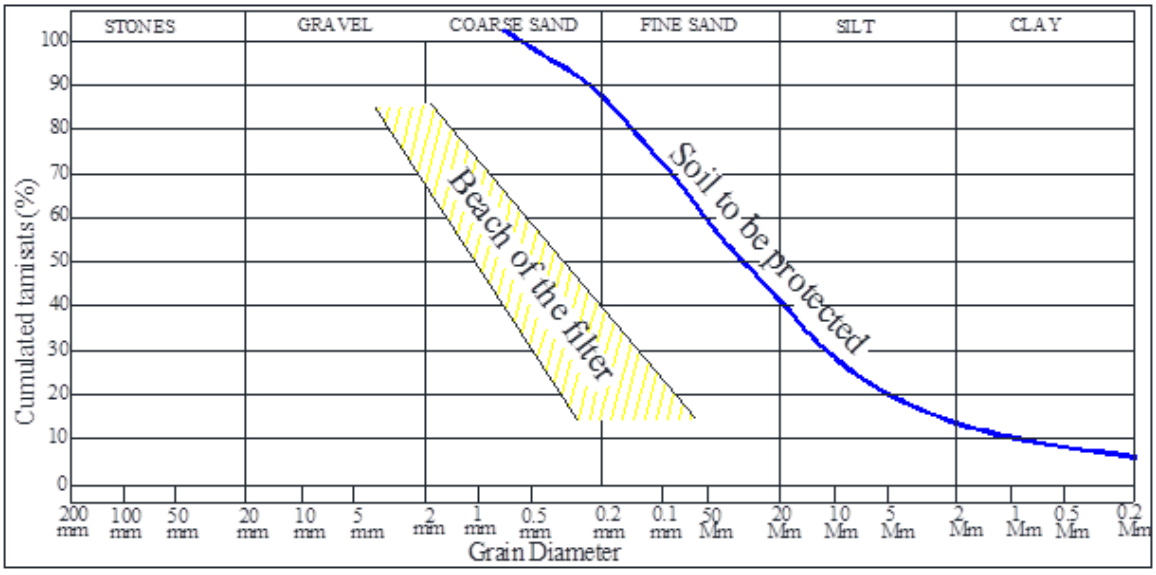

Fig. 3: Grading beach

The grading beach can be also drawn by means of the following conditions [5]:

$$12 < \frac{D_{15}(filter)}{d_{15}(soil)} < 40 \quad ; \quad 12 < \frac{D_{50}(filter)}{d_{50}(soil)} < 58$$

Of this beach is identified the sample which will undergo the test of Darcy's permeability:

$$K=f(D_i)$$

The use of Allen Hazen's empirical formulae, Casagrande, or that of Terzaghi for the determination of the coefficient of permeability is not recommended, because obtained values are very rough. The best way to define K is the test of Darcy on the sample suited to the grading beach. Besides the recommendation of Terzaghi must be considered[7]:

$$\frac{D_{60}(filter)}{D_{10}(filter)} < 2$$

2.4. Characteristics of the Cases of Dams

For our technical economic study between these two materials, the earth dam in Taoura (Souk Ahras)[1], and the hillside reservoir with local materials of Chouiret (Bouira)[2], were chosen to be the object of the comparative analysis.

To understand better our analysis, we give in the picture below the main technical characteristics of both works of the sample.

TABLE I: Main characteristics of both works

Dam	Type	Location of geotextiles	H_d, m	L_d, m	V_{earth} m^3	V_{water} Hm^3
Taoura	Homogeneous	slope+horizontaldrain+prism	14,8	406	99640	1,32
Chouiret	Homogeneous	slope+horizontaldrain+prism	15,0	174	44613	0,34

Table 2 showed the cost prices of every material relative to the small dam of Taoura and the hillside reservoirof Chouiret.

TABLE II: Economic analysis of both materials

Name of Materials	Unit	U.P DA	Taoura		Chouiret	
			Quantity	Amount DA	Quantity	Amount DA
Sand	m^3	1800	15608	28094449	6690	12040478
Geotextile	m^2	1200	23320	27984162	12565	15078926
Difference				110286		-3038448

DA: Local currency. (1$=120DA)

2.5. Comparative Analysis

At the first, before making an interpretation of the results of the table 2, it is useful to quote the advantages and the inconveniences of the use of one of the two materials.

Concerning the geotextile, these advantages are multiple, besides those aforementioned, the material is non-polluting and especially biodegradable after its life expectancy. The most important are that this material is the object of no set apart inconvenience its sometimes less favourable cost price with regard to the sand as the comparative analysis illustrated in the table 2 shows him.

Geotextiles imply no particular technical difficulty when the type of this material is exactly defined. Because the geotextile, once accommodated in the body of the embankment assures perfectly its functions to filter and of separator, while remaining intact during all the life expectancy of the dam. So the ease of its implementation confers him the privilege to be more appreciated than the sand.

As for the sand besides his rarity and the failure to respect the code established concerning the exploitation of this material, he remains however inevitable in the preparation of the concrete, and in certain parts of the constructions in the civil engineering. Unfortunately the sand remains a rather dangerous material when certain criteria and conditions of design are not strictly respected.

For the filters of drains and transition, sands indicated for this role require within the framework of their identification of the additional financial means with regard to concrete sands, and the mortar. Because the sand always remains very vulnerable in the clogging by the fine particles transported in the flow of water through the massif, in particular when the size grading of the latter is inappropriate with regard to the soil to be protected.

Therefore based on these realities, it is the responsibility of the clients are in charge to pilot projects operate with draining devices to be very watchful in the quality control, and the conformity of this material, during the deliveries on construction site and a rigorous follow-up during his implementation.

3. Conclusion

Of this analysis two points are to be retained:

1. The sample concerning the sand the size grading of which joins in the beforehand defined grading zone allows by means of the tray of Darcy to determine the permeability of the geotextile intended for the project.
2. During its delivery the geotextile must be verified in the capacity of permeability in compliance with the result on the sample of the sand corresponding to the grading zone. Thus, it is essential to plan besides the equipments of the mobile laboratory of the geotechnical tests in situ, a bench test allowing the check of permeability of the geotextile defined beforehand during the designing of the latter.
   This bench has to contain two compartments separated by a tablecloth of geotextile. The first compartment welcomes the entering flow, while the second tub intercepts the flow going out crossing the tablecloth of geotextile has fault, and of this fact the coefficient of permeability is easily identifiable from the law of continuity. This bench test will allow to identify also the degree of clogging of the geotextile once in touch with the soil has to protect.

At the end, we recommend the engineers designer to favor in the projects the use of the geotextile instead of the sand whatever is its cost price.

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