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USE OF SOIL-FILLED SYNTHETIC PILLOWS FOR EROSION PROTECTION
UFERBEFESTIGUNGEN MITTELS TEXTILER GABIONEN
PROTECTION DE BERGES PAR CONTENEURS TEXTILES

The use of fabrics on protects river banks has now become a classical procedure.

Near of conventional works (rocks dike with fabric filter) is born news solution using local materials and fabrics pillows. Gabions structures can be utilised for erosion control works, bridge piers protection or construction of temporary dike againts hydrocarbon pollution.

This paper reports on this uses and on economical study for a shore defences projects.

This studies are showed that the fabrics pillows erosion and pollution control system is economic and easily placed in not availability of rocks site.

INTRODUCTION

The use of pillows has always been a simple and rapid means to reuse local materials. In these temporary constructions, pillows were made with wicker or fabric bags (vegetal fibres) structures.

The first uses of these structures with wickerwork date from Egyptian times (cf the Bible) who to protect themselves against the floods of the Nile. The use of fabric pillows as container appeared much later.

However these constructions were only temporary and had to be frequently restored but the abundant and cheap manpower was a favourable element for this type of construction.

The use of fabric pillows in permanent construction was first used for maritime purposes in the sixties in the Netherlands (Delta project) and in Belgium. The first bag-shape fabric pillows have been used for dike foundations.

The use of fabrics on river banks defence has been more recently experimented in Rumania (1) and in the United States (2).

The use of fabric tubes for the construction of temporary dikes has been experimented in France (3) and in Brazil (4).

A - DAM AGAINST HYDROCARBON POLLUTION MADE WITH FABRIC TUBES

A-1- Presentation of the site

The SLACK bay situated on "Le Pas-de-Calais" coast,

photo 1 : Construction of a temporary dike on liquid mud to provide a hydraulic fill deck

at the north of Boulogne, is the remains of a "ria" closed about 5000 years ago when the valley was drowned by the sea.

Because of its aesthetic and biologic value, the SLACK bay (photo 2), dunes and "La Pointe aux Oies" have been scheduled by decree as a protected site (23/11/73).

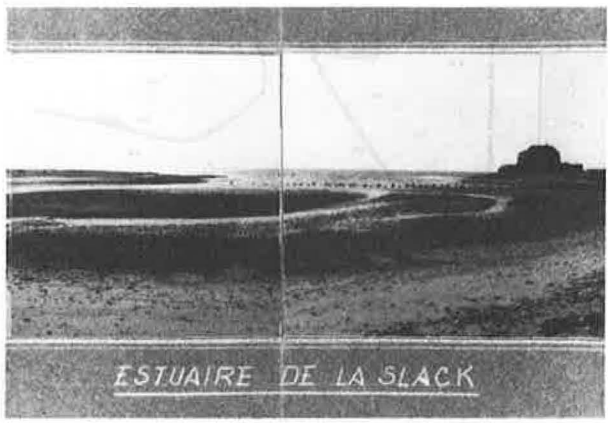


photo 2 : SLACK bay : protected site

This site which is situated in the heart of a very popular tourist area and presents numerous interests needed to be efficiently protected against an eventual hydrocarbon pollution. This is one of the reasons why the SLACK bay estuary has been chosen for the construction of a dam against pollution.

A-2- Configuration considered for the setting up of the dam

The setting up of the dam has taken the following conditions into consideration :
- the purpose of the dam is to avoid a pollution sheet coming from the South West ;
- the normal current has to be as slight as possible ;
- the virtual polluant must be directed in two different recovery areas ;
- the dam has to avoid :
  - rock areas ;
  - wooden poles which are from old wrecks.

All those conditions have lead to the construction of 2 dikes, one of which being a saving back dam necessary in case of rough sea (diagram 1).

1) Principle of the dike

The dike is composed with fabric tubes 10 m long provided with filling-in fabric filter. The tubes are placed up with hydraulic fill (diagram 2).

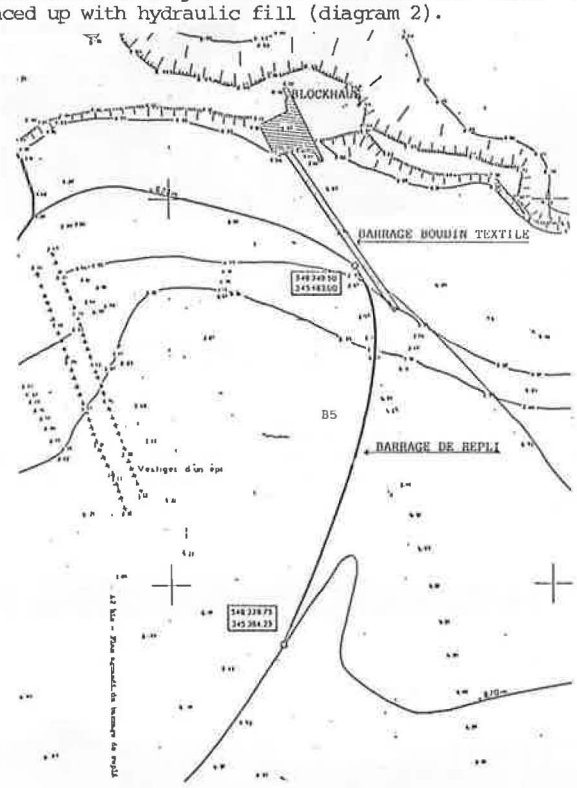
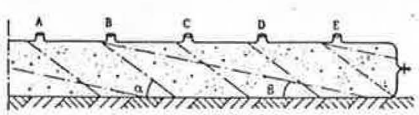


Diagram 1 : Setting-up dam plan



Diamgram 2 : Filling principle

2) Materials used

- Filling up materials : pumped materials in the bed of the river, coarse soil 0/50 mm.
- Fabrics : the fabric tubes have been manufactured with a polyester-polyethylen fabric of 300 g/m^2 whose properties are as follows (standards NF G 38...).

	Warp	Weft
. breaking load kN/m	68,7	70
. failure elongation %	26	18
. permeability (permittivity) $\frac{Kn}{e}$ s^{-1}	4.5	
. porometry O_{95} m	125 m	

the resistance to the hydrocarbons has been tested by an immersion of 2 weeks in domestic fuel oil (approximate time of contact with the hydrocarbons).

- Pumping equipment : the hydraulic embankment has been effected with a DP 50 B TOYO type simkable pump with a capacity of 360 m^3/h (in the worst conditions its efficiency has reached 30 m^3/h). This equipment can pump materials reaching 60 mm in diameter.

A-3- Laying power

Two problems could occur during the filling up of the tube :

1) the tearing of the fabric or of the stitching ;
2) an insufficient permeability due to the large output of the pump and of the quantity of water to drain off

But no problems have occured and the cloth has perfectly played its part (photo 3).

photo 3 : Filled fabric tube of SLACK bay dike

During the filling up we have observed a flattering in ellipse-shape (diagram 3).

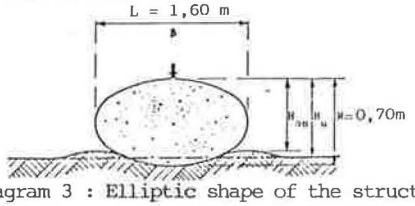


Diagram 3 : Elliptic shape of the structure

This demonstration leads to constructions of one or several elements in alternate rows in order to obtain the required height (diagram 4).

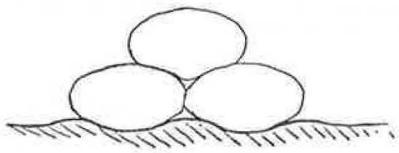


Diagram 4 : Piling of construction elements

A-4- **Conclusion**

This technique represents probably a new utilization for protection against pollution where the construction of floating dams is impossible. Furthermore, this type of work has appeared as a very acceptable defence against the swell.

The cost of this type of construction in the above mentioned conditions has been evaluated at 400 FRF/m of tube. Because of its simplicity, this technique will extend to other purposes.

SAND BAGS IN SHORE DEFENCES

The first utilizations of gabion structures on river banks protects have shown the interest and the flexibility of this system. Studies have therefore been undertaken to improve the existing technique for the river banks in improving the shapes and filling up techniques and by the extrapolation of the shore defences technique in the most threatened areas.

1 - Fabrics and protection of banks

Studies have been made to build up the most suitable cubic pillow for the protection of banks with sand bags.

The cubic pillows made with geotextiles present the following properties :

- protection against contamination,
- filtration function,
- reinforcement function.

With geotextiles (woven fabrics, water-proof membranes, non woven fabrics or woven fabrics and non woven fabrics association), we can make bags of determined shapes and fill them with materials.

When they are closed, these bags fit the shape and the topography of the ground on which the construction is made and of which they are part.

According to the works, these bags have a double role :

- preservation - they protect the ground by enveloping it - the ground can have good or bad mechanical properties ;
- cohesion - effect mechanical part - this cohesive effect is carried out by the retaking of the normal efforts developped during the realization of the work.

The geotextile used to make the cubic pillows must be able to achieve this double part.

Consequently, the geotextile chosen for the realization of cubic pillows has to be submitted to hydraulic and mechanical tests.

The filter properties are determined with a lapping simulator adjusted by STPMVN (diagram 5) for the considered geotextile and the material to be confined (6).

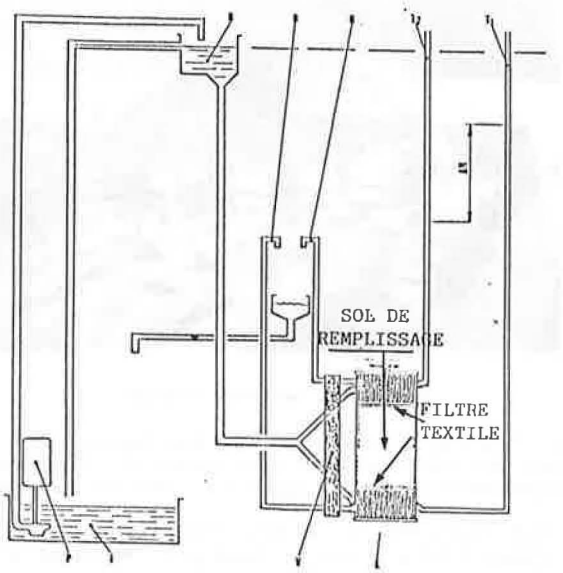


Diagram 5 : Lapping simulator ; synoptic

The product properties are determined according to be standards NF G 38... with special attention to the stitching strength.

The shape chosen for the cubic pillow must allow its auto-stability, the height of the cubic pillow must be inferior to the smallest dimension of its base (5).

For certain defence constructions it can be of interest to give a paralelepipedic shape to the gabion so that they can be better piled up or lined up (channels protection and works protection : bridge piers) (photo 4).

photo 4 : Sand bag : sea testing

Studies on the realization and on the possibilities of assembly of such pillows have been made when constructing civil engineering works. Cubic elements of one ton have been made and assembled for supporting works (7) (photo 5).

photo 5 : Sand bag storage

The filling up of these cubic pillows has appeared very simple and their handling easy (photo 4). Experimental working sites using this type of pillows are envisaged.

In most cases, the use of more classic type bags allows problems of defence against lapping to be solved : this is the case for shore defences works.

2 - Technico-economical study of sea defence with sand bags

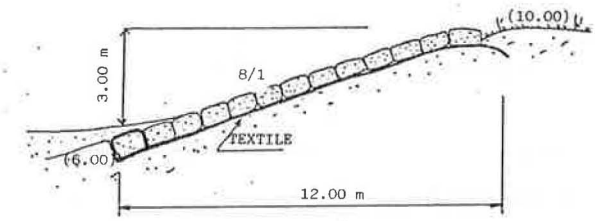
The purpose of this study is to compare this structure to a classical rock defence.

When considering the SCTPMVN manual regarding the construction of coastal structures, it becomes possible to allocate reflection, stability and rugosity coefficients to the system using sand bags in order to establish a rough technical comparison :

- a sand bag defence reflects half as much as a rock defence. An angle of slope at 3/1 is therefore necessary to obtain an acceptable coefficiency of reflection ;
- it is less rugose - coefficiency of rugosity estimated at 0,85-0,90 instead of 0,75-0,80 for the enrockments - and therefore needs a defence size 13 % higher as the swell-mark ;
- at a unitary equal weight, it is less stable. It is considered that its stability is three times as weak as of natural or prefabricated enrockments.

The utilization of 1 to 2 m^3 sand bags can be compared to a light enrockment defence from 1 to 2 tons.
When considering all this data, the solution of shore defence with bags must have the following geometrical characteristics : diagram 6.

The cost of realization of this defence can be estimated at 2 150 FRF/ml which represents the present cost of an enrockment defence. However, a different configuration of the placing of the bags could permit an increase of the rugosity and the stability of the structure. The advantages obtained by the use of long tressed fabric tubes (diagram 7) enable the laying slope to be increase inc and reduce the lineary cost of the defence. Studies are therefore under way in canals and feasability trials with plaiting are undertaken.



- Earth movement	100 FRF/ml
- Geotextile layer	180 FRF/ml
- Supplying of bags	630 FRF/ml
- Bag filling	546 FRF/ml
- Laying of the bags	397 FRF/ml
- Surface treatment	300 FRF/ml
Rainded off to.....	2 150 FRF/ml

Diagram 6 : Type work : sea defence by sand bags

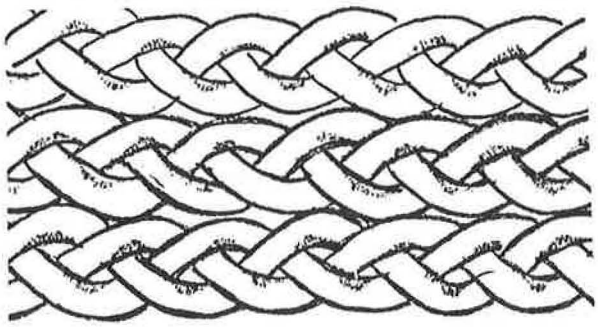


Diagram 7 : Sea defence : sand bags new configuration

3 - Conclusion

In any case, the sea defences with fabric pillows are on an economical and technical point of view possible in sandy regions. Their use will be extended when the fear of U.V. effects and sabotage has disappeared.
Studies are being made to realize constructions with asphaltic sand (containing resin) in order to palliate those still justified critics.

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BIBLIOGRAPHIE

(1) BOTZAND et Al :
Elements constructifs pour la protection des berges utilisant des géotextiles tissés
IId Int geot Las Vegas

(2) STEPHENSON R.W. :
Une étude de sacs en matière synthétique remplis de sable pour la protection contre l'érosion.
IId Int geot Las Vegas

(3) GUILLEMAND H. :
Aménagement de terre-pleins sur vase marine au moyen de digue provisoire.
R et D Rhône Poulenc

(4) BOGOSSIAN et Al :
Digue continue de rétention au moyen de géotextile
IId Int geot Las Vegas

(5) PERRIER H.
Conteneurisation Textile - C.R. de recherche
Centre d'Expérimentation Routière - mars 85

(6) MERRIEN A.
Dimensionnement des filtres géotextiles simulateur de batillage.
Rapport STPMVN (Service Technique central des Ports Maritimes et des Voies Navigables).

(7) PERRIER H. et Al :
Stabilisation d'un glissement de terrain par renforcement tout textile.
Revue Générale des Routes - mars 85