Third International Conference on Geotextiles,
1986, Vienna, Austria

BROUSEK, M., Technische Universität VUT Brno, CSSR
NOVOTNY, P., Výzkumný ústav inženýrských staveb, CSSR

USE OF GEOTEXTILES IN WASTE DISPOSAL CONTAINMENT
GEOTEXTILIEN AUF LAGERPLÄTZEN UND DEPONIEN
EMPLOI DE GEOTEXTILES POUR LE STOCKAGE DE RESIDUS

The contribution deals with the use of geotextiles for tailings. The first part the article describes the first realisation in Czechoslovakia which started 18 years ago and this technology system is continuing.
In the next part there are described three modern application methods designed by Research Institute of Civil Engineering Brno (VÚIS):
- simplification forming of increasing dikes constructed by the means of tailing material,
- the use of textiles as a wind protection,
- the use of textiles against wave abrasion.

For this purpose non-woven textiles (made of second-class materials) have sufficient characteristic,sufficient durability and low price.
We can suppose after these experieces, that the use of the textiles is perspective.

Introduction.

This aim of our paper is to inform the technical public on several possibilities of the use of geotextiles at the construction and operation of waste disposal containment. It means especially on wastes in fluid state which are embeded hydraulically in tailings. The tailings and waste disposal containments influence very unfavourably the geology and hydrogeology conditions of the surroundings, dust the atmosphere, contaminate natural waters and deteriorate the whole eco-system of the near surroudings.That is why it is necessary to set up in a very conscientious way the tailing in natural surroudings and to solve its foundation and operation with greatest care.Of great importance are here the construction costs the need of technologic procedures and work productivity. To this aim prove to be very successful the geotextiles. In our paper we will describe first of all the first engineering application in Czechoslovakia in the years 1967 and 1968 as

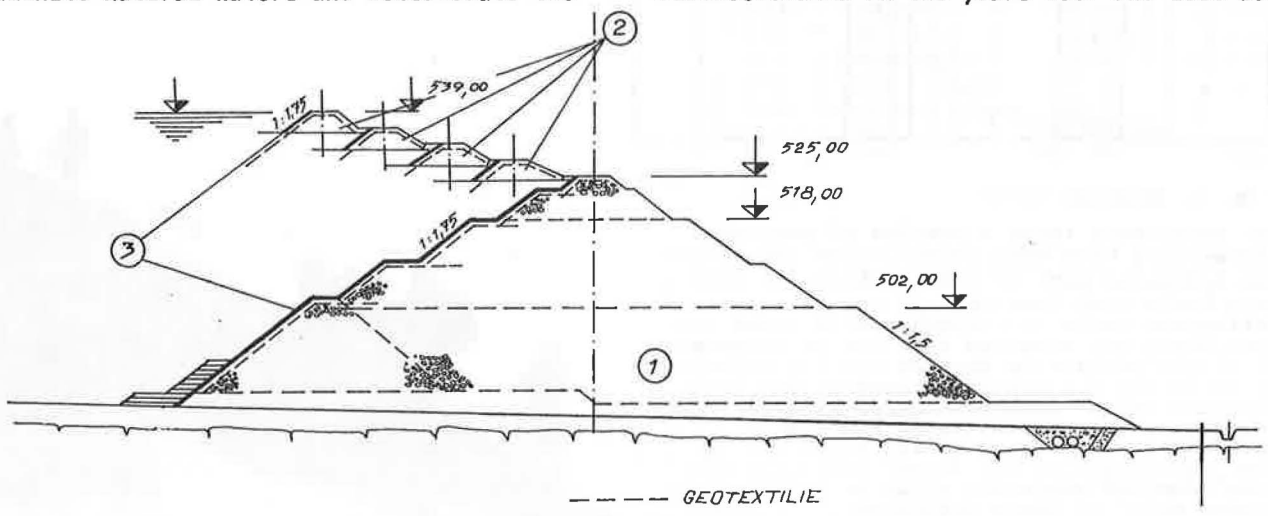

Fig.1. Cross section of tailing with geotextile
1-Rockfill, 2-Raising dams, 3-Geotextile

well as 3 up-to-date applications from the actual time.

1. THE EXPERIENCE FROM THE CONSTRUCTION AND OPERATION OF A TAILING WITH GEOTEXTILES

The work was built 18 year ago at the construction of the tailing for uranium indastry.At that time it was necessary to construct a sufficiently leak proof tailing with rock-fill dame of 41 m maximum height within a very short time.At the same time one had to limit in a maximum way the expected settlement of the dame.The original solution assumed the construction of dams with clay sealing.Because of the imposibility of treating this sealing in winter climatic conditions this solution has been abandoned.Also the sealing from reinforced concrete elements could not be utilized because of considerable aggresiveness of sludge embedded into the tailing. After many discussions a new up-to-date solution was chosen which has been not used so far i.e. the use of geotextiles put on the upstream face of the dam.This solution had to show a sufficient stregth and elasticity of the sealing element as well as a suffcient resistance to the chemical aggressiveness.It had also to assure the sufficient resistance to atmospheric condotions and short construction terms.The tailing design had been done over again and the peripheral dame of the tailing had been filled with stone extracted from a shaft using the seal ing capacity of fine-grain sludge in connection with suitable geotextiles (Fig.1).

1.1 THE CHOICE AND TESTING OF BUILDING MATERIALS

The base for the choice of geotextiles formed the grain size of the sludge embedded.The proposal was based on general knowledge on the sealing action of the material referred to whose grain size below 0,1mm amount to about 91%(Fig2)

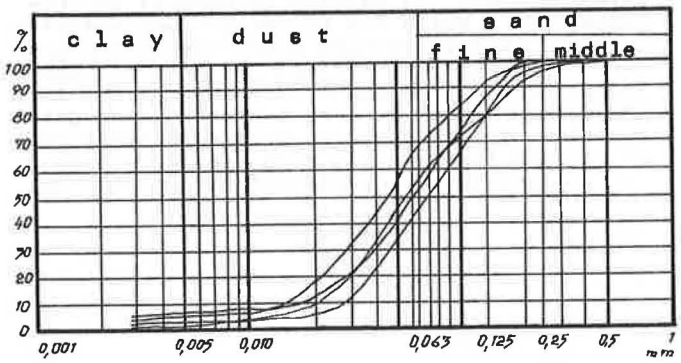

Fig. 2. Grading curve

For laboratory tests 5 samples of polyamide geotextiles have been chosen.First was solved the hydraulic part of this problem.The laboratory tests have been carried out on a special filtration table in cylinders with 127mm diametr.There was examined both the perviousness of single geotextile samples and the capacity of retaining the grains of leaking mud.Both characteristics have been ascertained in vertical flow of liquid.Following mud retaining in geotextiles with frame of the tests carried out the penetration of the finest particles has been observed which was shown by turbidity of leaked water.At these measurements the leakage coefficient of sedimented mud through textiles in range $k=5.10^{-6}$ to $2.7.10^{-5}$ cm/s was determined.Following the positive result of hydraulic tests the resistance of geotextiles was found out.The test have been realized with a tearing machine at the entreprises of textile industries of Brno with a tearing force of 500 kp.One has ascertained the strength of standard ring 5cm wide and 20 cm long.The average of five measurements is shown in tab,1.

Tab.1.

warp		weft	
resistance kp	duebility %	resistance kp	duebility %
223,6	37,0	321,1	42,6

After these simple resistance tests was necessary to demonstrate the hydrostatic pressure directly on the base course designed.For this investigation have been chosen 2 weakest kinds of geotextiles.The tests have been carried out with a permeabilimeter of ⌀40 cm for maximum positive pressure of 5,2 atm. For checking the maximum loading the first tests have been realized on a layer of angular gravel placed on the surface of a layer of finer material.At the test arose no perforation of the geotextile checked.Following these tests and the checking of delivery posibilities has been chosen chemlon geotextile which was supplied in bands 148 cm wide.

1.2. THE JOINING OF GEOTEXTILES

3 methods have been examined : the joining of geotextiles by gluening,welding and sewing.The gluening of geotextiles enable to check a series of glues both on the basis of epoxide, rubber,asphalt and on the basis of putty.The joining of geotextiles by means of welding at the begining seemed to be promising but had to be abandoned as at that time no suitable apparates was available.In competition of 3 available methods the sewing has proved most necessful.For sewing have been developed special terylen threads (123/3).The sewing machine was placed on an inclined working platform which could work in the open air.The device was lowered on to the dam slope with the cable winch of a S 80 dozer (Fig.3.).

1.3. COMPACTING TESTS

To eliminate the deformation of the dam slopes in case of water and mud loads the upstream side had to be perfectly compacted.At the same time it was necessary to finish the surface of the dam faces with fine crushed material to prevent in case of loading the damage of geotextiles.The optimum compacting conditions of the slope have been ascertained on the basis of compacting tests.As the most suitable proved to be a vibratory roller with a 4t mass.

1.4. CONCLUSION

The described sealing of the dams in uniting the sealing effect of mud and geotextiles (joined by sewing) proved successful.The advantage of this method is the possibility of work in unfavourable climatic conditions at frost and snow.In our case on the partial dam of the tailing the geotextiles were laid down from 11. to 19.dec.1967 and on the main dam from 7. to 9.february 1968 (first layer) and from 12. to 19.february 1968 (second layer).In fig.4 we may see the laying down of geotextiles on the dam of tailing.

Further are described 3 solutions with which at present-with a great intensity-dealt the Research Institute of Civil Engineering (VÚIS) in Brno

2. THE APPLICATION OF TEXTILES FOR SHAPING THE RAISING DAM CONSTRUCTED BY TAILING DISPOSAL UNDER TAILINGS OPERATION

The hitherto way of operation of tailing disposal of consists in forming peripheral dams either from tailing disposal material-method mostly applied for ore tailing-or from soil or rock-fill material remaining from other construction activity-methods usual for ash tailing.By the dam constructed in this way is gained the necessary accumulation space for waste storage.

Periohetal raising dams constructed by tailung disposal are formed by means of hydrocyklones, channels or by utilization of building mechanismus,the hand work however being,always necessary.Exceptionally for the construction is used a displaced wood table shuttering.The surface of the peripheral dam constructed in this way is unstable as to the shape,is strongly influenced by climatic conditions and first of all is the source of secondary dustiness. These deficienees and difficulties at the construction of dams removes the structure called textile shuttering designed in several variants differing according to the method of constructing peripheral dams.As the basis for the design have been used the information on wind speed and direction acquired by direct measuring as well as model tests on a special model in an aerodynamical laboratory permitting to check the efficience of technical arrangements at the tailing.The textile-shuttering facilitates the work at the construction of peripheral raising dams of suppress the secondary dustiness, assures the surface stability and thereby the dam shape and reduces the part of hand work in dam construction.It consists of panels with technical textiles anchored in tailing disposal material and assembled gradually in a set shaping the dam surface.The textile shuttering assemblies have been developed for the most often arising tailing disposal methods:

1. tailing disposal with perforated channels - textile shuttering arranged in casettes,
2. tailing disposal with hydrocyclones:
   - textile shuttering of frame type,
   - textile shuttering with contiuous textile on downstream face,
3. tailing disposal through small branches - textile shuttering with continuous textile on upstream face.

2.1. TAILING DISPOSAL WITH PERFORATED CHANNELS

At the tailings silted up with perforated channels proved successfull the construction type shown in Fig 5 where the walls of technical textiles form casettes into which is discharged the material through openings in the

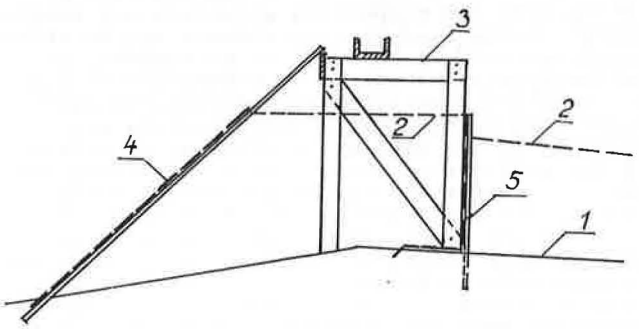

Fig.5. Casette shuttering scheme
1-original surface, 2-surface of hydraulical deposit, 3-supporting construction of channel, 4-textiles, 5-textile netting

channel bottom.In the casettes is first priority embedded material of gross grain.By scattering mud outflow from casettes as it is forced to pass through thin textile,is reduced the entraining force of wat er flow and consequently is intensified the sedimentation of silted material in the space between the casette and the water level in the tailing.The sediment

surface-beach attains then langer slopes than in the case of simple tailing disposal from channel thereby being obtained a larger advance in the height of the peripheral dam above the height level herewith being increased the safety of tailing operation.

2.2. TAILING DISPOSAL WITH HYDROCYCLONES

The second type of struction utilizable for tailing raised on peripheries by means of hydrocyclones forms the panel assembly of frames mounted in stages before hydrocyclones in operation.In the first stage the structure with textile forms a wind obstacle which by breaking down the wind blast suppresses the wind erosion on the sediment surface as well as on the recently raised dam;in the second stage serves to defining the dam shape on the downstream side face fulfilling at the same time the function of losing shuttering.After tailing disposal of the dam it strengthens the downstream surface, prevents wind and water erosion till the realisation of the final surface stabilisation and surface recultivation.

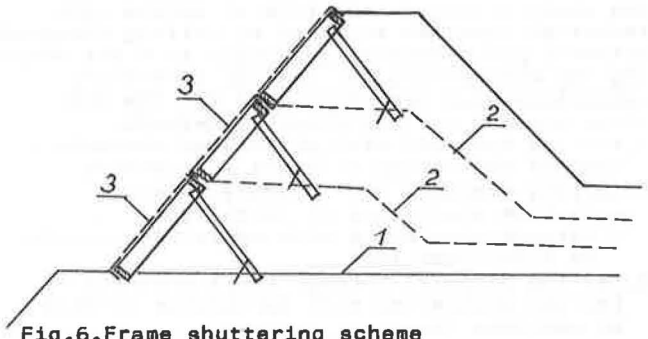

Fig.6.Frame shuttering scheme
1-finished stage og hydraulical deposit, 2-step-to-step increasing of dikes, 3-frame filled up with textiles

The rough material sorted out by hydrocyclone is maintained at comparatively large slope-as much as 1 : 1-so that the horizontal forces acting upon the supporting structure are small. Therefore,the load-bearing element may be relatively subtile.It consists of an assembly of self-supporting frames with dimensions of 1,5x 2,5 m filled with tightened textile.The self-supporting frames (Fig.6) with textile are anchored in the sediment surface or in silted up dam with stakes and supports.The frames are set up to widht and height according to the need.On the test site we have installed 120 l.m. of frames.As a variant solution on the same site we have tested a structure assembly formed of skew webs anchored into the surface with pegs and brace (Fig.7).To assure the transverse stability webs are mutually joined with a brace to which textile is attached.The textiles and braces are put on downstream side gradually to the height depending upon the tailing disposal of the dam.

2.3. TAILING DISPOSAL THROUGH SMALL BRANCHES

For tailings where silted material is only little suitable for the construction of peripheral raising dams the dams are constructed from rock or soil rock-fill material.These dam 3 m heigh,at the crest 4 m wide (the width necessary for driving motorcars) and with slope inclinations 1 : 1,5 represent a considerably large volume of material.By the solution of the suitable type of textile shuttering we have

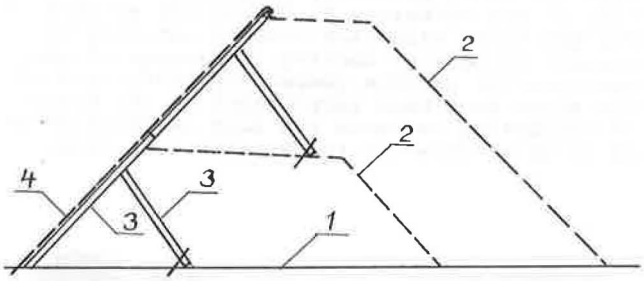

Fig.7.Continuos textile shuttering
1-original surface, 2-step-to-step increasing of dikes, 3-supporting construction,4-textile

followed first of all two aims - to reduce the quantity of conveyed material needed for the construction of the raised dam and to assure more expressive forming of the beach (i.e. of its more slope and take away the free level from the dam).That is why on the test site we have assembled one half-frame structure attacked both in the tailing disposal material and the dam mutually joined with transverse braces (Fig.8).To this structure was attached the textile so thust its lower edge was slided in under the tailing disposal surface.The tailing

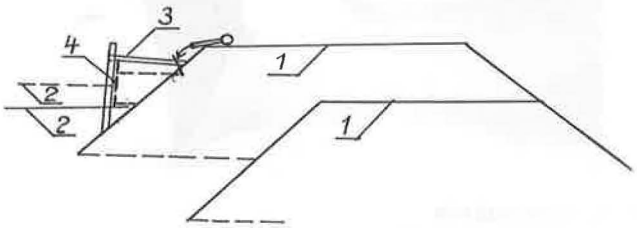

Fig.8.Textile shuttering on the downstream side 1-step-to-step increasing of dikes, 2-surface of hydraulical deposit, 3-supporting construction, 4-textiles

disposal of material was carried out by branch pipes ø 70 mm from the main mud pipeline led on the crest.The lenght of the test field was 45 m and the verification time 1 year.

3.THE USE OF TEXTILES AS PROTECTION AGAINST DUSTING

One of the most serious problems which by its consequences considerably influences the surroundnigs is the secondary dusting from the surface of tailings due the wind erosion. The tailing disposal material is dried out by wind and airborne as far as several miles.Following the carrying out of laboratory tests and of direct installations on various localities we have made a proposal using technical textiles. The tailings operation since the beginning till the end of its function is done at several stages.In each of these stages arise secondary dusting of tailing disposal material,for each stages,however,is critical a different part of its surface.
At the tailing in operation whose peripheral dam is constructed of tailing disposal material the most exposed place is the crest of the peripheral dam adjoing parts of the upstream and

downstream side faces.As the most suitable way of surface stabilisation proved successful textiles laid in bands 6 to 8 m long transversely to axis of the dam and anchored to the surface with steel hooks (Fig.9).By the large space verification in this way was protected

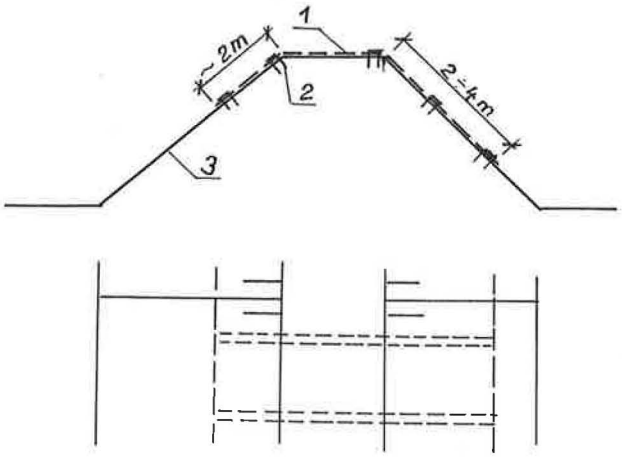

Fig.9.Textile covering on the dike 1-textiles, 2-anchor clip, 3 surface of hydraulical deposit

the peripheral dam of an ore tailing on the lenght of 750 m.After one year observation it was stated that the principle of crest shape stabilisation and of the adjoining dam slopes with a textile covering is good and efficient. Proved successful also the types used of textiles - for the most exposed places all synthetic knitted textiles of 100% polypropylene meanwhile for other surface sufficed non-woven textile made of secondary raw materials.
A tailing put out of operation e.g. for the construction of raising dams dusts most from the sediment surface.The water level is during raising intentionally lowered to diminish the moisture of tailing disposal material,to permit using it for the construction of peripheral dam and at the same time to enable the driving o mechanisation equipments on the surface of tailings.In this case the surface of beach is for a long time as many as 3 years exposed to wind action. The substance of the new solution consists in constructing a covering from technical textiles anchored into tailing disposal material. To this aim was very advantageously used non-woven textile which has a limited service life is produced mostly of secondary raw material. In usual estimatic conditions it is gradually biologically degraded the composition heterogenity assuring long termed nearly 3 years coherence against photochemical degradation in dry or drying subsoil. It is deteriorated by the action of microorganismus in moist medium or owing to covering by wastes. It is placed on the surface in such a way that single bands of textiles have a mutual overlap of 10 cm. At the place of overlap the textile bands are attached to the surface with iron hooks (Fig.10).
The filled up tailing whose operation has been ended dries and dusts from the whole surface especially at the spots damaged by other activities (water erosion, travel of motor cars etc.). Till the finish and recultivation of the surface suitable is also the treatment described above.

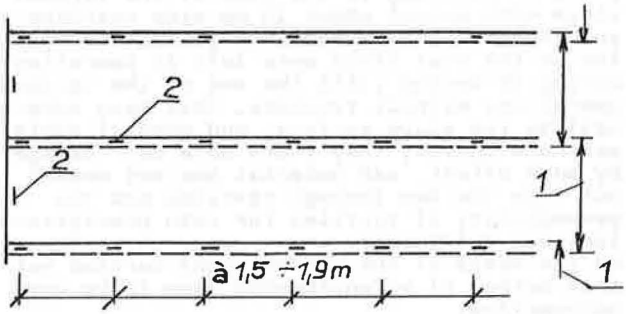

Fig.10.Scheme of deposit and anchoring of textiles on beach 1-stripes of textiles, 2-anchor clip

4. THE USE OF TECHNICAL TEXTILES FOR THE PROTECTION OF THE UPSTREAM FACE OF PERIPHERAL DAMS OF TAILING AGAINST WAVE ABRASION

The upstream faces of dams especially of slag-ash tailings are usually protected against abrasion of waves by a macadam layer 25 cm thick spread on the slope surface. This made of protection is rather expensive. Beside that the lining is gradually overflown with tailing disposal material, its function time is relatively short - max 3 years - and the rock-fill material is not sufficiently utilized.

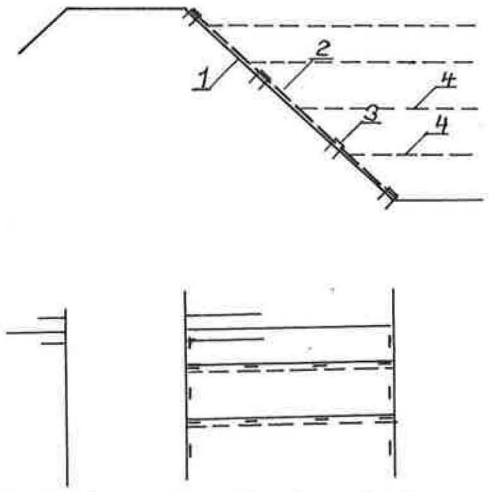

Fig.11. Surface strengthening of the upstream side 1-surface of dam, 2-textiles, 3-anchor clip, 4-gradual material deposit on tailing

As a substitute solution for the stabilization of the upstream slope surface has been designed and experimentally verified the use of

textiles on a slag-ash tailings. A test field was chosen more than 60 m long and 5 to 8 m wide with several types of non-woven textiles produced of secondary raw materials. The textile bands have been placed on the slope surface according to the line of the largest slope with mutual about 10 cm wide overlaps and anchored into subsoil (Fig.11). The textiles on the test field were left in operation during 16 months (till the end of the tailing operation) without troubles. They have adhered well to the slope surface, and even if surface was here uneven, they there were not damaged by wave effect, ash material was not washed out from the dam through textiles and the permeability of textiles for rain precipitations was sufficient.
On the basis of the observations carried out this method of strengthening seem to be very perspective.

5. CONCLUSION

On the basis of hitherto experience with trial application of geotextiles we may state that their utilization is very perspective especially with regard to the fact that on the tailings surface after about 3 years the finish and recultivating are carried out.The textiles especially non-woven one made of secondary raw materials with a limited service life are of very low price and have sufficient resistance characteristics and, therefore, for the purposes of temporary protection of the surface are fully equivalent to traditional materials.