GEOTEXTILES - A NEW WAY OF CONSTRUCTING QUALITY ROADS AT LOWER COST

by

Professor J.M. RIGO,
Ir. L. COURARD

Geotextiles and Geomembranės Research Centre
State University of Liege

SUMMARY
Geotextiles and geotextiles related products are now widely used in many fields of civil engineering.

This paper is focused on applications in road engineering.

Recent developments of successfull technics will be presented hereafter : the use of geocomposites in roads drainage and the use of geotextiles in reflective cracking problems.

1. INTRODUCTION

Geotextiles and geotextiles related products were considered in the past and for a long period as secondary materials and materials embankments. Progressively with the help of serious researches and experiences they were accepted in more and more severe conditions of uses. Geotextiles are now widely used and often in constructions where they participate actively to the general safety.
The original materials are now used in combination with grids, tubes... to constitue the so called **"geocomposites"**.
This paper will present briefly a type of material that can be used as lateral drainage system for roads.

Used in combination with modified bitumens, geotextiles can create a stress absorbing interlayer in road structures.
The uses in reflective cracking is to be considered as one of the most promising market growth of geotextiles and geotextiles related products.

2. GEOCOMPOSITES IN ROADS LATERAL DRAINAGE SYSTEMS

The drainage of road structures is essential to insure a suffisant life-time. Water there is inauspicious because it reduces the soil bearing capacity, and it can also induce deformations in case of freezing.
Water can be accumulated :

- by infiltration through the road structure;
- due to water flow in the surrounding soil;
- by the thaw of the freezed layer of the road structure.

In order to eliminate this water, lateral drainage systems are installed. These are "classicaly" constitued of a trench in which pipes and aggregates wrapped in geotextiles are installed.
Alternative solutions are now proposed : continuous parallelipipedic plastic drain is wrapped into a classical geotextile acting as filter (fig. 1) [1].

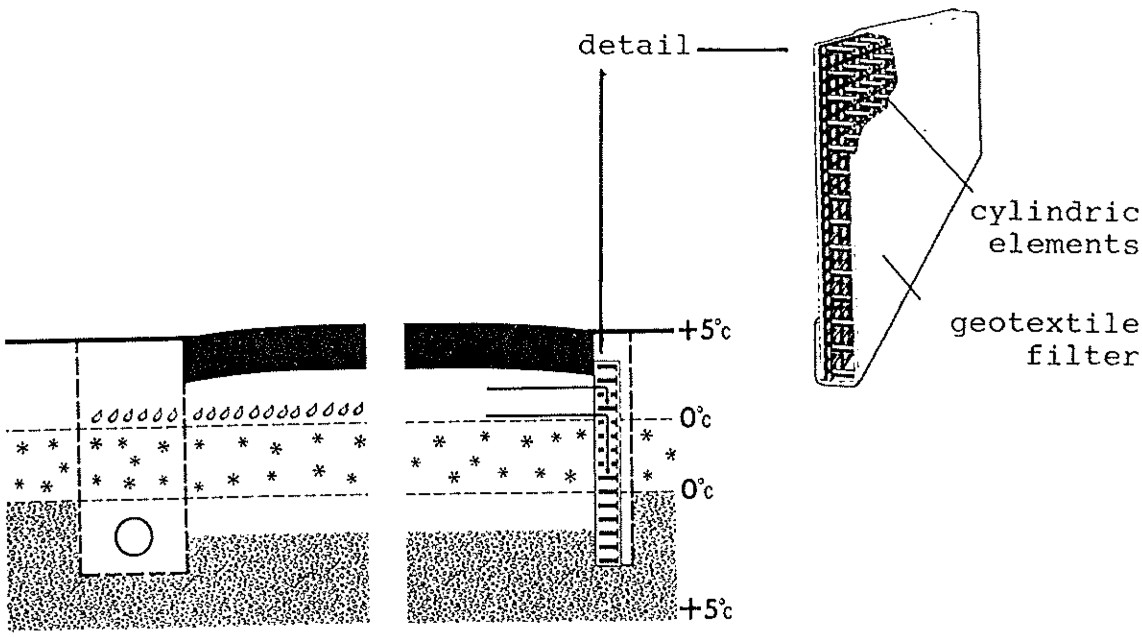

Figure 1 : road lateral drainage with geocomposites

These prefabricated elements are installed uninterruptedly at the limit between the road and the sideway. Special junction elements permit to insure connections with main pipes.
When a road structure is waterproof and of good bearing capacity, the placement of vertical drainage system avoid, at low cost, the installation of freezing barriers.
In fact, at the end of the winter (fig. 1) the thaw of the upper of the surrounding soil. A classical drainage layer doesn't permit the evacuation of the thaw water because the lower layers are freezed.
Degradations in the road structure can then occur under traffic loading.
In such a case a traffic limitation is the only solution.
Lateral vertical drainage permits the lateral progressive evacuation of the thaw water.
This type of application shall be a success if the next requirements are fulfilled :

- the geocomposite must have a great lateral **resistance to compression** (> 400 kPa);
- the **transmittivity** must be high even under lateral pressure and under fatigue loading;
- the geotextile must be designed to resist to **blocking**;
- the plastic drain and the geotextile must be bonded together to insure the system integrity after placement;
- the placement must be correct. A good contact between the drain and the trench is necessary for the creation of a natural filter that avoid the blocking or clogging of the geotextile.

3. GEOTEXTILES IN REFLECTIVE CRACKING

Geotextiles and geotextiles related products can be adequately used in combination with modified bitumen to act as stress or strain absorbing membranes interlayer in road structures.
The road structures (fig. 2) are subjected to :

- traffic loads;
- temperature changes.

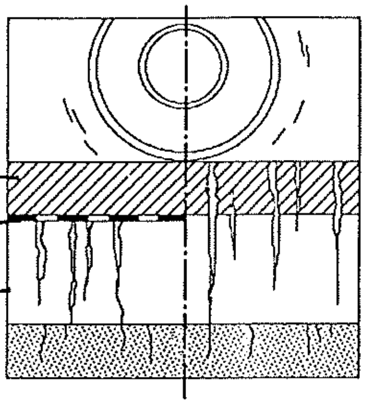

Figure 2 : the use of geotextiles in reflective cracking

Due to loadings and/or to the shrinkage of the cement stabilised gravels used for the foundations, some cracks can appear in the road structure.
Repair technic often consist in laying down an overlay on the existing structure (5 to 7 cm thick).
If the new overlay is bonded firmly on the cracked structure, the existing cracks will propagate quickly through the overlay and appear at the new surface at the same locations : this is the so-called reflective cracking phenomenon.
Many solutions have been studied up to now to wrestle against the crack propagation in existing roads :

- to increase the overlay thickness;
- to reinforce the overlay with plastic a steel wires;
- to use modified bitumen in the overlay;
- to place thick (1,5 cm) layers of sand-bitumen mixes between the structure and the overlay;
- to place plastic grids at the interface;
- to place modified bitumen saturated geotextiles at the interface.

This last solution was the center question of a conference held in Liege in March 1989 and organized by the authors and others [2].
It should be too long to discuss and compare the solutions presented here before. It must be pointed out that the solution using geotextiles saturated with modified bitumens present a very good quality/price ratio.
It is essential to understand the mechanism by which cracks of the lower layers of a road structure can propagate to the top.

Three mechanisms can be pointed out but no agreement has been obtained to know which one is preponderant :

- the classical thermal fatigue mechanism : the daily temperature changes create openings cycles of the shrinkage cracks of the cement treated layers. If the bituminous overlay adhere perfectly to these layers, the deformations due to the openings of these cracks will induce a stress concentration at the crack tip inducing a debonding of the overlay from its substrate. If the bonding of the overlay on the substrate resists, the crack will propagate from the bottom to the top;
- a second mechanism, also from thermal origin was presented during the conference : cracks could be initiated at the top of the overlay and propagate from the top to the bottom.
  In this mechanism, the thermal gradient in the structure during cold weather induces a heaving of the overlay edges at the level of the cracks. This induces tensile stresses in the upper part of the overlay.
  The stresses, added to the thermal contraction stresses, can induce cracks;
- the third mechanism involves the traffic : the repetition of traffic stresses help to the propagation of thermal cracks. Traffic loads can induce different kinds of cracks movements : bending of the structure with an opening of the cracks (mode I), shearing movements of the cracks (mode II) due to bad bearing transport between the slabs elements.

A general agreement was obtained on the facts that the thermal stresses initiate the cracks and insure the beginning of their propagation and that the traffic is responsible of the latter cracks propagation.

To explain how the anti-reflective cracking interlayers act, the first of the above described mechanisms can be chosen. It is requested to avoid the transmission of the opening movements of the cracks in the overlay. Two different ways are possible :

- to create a debonding between the overlay and the structures, this is for instance a mode of action of the geogrids;

- to diffuse the displacements within highly deformable layers for the thermal stresses (slow motion), this is for instance a mode of action proposed for the thick stress absorbing membranes interlayer using rubber modified bitumens or for the modified bitumens saturated geotextiles.
  Those who present this last thesis insist very much on the necessity of a good bonding between the overlay and the structure.

The difficulty in designing these membranes is that these musn't be too deformable in case of traffic loading because excessive fatigue stresses can be induced in the overlay as it could be done if a debonding occur.
To reinforce the overlay needs reinforcement with high stiffness compared to the stiffness of the material to be reinforced.
Table 1 gives stiffnesses of various materials.

Table 1 : material stiffness (MPa)

Materials	Stiffness (MPa)
Overlay for traffic loads	10.000 ——> 30.000
Overlay for thermal loads	1.000 ——> 10.000
Polyester	12.500
Polypropylene	12.000
Geogrids	15.000
Fiberglass	75.000
Steel	210.000
Cement treated materials	15.000
Cement concrete	20.000

This processus has been presented by those using polyethylene or polypropylene geogrids. It seems actually that the debonding processus explains better the relative efficiency of the geogrids.

It is evident that a geotextile with its low moduli can not reinforce an overlay.
It is also believed that the geotextile-bitumen interlayer can slacken the cracks propagation due to traffic loading. This can be explained by the fact that the bitumen is visco-elastic : the material stiffness increases with the loads application rate.
Finally it must be reminded that the interlayer membranes must also insure a waterproofing function when the overlay is cracked.
The use of geotextiles and geotextiles related products have proved to increase the overlay life-time by factors of 2 to 10 relatively to the case where the overlay is placed directly on the road structure to be repared.
Substantial economies can be obtained at the condition that the adequate products and placement technics are used.
In U.S.A., reflective cracking represent one third of the total geotextiles market. In Europe, this market represents only a few percent of the total consumation.
These differences cannot be very easyly explained : differences in mentalities for the use of new materials, different weather and traffic conditions, different road structures...

4. CONCLUSIONS

The use of geotextiles and geotextiles related products have changed the conception and the design of many civil engineering works. They introduced new functions and permitted some original and cheap solutions.
In the road engineering specially, they permitted to increase significatively the structures life-time.

5. BIBLIOGRAPHY

[1] Hydraway Info, summer 1988.

[2] Reflective Cracking in Pavements : Assessment and Control, edited by RIGO J.M. - DEGEIMBRE R., Liege, March 1989 (a conclusion proceeding will be published).

1. Internationales Techtextil-Symposium 1989

Geotextilien für den Tiefbau
Les géotextiles pour le génie civil
Geotextiles for Civil Engineering

TECHTEXTIL 2.1

Dipl.-Ing. K. C. Zerfaß, Hoechst AG, Frankfurt (D)

Practical experience with geotextiles - typical applications.
Résultats obtenus avec les géotextiles - exemples de problèmes résolus.
Erfahrungen mit Geotextilien - beispielhafte Problemlösungen.

2.1.25

R. Biguet, Asqual, Paris (F)

Quality certification for geotextiles - a need for the European market?
Le certificat de qualité des géotextiles: une nécessité pour le marché européen?
Das Qualitäts-Zertifikat für Geotextilien - ein Erfordernis für den europäischen Markt?

2.1.26

Dr. E. Leflaive, Texsol, Paris (F)

The Texsol method - soil stabilization with filament yarns.
Le procédé Texsol: une nouvelle méthode de consolidation des sols à l'aide de fils continus.
Das Texsol-Verfahren - eine neue Methode zur Bodenverfestigung mit Filament-Garnen.

27

Dr. J. P. Gourc, IRIGM, Grenoble (F)

Soil stabilization - theoretical studies and practical results.
La consolidation des sols - recherches théoriques et résultats pratiques.
Bodenbefestigung - theoretische Untersuchungen und praktische Ergebnisse.

28

P. R. Rankilor, Manstock Geotechnical Consultancy Services Ltd., Manchester (GB)

The use of wharp knitted DSF geotextiles and erosion control geotextiles in landscape architecture, civil engineering and landslip stabilisation.
Tricots chaîne mono-, bi- et multiaxiaux dans la construction paysagée.
Mono-, bi- und multiaxial ausgelegte Kettengewirke im Landschaftsbau.

29

Prof. Dr. J. M. Rigo, University of Lüttich (B)

Geotextiles - a new way of constructing quality roads at lower cost.
Les géotextiles: une nouvelle technique de construction de routes de haute qualité, à moindre coût.
Geotextilien - ein neuer Weg zum Bau von Qualitätsstraßen zu niedrigeren Kosten.

30

Dr. Ing. P. Ehrler, Institut für Textil- und Verfahrenstechnik, Denkendorf (D)

Short-time tests for determining long-term durability of geotextiles in dynamically-stressed structures.
Essais accélérés pour déterminer la résistance à long terme des géotextiles dans les ouvrages soumis à des sollicitations dynamiques.
Kurzzeit-Tests zur Ermittlung der Langzeitbeständigkeit von Geotextilien in dynamisch beanspruchten Bauwerken.

31

Dipl.-Ing. P. Risseeuw, Akzo, Arnhem (NL)

The long-term behaviour of polymers for soil stabilization.
Comportement à long terme des polymères dans le renforcement des sols.
Das Langzeitverhalten von Polymeren in Bodenarmierungen.

32