Design of waterflow in geodrain composites under the aspect of creep

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Keywords: Drainage, Creep, Design method, Filtration, Shear

ABSTRACT: In a multilayer composite for drainage all elements (nonwoven filter, drain core) may creep. Tensile creep of nonwovens and compressive creep of drain cores lead to reduced in-plane water flow. Creep tests under normal and combined normal and shear loads give estimations of the behavior. If in-plane water flow is measured versus thickness instead of pressure, a simple design nomogram can be proposed.

1 INTRODUCTION

Geosynthetic drain composites are widely used. Some main applications as landfill covers, road and railroad drains, require safe long-term function. The drain composite has to conduct downslope the amount of water, which reaches and passes the geotextile filter. Fig. 1 shows the generic function on a landfill.

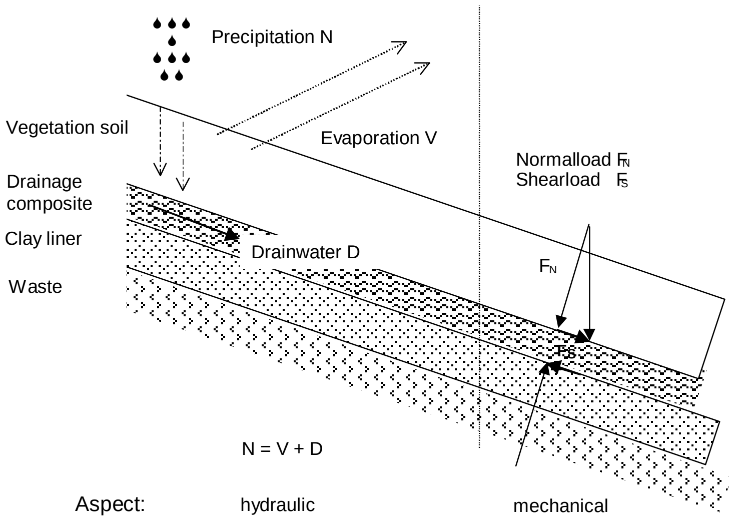

Fig.1: generic function of drain in a landfill cover

2 CREEP OF DRAIN COMPOSITE'S ELEMENTS

Geodrain composites consist of two or three elements (see Fig.2a): Filter on top, draincore; and optional filter or liner at the bottom (backing) (typical product in Fig. 2b).

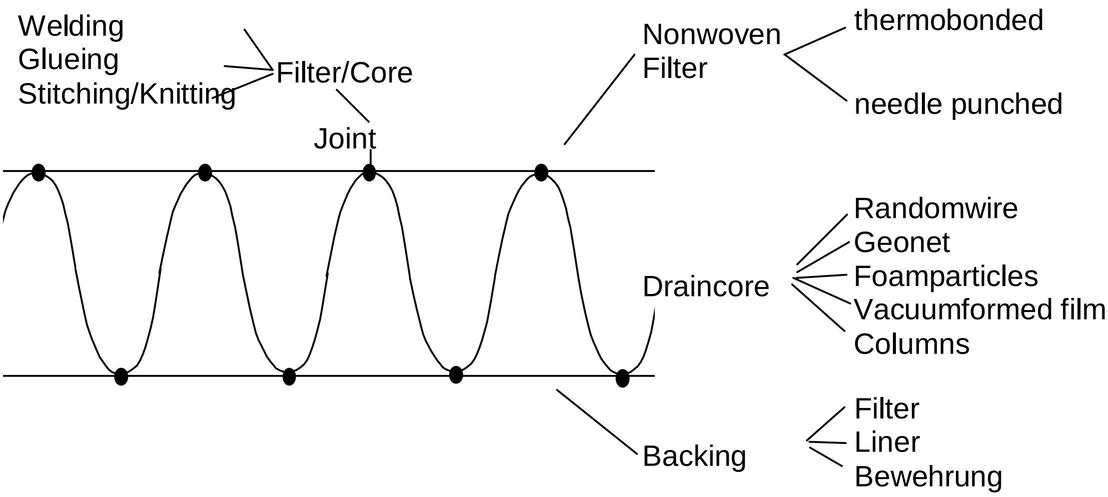

Fig.2a: generic function of drain in a landfill cover

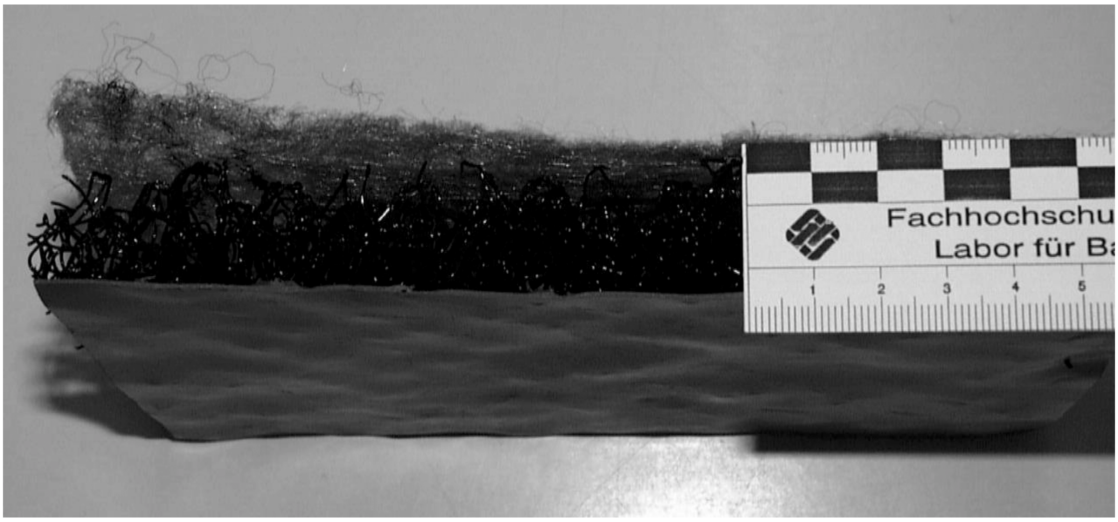

Fig.2b: typical drain composite

In this composite creep may influence the drain in-plane water flow by
- tensile creep of the nonwoven
- compressive creep of drain core
- shear failure

3 TENSILE CREEP OF NONWOVENS

As creep of nonwovens is rarely tested we refer to an old thesis work from 1986/1/, which shows the different creep behavior of mechanically (M) and thermobonded (T) products (Fig. 3)

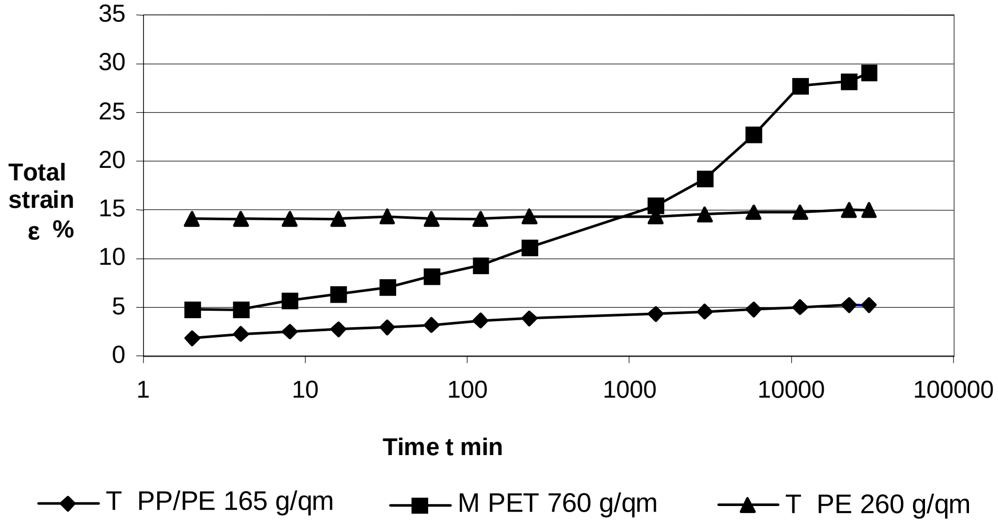

Fig.3: Tensile creep of 3 nonwovens /1/

4 COMPRESSIVE CREEP OF DRAIN CORES

The creep behavior of corematerials depends on their polymer and forming (see also Corbet at Eurogeo 1). Some typical curves are shown (Fig. 4)

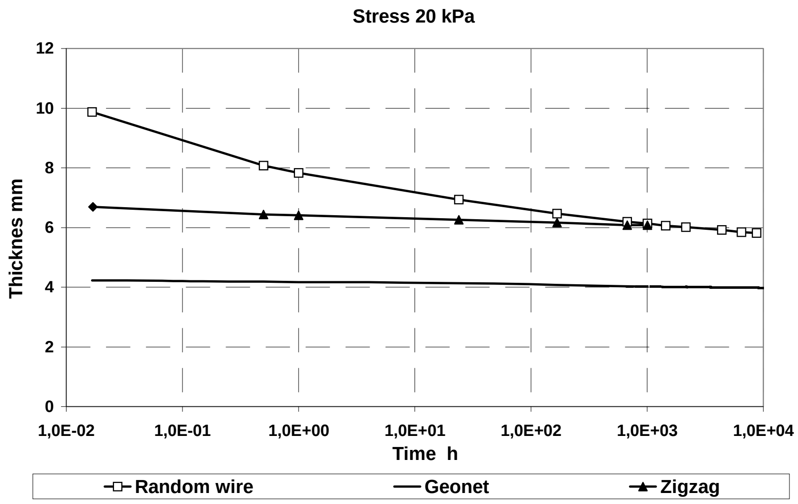

Fig. 4: Compressive creep of 3 Draincomposites /3/

5 SHEAR FORCES ACT SIMULTANEOUSLY

The curves change for some products, as there is stability failure, see Fig. 5. These curves are not predictable for the whole time scale, long term behavior is only predictable after collaps of the form.

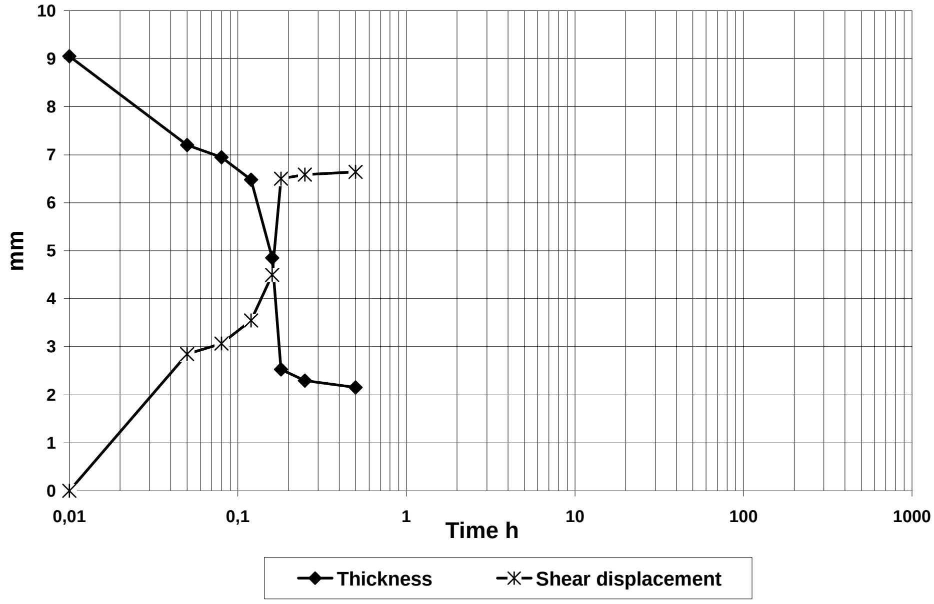

Fig. 5: creep of vacuum formed films under normal and 20% shear stress.

Other materials show extrapolatable curves.

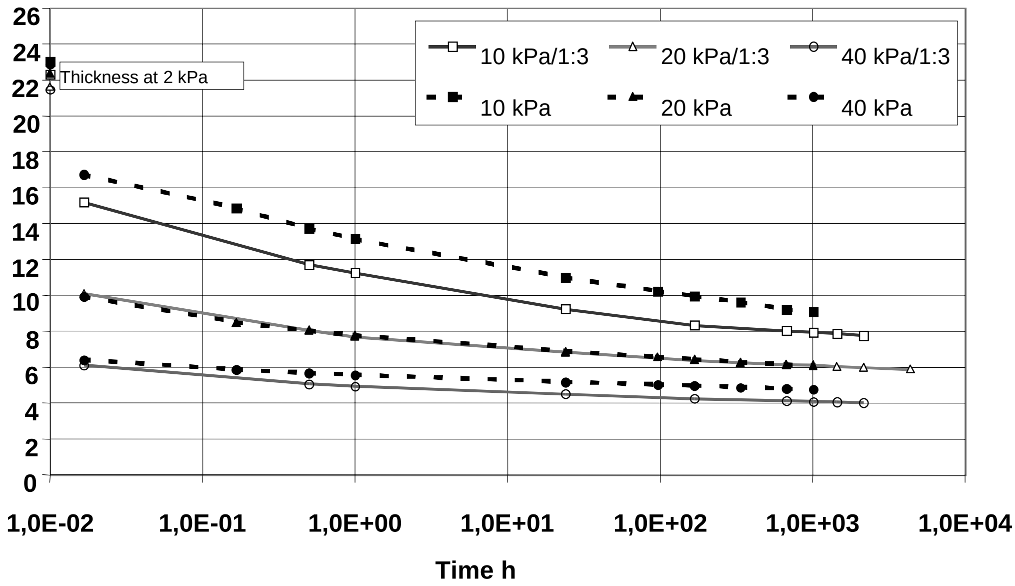

Fig. 6: random wire creep under normal and shear stress

The creep curves of geonet, random wire cores seem predictable. The linear extrapolation of creep curves is conservative, as there is no final value ZERO imaginable. A product of 1000 g/m² PP has at least a nonporous material thickness of 1.1 mm.

6 WATER FLOW TESTING FORCE CONTROL / THICKNESS CONTROL

The Standard EN ISO 12958 requires tests under constant stress. As creep is acting during the test time, a time dependent value is resulting. Using the identical EN ISO techniques it is possible to measure flow in thickness control. If the flow is known for a range of thickness values (see Fig. 7), the flow at a certain date including creep deformation i.e. a certain thickness can be interpolated.

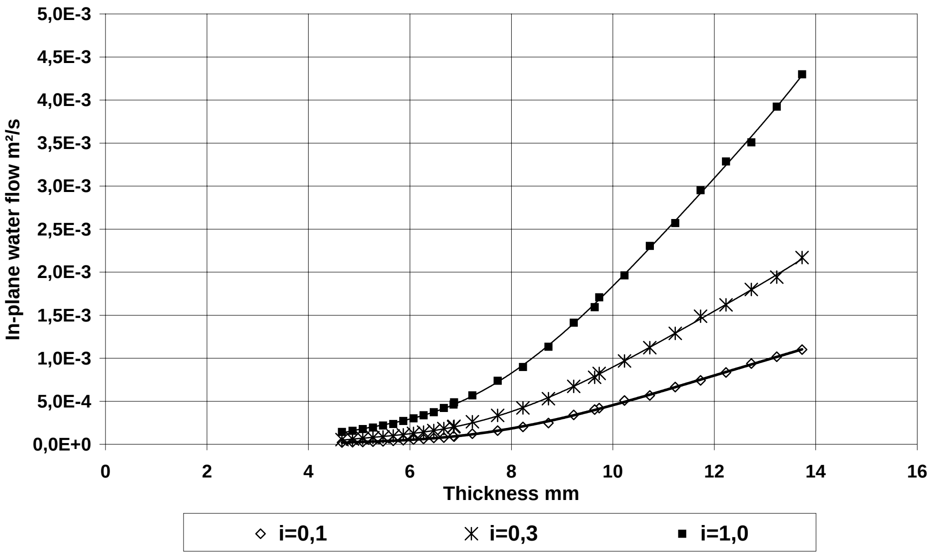

Fig. 7: measure in-plane water flow in thickness control.

7 DESIGN APPROACH BY NOMOGRAM

A design of a drain composite is possible with high accuracy by a nomogram combining the creep curve (thickness vs. time) and the flow curve (flow vs. thickness) in a form shown in Fig. 8.

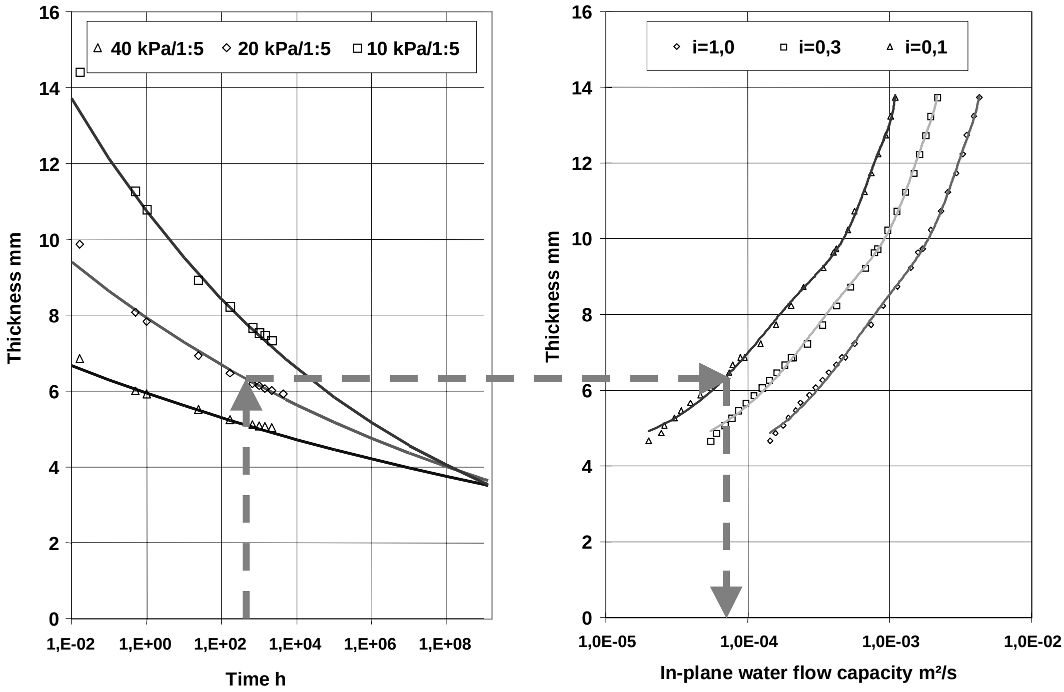

Fig. 8: Design nomogram drain flow at desired thickness (time)

8 RESIDUAL UNCERTAINTIES

The method proposed (thickness controlled flow measurement) does not take into account, that the creep of the nonwoven filter after long time may effect the flow a little bit more than in the day's measurement. We think this influence of secondary order.

9 CONCLUSION

For the design of the longtime waterflow of geodrain-composites a combination of creep and thickness-controlled measurement seem to give more accurate values than designing the drain from short-term properties using reduction factors.

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