

Contribution according to the behaviour of geosynthetic filters in case of colmation and the borderline of occurrence

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ABSTRACT: The colmation of mineral grain-particels on the surface of and into geosynthetic filter-elements may probably lead to an impairment of their serviceability. With regard on this phanomina the behaviour of geosynthetic filters concerning the process of colmation has to be taken into account during the dimensioning. The present paper deals with the probability of appearance and the borderlines of occurrence of colmation, particularly according to the application of geosynthetic filter-elements.

0 Introduction

To assess the behaviour in case of colmation within the application of filters, particularly geosynthetic filter-elements, requires to reflect especially on the following mentioned complexes of problems:

- ⇒ The kind of material of geosynthetic filter-elements, especially pore-size and pore-structure,
- ⇒ Assessment to the danger of suffosion caused by seepage-flow in the mineral soil (Basis-Mineral-Soil) in front of the filter
- ⇒ Possibility of transporting mineral grain particles within the seepage-flow through the pore-area of a Basis-Mineral-Soil,
- ⇒ Conditions of seepage-flow (hydraulic gradient)

The mentioned complexes of problems have got no influence on the recommendation that effects of a potential colmation should only be assessed in connection with the whole construction in general. Further more it is very important to have an united speach according to the terms „filter“, „colmation“ and the special forms of colmations' appearance.

The specific evaluation and the consequences of a geosynthetic filter element being partly or totally colmated can be realised by observing the changes of its coefficient of permeability. Another way to get ahead with this problem is to deal with the changes of the seepage line in front of the filter.

1 Terms and their meanings

The process of „colmation“ describes the accumulation of fine-grained particles transported within the seepage water at the surface or into the pore-area/cavities of a porous medium.

The term „filter“ in geotechnical engineering is said to represent a layer made of a natural or an artificial material. It is worked into the interface of a flown through mineral soil where the seepage water escapes. Therefore the filter takes it's part to avoid deformations in the Basis-Mineral-Soil. The deformations are caused by the transport and loss of mineral grain particles as a result of the hydraulic forces of the seepage water.

In divergence to the wellknown meaning of a filter in geotechnical engineering there are other fields of technology where the term filter is to be used and known, for instance: Filters in process technology. Both technologies use the same word but however mean very different functions. A filter in process technology in contrary has the function to separate and select solid/liquid particles out of liquid/gaseous media.

Filters in geotechnical engineering are used to stabilize the grain skeleton being not in motion in the area of seepage water escaping. Consequently they help to avoid deformations caused by the stresses of seepage flow. In a special case of

application e. g. suffosion has already started, filters in geotechnical engineering may be used to prevent solid particles (grain of suffosion) from moving through the pores of the Basis-Mineral-Soil with the seepage water.

Considering the mentioned facts the authors offer the suggestion to distinguish between two forms of the reduction of permeability -colmatation-within filters, especially geosynthetic filter-elements. These forms are: The „Real Colmatation“ which may appear using mineral grain filters as well as geosynthetic filter-elements and the „Apparent Colmatation“ that only may take place with the application of geosynthetic filter-elements. More background information for the suggestion to distinguish between these two forms are to be read in chapter 1.2 of this paper.

1.1 „Real Colmatation“

The term „Real Colmatation“ means a disposition of suffosive grain being transported with the seepage water on the surface and/or the pore area of a porous media.

Two different forms of „Real Colmatation“ have to be distinguished:

⇒ Colmatation caused by Blocking and Clogging

The particles being transported to the filter-element with the seepage water hit pore diameters and can't get through these pores because of geometric reasons -the pore-diameter is smaller than the diameter of the grain-particles. The grain particles stop moving and block or clog the pores.

⇒ Colmatation caused by Accumulation

The particles being transported with the seepage water stop their movement on the surface of the filter-element; it is important to mention, that there is no geometric criteria for the particles to stop moving and lay down on the filter. The process is caused by surface forces of the mineral filter and/or geosynthetic fibres. The process mainly requires silty and clayey grain being transported with the seepage water. The stability of the colmatation caused by accumulation depends on the intensity of surface forces (in case of application of a geosynthetic filter-element the technological equipment of the fibres), the seepage force (hydraulic gradient) and the pores' geometry.

1.2 „Apparent Colmatation“

„Apparent Colmatation“ means a decrease of the filter element's permeability as a result of the

contact in the interface between the Basis-Mineral-Soil and the geosynthetic filter-element while the seepage water is running through the system (Basis-Mineral-Soil + geosynthetic filter element) for the first time. Important marginal conditions: The Basis-Mineral-Soil is characterised as non-suffosive.

The term „Apparent Colmatation“ could take into account that material and structure of mineral grain filters and geosynthetic filter-elements are very different from each other. At present unknown or not finally investigated influences, special mechanisms etc. according to the decrease of permeability could probably be named and summarized with the term „Apparent Colmatation“. Such a mechanism is the wellknown reduction of permeability while seepage water flows through the system for the first time. At present there's no possibility to clarify finally wether the marginal condition „Intimate Conactct“ has got an influence on the mentioned reduction or not.

2 Manners of appearance

2.1 The process of „Real Colmatation“

a) Marginal Conditions

As decisive marginal conditions for a „Real Colmatation“ have to be mentioned:

⇒ Suffosive, non-cohesive Basis-Mineral-Soil in front of the filter (Plasticity can't be proved). Alternatively the suffosive grain particles can be transported into the porous medium from outside of the medium itself.

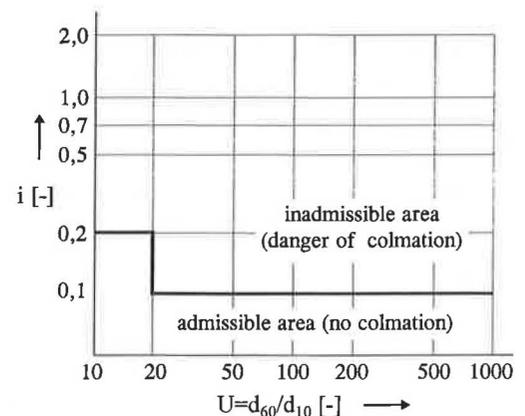


Diagramm 1: Relation between the hydraulic gradient and the coefficient of uniformity according to the possibility of colmatation [Istomina 1957]

⇒ The effective hydraulic gradient takes place in the area of inadmissibility according to diagramm 1.

b) Conditions

The conditions for the occurrence of a „Real Colmation“ can be taken for granted in case of:

⇒ Mineral grain is available and may be transported with the seepage water. This condition requires:

– A minimum of seepage forces represented by the hydraulic gradient,

– A suffusive Basis-Mineral-Soil in front of the filter or,

– A pore area in the Basis-Mineral-Soil that allows a transport of grain-particles.

⇒ The structure of the filter-pores restrains the mineral grain that may cause colmation-processes.

That means:

– The pore structure includes lots of bottlenecks where transported mineral grain particles get stuck and/or may stop their movement because of the upper mentioned surface forces (chapter 1.1).

– The hydraulic gradient decreases as far as the transport of mineral grain particles with the seepage water is also reduced in a noticeable way. Both mentioned reductions are required for the beginning of a desposition of mineral grain particles.

c) Character and Intensity

The „Real Colmation“ may occur in various intensities when the necessary conditions are being fulfilled. The process itself will last as long as a stable state of equilibrium is reached between the influences of colmation. The stable situation has appeared, when the flow velocity of the seepage water decreases as far as there's no transport of mineral grain particles.

As a result of the upper facts the potential situation, represented by the hydraulic gradient, changes.

Important criteria having an influence on the character and the intensity of a „Real Colmation“:

⇒ Total mass of the available mineral grain that may cause the process of suffosion,

⇒ Maximum diameter of the suffusive mineral grain being transported by the seepage water,

⇒ Global hydraulic situation in the building ground or the earth structure,

⇒ Relation between the effective pore-size of the filter and the maximum diameter of the suffusive mineral grain,

⇒ Quality of the pore-structure in the filter.

2.2 The phenomena of „Apparent Colmation“

The phenomena of „Apparent Colmation“ is exclusively released by the components Basis-Mineral-Soil and geosynthetic filter-element and their interaction. Both components are put together and build one system. Especially interesting and important is the „moment“ when seepage forces put their stresses onto the system for the first time. There's no decisive transport of mineral grain caused by the seepage water. No suffusive Basis-Mineral-Soil is required.

3 Evaluation

The process of colmation and its consequences have to be evaluated in connection and in interaction with the filter's part and function in the whole structure. Therefore it's worth to mention, that not every colmation process has to be treated in conjunction with compulsory negative effects for the structure.

The character of colmation processes in general leads to a decrease of the filter's permeability. As a result of this reduction the flow-velocity of the seepage water in the Basis-Mineral-Soil decreases too.

Hand in hand with the decrease of the flow velocity the transport of mineral grain is reduced. That's why colmation processes in common are processes of partly colmation. The result is a new state of equilibrium between the flow-velocity of the seepage water, the transport of mineral grain particles and the colmation for itself.

Because of the flow-velocity of the seepage-water having an influence on the new state of equilibrium the reduction of the filter's permeability may also be evaluated in a hydraulic way by dealing with a prolongation of the seepage path. Accordingly a new flow net can be constructed for the respective area. This new flow net expresses the consequences for the specific construction in case of colmation.

4 Conclusions

At present the following mentioned statements according to the appearance and the consequences of colmation processes can be given:

- ⇒ The process of „Real Colmation“ requires a suffusion of a cohesionless Basis-Mineral-Soil. The possibility of changes in the grain texture caused by the seepage water and/or mechanical processes can't be excluded at present.
- ⇒ The process of colmation in general will usually appear as a partly colmation except suffusive grain particles are transported from outside into the Basis-Mineral-Soil. Excluded are wanted processes of colmation during the dimensioning.
- ⇒ A partly colmated filter element can be evaluated with the prolongation of the seepage path in the flow net. The consequences of the decrease of the filter's permeability has to be assessed to the specific construction.
- ⇒ Detailed informations according to the essentially structural differences between mineral grain filters and geosynthetic filter-elements require specific investigations for instance in view of the contact action in the system Basis-Mineral-Soil/geosynthetic filter-element.

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