PROTECTION OF ROAD AND RAILWAYS EMBANKMENTS AGAINST COLLAPSE INVOLVED BY SINKHOLES

DESIGN PRINCIPLES
The development of high modulus and high strength geosynthetic reinforcements (AR, PVA, PES) created at the beginning of the 80ies a new art of void bridging.

The role of the geosynthetic reinforcement is to ensure that the serviceability is maintained and that the collapse (ultimate limit state) does not occur.

The time needed for reparation by filling is usually assumed to be the design time. During this time reinforcement bridges the void and limits the surface deformation to the given allowable value.

General design procedure:
- determination of the maximal acceptable surface deformation for example according to BS 8006 (1995), \( d_s/D_s < 0.01 \)
- determination of the design value of the void size \( D \)
- determination of the maximal allowable strain \( e_{\text{max}} \) such that the criterion a) is satisfied
- determination of the tensile properties of the reinforcement needed respectable to design time and acting loads

PERRIER’S METHOD (1995)

BS 8006: 1995 DESIGN METHOD

Failure/Deformation mode

Dimensioning and parameters

Maximum allowable strain in the reinforcement:
- for long voids:

\[
\varepsilon_{\text{max}} = \frac{8 \times \frac{d_s}{D_s^2}}{3 \times (D_s \times (D - D_s))}
\]

- for circular voids:

\[
\varepsilon_{\text{max}} = \frac{8 \times \frac{d_s}{D_s^2}}{3 \times (D_s \times (D - D_s))}
\]

Tensile load in the deflected reinforcement:

\[
F_{\text{BD}} = \frac{T_{\text{BD}}}{\varepsilon_{\text{max}}} = 0.5 \times \left( \frac{f_{\text{BD}} \times H \times f_s \times w_s}{D_s \times (1 - \varepsilon_{\text{max}})} \right)
\]

- \( d_s \) - the unit weight of the embankment fill
- \( w_s \) - the surcharge intensity on top of the embankment
- \( e_{\text{max}} \) - the strain in the reinforcement which is less than or equal to \( e_{\text{max}} \)
- \( f_s \) - the partial load factor for soil unit weight
- \( f_r \) - the partial load factor for external applied loads

EXAMPLES OF BRIDGING WITH GEOSYNTHETICS

B 180, Neckendorf, Germany 1993
Fortrac® R 1200/50-10A

A20, Bypass Châteraurox, France 1999
Stabilenka® 1000/100

Bypass Zeitz-Theißen, Germany 1999
Stabilenka® 1000/100

Bypass Angers, France 1999
Stabilenka® 1000/100

A29, Le Havre, East Yvetot, France 1994
Contras® D480/B-820