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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 occure.

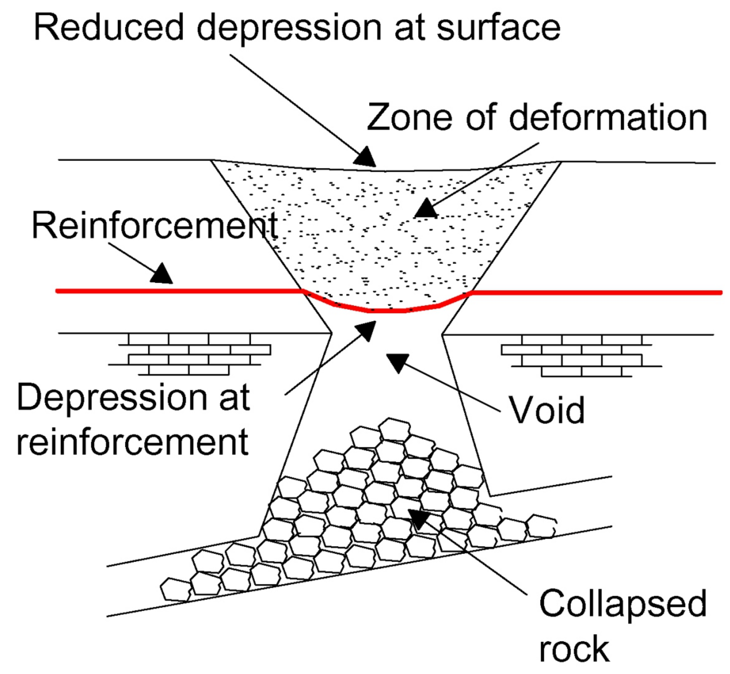
The time needed for reparation by filling is usually assumed to be the design time. During this time reinforcement bridges the void and limits the surface deformation to the given allowable value.

General design procedure:

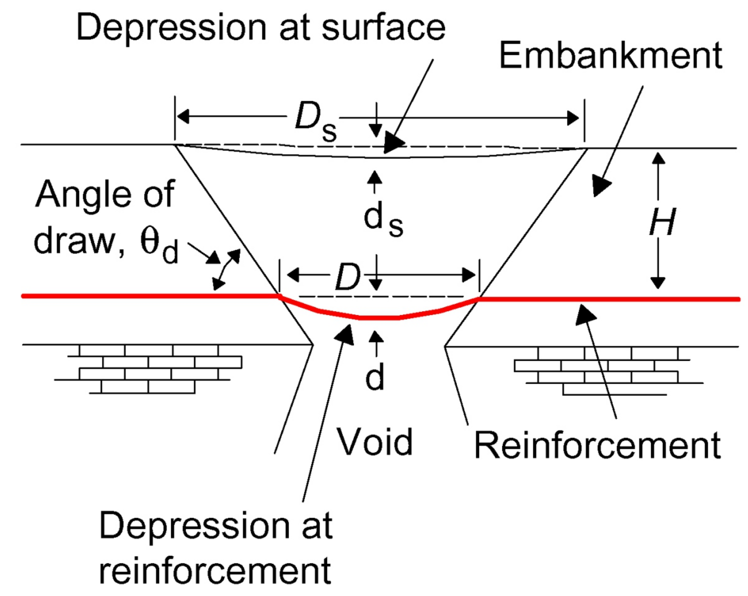
a) determation of the maximal acceptable surface deformation for example according to BS 8006 (1995), $d_s/D_s < 0.01$
b) determination of the design value of the void size D
c) determination of the maximal allowable strain ε_{max} such that the criterion a) is satisfied
d) determination of the tensile properties of the reinforcement needed respectable to design time and acting loads

BS 8006: 1995 DESIGN METHOD

Failure/Deformation mode



Dimensioning and parameters



Maximum allowable strain in the reinforcement:

- for long voids:

$$\varepsilon_{max} = \frac{8 \cdot \left(\frac{d_s}{D_s}\right)^2 \cdot \left(D + \frac{2 \cdot H}{\tan(\theta_d)}\right)^4}{3 \cdot D^4}$$

- for circular voids:

$$\varepsilon_{max} = \frac{8 \cdot \left(\frac{d_s}{D_s}\right)^2 \cdot \left(D + \frac{2 \cdot H}{\tan(\theta_d)}\right)^6}{3 \cdot D^6}$$

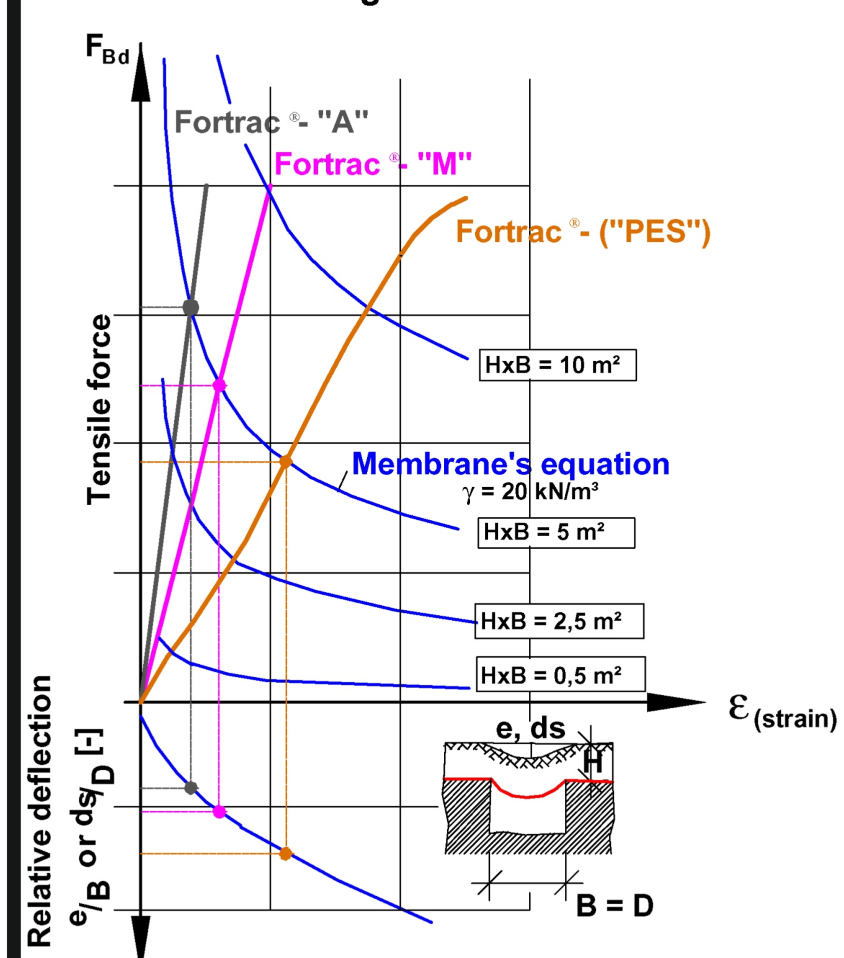
Tensile load in the deflected reinforcement:

$$F_{Bd} = T_{rs} = 0.5 \cdot \lambda \cdot (f_{fs} \cdot \gamma \cdot H + f_q \cdot w_s) \cdot D \sqrt{1 + \frac{1}{6 \cdot \varepsilon}}$$

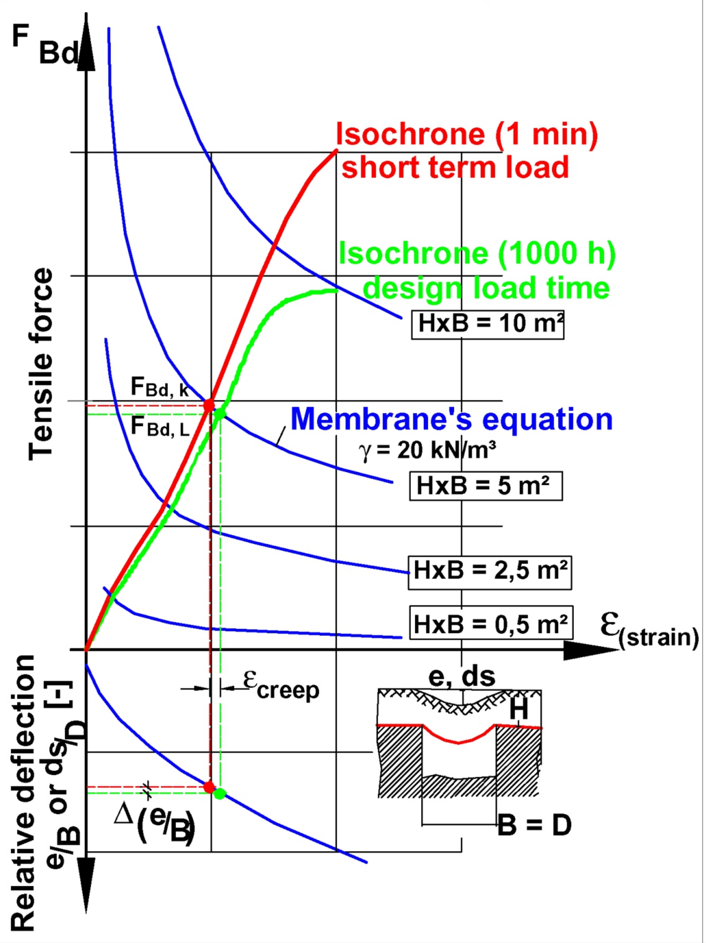
γ - the unit weight of the embankment fill
w_s - the surcharge intensity on top of the embankment
ε - the strain in the reinforcement which is less than or equal to ε_{max}
f_{fs} - the partial load factor for soil unit weight
f_q - the partial load factor for external applied loads

PERRIER'S METHOD (1995)

Short time loading

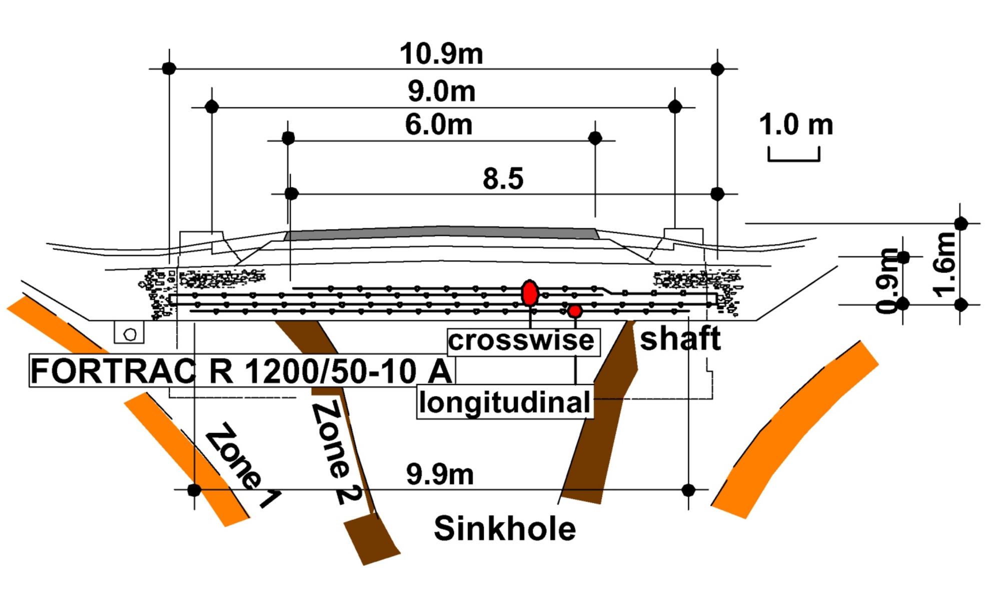


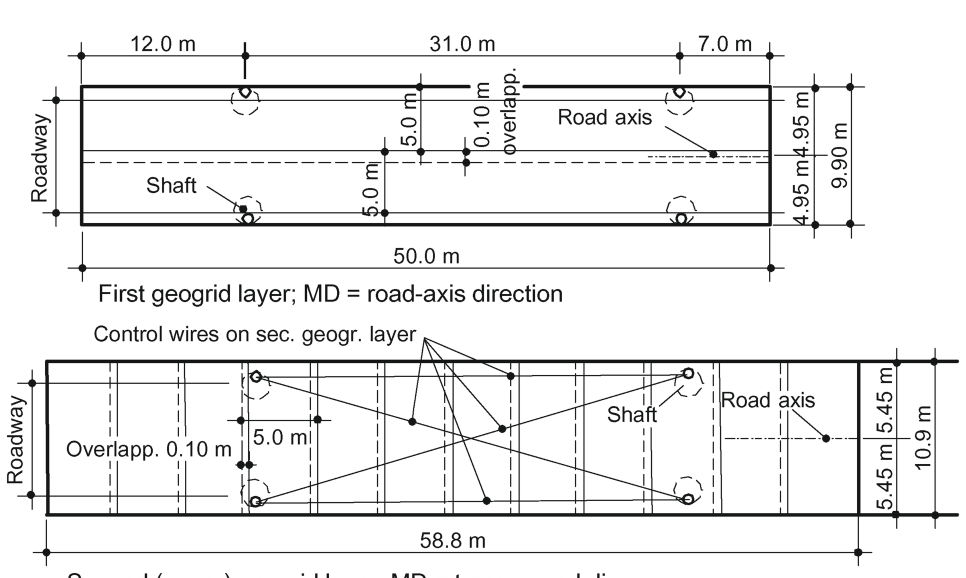
Long time loading (Isochrones, Stabilenka®PES)



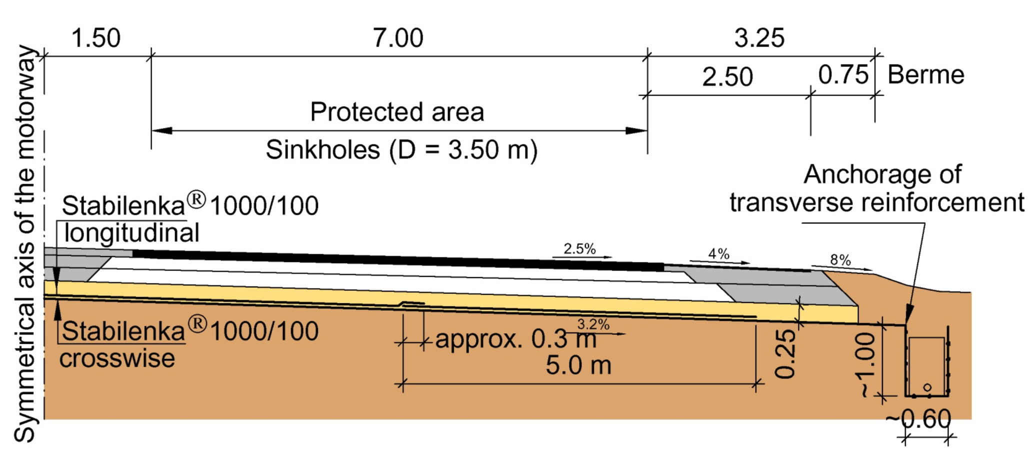
EXAMPLES OF BRIDGING WITH GEOSYNTHETICS

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

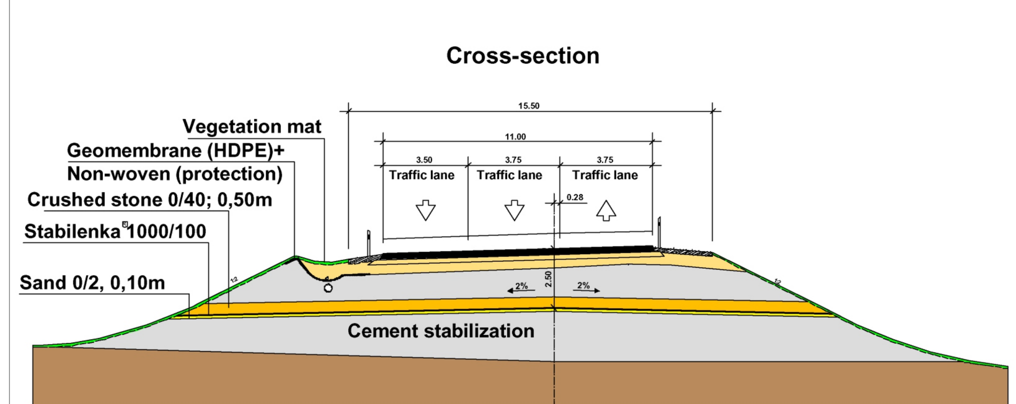




A20, Bypass Châterauroux, France 1999
Stabilenka® 1000/100



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



Bypass Angers, France 1999
Stabilenka® 1000/100

A29, Le Havre,East Yvetot, France 1994
Comtrac® D480/B-B20