Application of different failure models for the grass cover at the land-side slope of a river dike in Flanders

department
Mobility and
Public Works

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Vlaamse overheid

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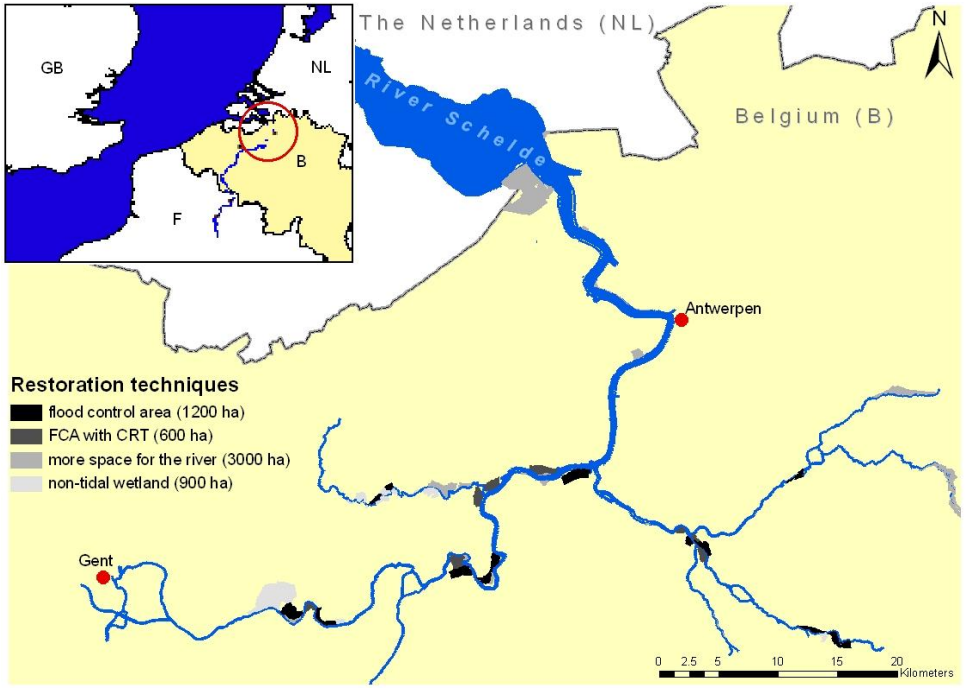
Actualised Sigmaplan

- Aiming for a sustainable estuary of Schelde
- More space for the river
- No longer 1 flood protection level – Flood risk assessment
- Taking into account possible breach formation



Waterwegen en Zeekanaal NV
weg van water

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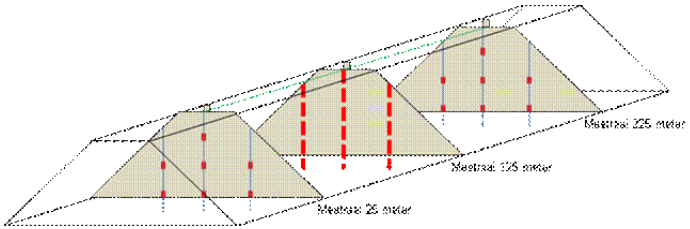
“Research into practice” by FHR

- Within the frame work of the realisation of the ‘Actualised Sigmaplan‘

- Geotechnical & hydrometric surveying
- SMART dikes (on-going)
- Non destructive dike investigation (on-going)
- Wave overtopping simulator (2010)
- Overflow experiments (in preparation)
- Breach tests (2012-2014)



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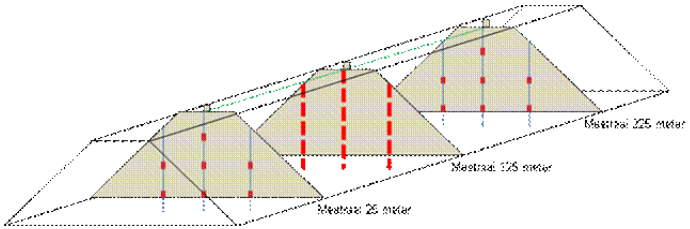

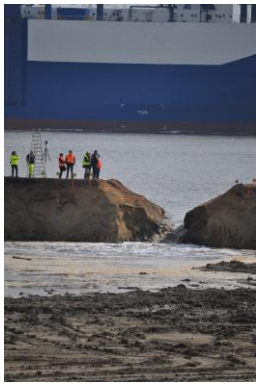

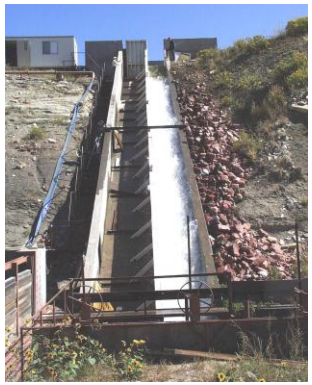

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Goal and setup overtopping tests

- Increase knowledge of driving forces, factors and mechanisms to understand grass cover failure due to wave overtopping

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Outcomes overtopping tests

- Presence of small c … er) weeds (probably interconnected) res… 0% of the (local) grass coverage (de…

  …laintenance issues

- Steep slopes togeth… rise to the presence of small cliffs.

  …maintenance issues

- A higher permeabili… n) and lower permeability of unde… of the top layer. Superficial sliding w…

  …onstruction issues

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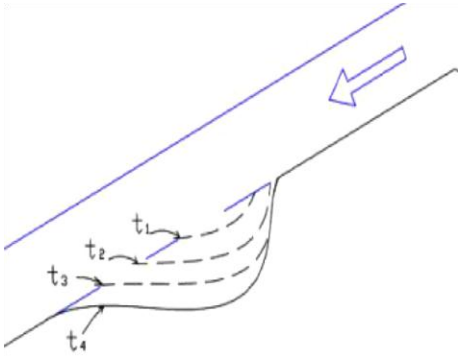
Types of external erosion (failure modes)

- Surface erosion
- Superficial slip erosion (turf sliding)
- Head cut erosion (upstream migration)



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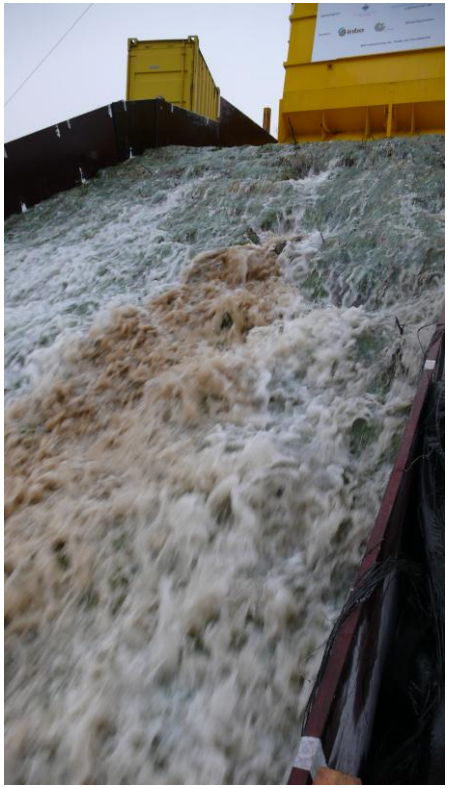
Assessment grass cover stability (I)

- Prediction of time of failure
  - **Time of vegetal cover failure (Temple, 1992)**
  - **Cumulative (effective) (over)load (van der Meer *et al.*, 2010)**
  - **Erosion equivalence (Dean *et al.*, 2010)**
- Susceptible to superficial sliding
  - **Turf sliding model (Young, 2005)**



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Assessment grass cover stability (II)

- Estimation of overtopping flow parameters (load side)
  - ~~Average overtopping rate (q)~~
  - **Depth-averaged wave front flow velocity along the slope (u) ?**
  - **Characteristic wave flow velocity (?) ($\frac{1}{2}$u … $\frac{1}{\sqrt{2}}$u … u) ??**
  - **Shear stress ($\tau = f(u, \_{u}, roughness)$) ???**
- How to account for root-reinforcement (strength side)?
- Grass-cover duration curves are derived for steady overflow conditions …

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Assessment grass cover stability (III)

- Pretty good results in estimating time of failure …
  - **Time of vegetal cover failure (Temple, 1992): $\frac{1}{2}\mathrm{u}$**
  - **Cumulative (effective) (over)load (van der Meer *et al.*, 2010): u**
  - **Erosion equivalence (Dean *et al.*, 2010): $\frac{1}{\sqrt{2}}\mathrm{u}$**

- Susceptibility to superficial sliding comparable with what we saw …
  - **Without accounting for root-reinforcement, all the slopes are susceptible to superficial sliding**
  - **Given minor root-reinorcement, slope 1:3.5 becomes stable, slope 1:2.5 is still unstable**

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~~Conclusions~~ Questions to you …

- Although …
  - **Estimations of the load side are bad**
  - **For the strength side it is even worse (we end up with a sensitivity analysis regarding the apparent root cohesion)**

- … we managed to hindcast the time of failure pretty well and it's susceptibility to superficial sliding (using quite simple formula).

- But should you trust these outcomes (and remain seated on the dike) when lacking the prototype results?

- And what about taking into account the influence of turbulence … (How?)

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Thank you for your attention

Any suggestions …

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