Memo

To
Ulrich Forster, RWS-WVL

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Subject
Use of the L/H ratio rule

The WTI2017 will allow a level 1 assessment ('*eenvoudig*'),in order to rule out "obviously safe" cases. This level 1 assessment can be based on a simple rule (L/H ratio) calibrated for the Dutch conditions using probabilistic analyses (memo 1220084-001-GEO-0001). The recommendations of the L/H ratio study were:

- As no significant difference (benefit) was observed when clustering per Region or Return period, and since this is intended to be a simple rule, it is recommended to use the L/H rule derived from the 20% quantile of all cases:
  – $L/Hratio = 17\ \beta_{T,cross} - 29$

- Furthermore, a somewhat more effective rule can be given as an option, which distinguishes between situations with thick layer and without cover layer:
  – No cover layer: $L/Hratio = 16\ \beta_{T,cross} - 19$
  – Thick cover layer (>6m): $L/Hratio = 17\ \beta_{T,cross} - 48$
  – Thin cover layer (0-6m): $L/Hratio = 17\ \beta_{T,cross} - 29$ (same as all cases)

How to use the L/H ratio rule in a practical case:

For each cross-section under study:

- For this cross-section the piping parameters are also known, namely the seepage length and the head difference between water levels, L and H respectively.

- The location is known, therefore the segment to which this cross-section and the safety standard can be taken from the Deltaprogramma 2015, e.g.: segment 15-1, return period T = 3,000.

- Transform this return period (T) into a required reliability at cross-section level ($\beta_{T,cross}$), using the following formulas:

$$\beta_{T,cross} = \Phi^{-1}\left(1 - P_{T,cross}\right)$$

Where

$$P_{T,cross} = \frac{P_T}{\left(1+\frac{a \cdot L_{segm}}{b}\right)} = \frac{f \cdot \frac{1}{T}}{\left(1+\frac{a \cdot L_{segm}}{b}\right)}$$

Herein:

$\beta_{T,cross}$ Cross sectional reliability requirement (reliability index) [-]

$P_{T,cross}$ Cross-sectional target failure probability; the average cross-sectional probability of failure may not exceed $P_{T,cross}$ [yr^{-1}]

P_T Target failure probability: target probability of flooding due to the series of events triggered by the instability of the inner slope that lead to flooding [yr^{-1}]

a Fraction of the length that is sensitive to the failure due to piping [a = 0.75]

b Length-effect factor for piping failure [b = 300 m]

L_{segm} Total length of the dike segment

f is the failure probability factor (faalruimtefactor): target contribution of the failure mode (in this case piping) to the probability of flooding [f = 0.24]

T Return period that corresponds to the safety standard of a segment [yr]

For more information on the length-effect and transformation of the requirements from a segment to a cross-section level refer to reports: 1207805-004-ZWS-005, 1202123-002-GEO-0005, 1220080-002-ZWS-0006.

As such:

- The L/H ratio present in the cross-section under assessment has to be bigger than $L/Hratio = 17\,\beta_{T,cross} - 29$

More explicitly:

$$(L/Hratio)_{existing} \geq (L/Hratio)_{rule}$$

$$(L/Hratio)_{existing} \geq 17\,\beta_{T,cross} - 29$$

$$(L/Hratio)_{existing} \geq 17 \cdot \Phi^{-1}\left(1 - P_{T,cross}\right) - 29$$

$$(L/Hratio)_{existing} \geq 17 \cdot \Phi^{-1}\left(1 - \frac{0.24 \cdot {}^{1}/_{T}}{1 + 0.0025 \cdot L_{segm}}\right) - 29$$

Where the variables L, H, T and $Lsegm$ are known.