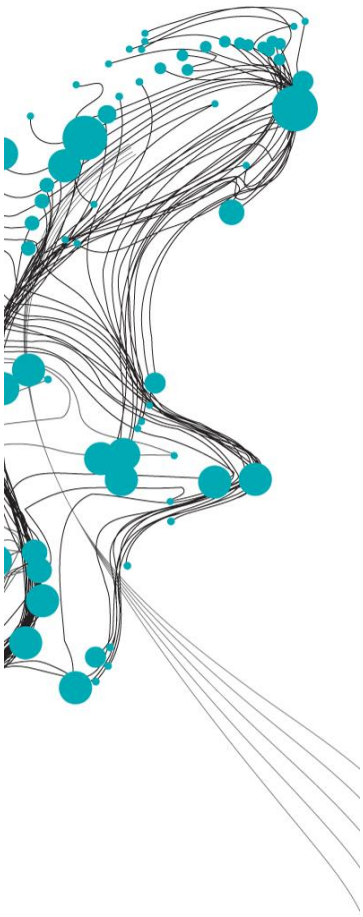
Reliability analysis of piping assessment: Assessing the influence of the spatial variation of subsoil parameters



The Netherlands is protected against inundation by nearly 3500 km of primary flood defences. These are periodically checked using the Legal Assessment Instrumentation (Dutch: Wettelijk Beoordelings Instrumentarium 2017 (WBI)). The present work focusses on the assessment procedure concerning the piping failure mechanism. Piping is caused by the hydraulic head difference between the waterside and landside of the dike, which can lead to the erosion of sand underneath the dike, which can ultimately cause a collapse of the dike. Piping depends on the local variation of subsoil parameters, such as the grainsize and hydraulic conductivity of the sand in the aquifer and the thickness of the cohesive layer on top.

The objective of the research is to assess the reliability of the WBI-assessment procedure. Focussing on the probability of either unjustly approving or disapproving dike sections. Unjust approvement can occur when the assessment procedure overestimates the true strength of the dike, whereas unjust disapprovals can occur when the true strength of the dike is underestimated.

The objective is completed by creating a representative dike section (see Figure 1), this dike section is comparable with dikes which are present along the Dutch rivers. The spatial variation of the relevant subsoil parameters was simulated using random fields. Random fields provide a realisation of the stochastic parameters depending on a mean, standard deviation and correlation length. The correlations length provides a measure for the rate of spatial variation, this is depends on the parameter and can also vary per location. In order to take this into account multiple correlation lengths are tested in this study.

Based on the representative dike section the assessment procedure is executed, also the true strength of dike section is calculated using deterministic formulas. The outcome of these methods is compared and it is checked whether the assessment procedure either overestimated or underestimated the true strength of the dike section.

The results showed that the strength of dike was only overestimated a limited amount of times, in the most unfavourable scenario 0.08% of the dike length was overestimated. This mean that, the probability of unjust approval of dike sections is very small. However, the amount of underestimation by the assessment procedure was significant, leading to a substantial probability of unjust disapprovals. Resulting in an increased workload for waterboards who have to assess the a large quantity of dikes in most detailed assessment level. Furthermore, the study showed that by including spatially continuous measurements of subsoil parameters like electromagnetic measurements the probability of unjust approvements decreased.

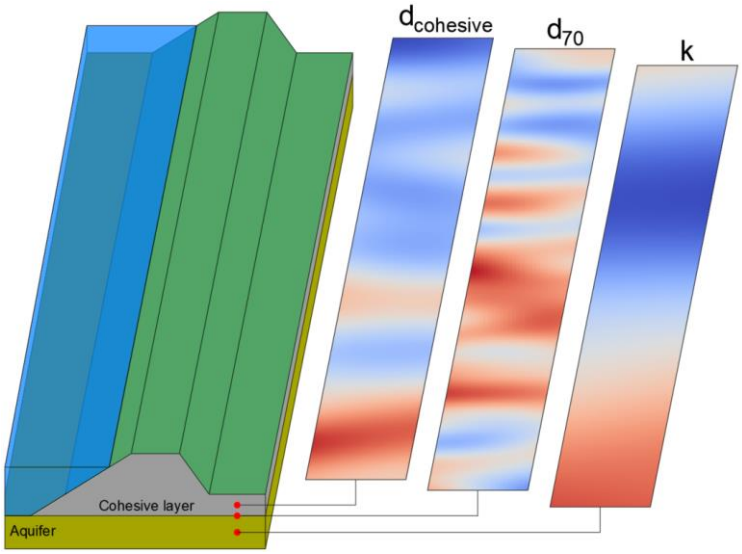


Figure 1: Representative dike section with random fields displaying spatial variation of subsoil parameters.

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