DEVELOPING A MEASURING & MONITORING STRATEGY FOR DIKES REINFORCED WITH INNOVATIVE ANTI-PIPING FILTER SOLUTIONS

Kevin Vermeulen

Graduation Date:
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Graduation committee:
University of Twente
dr. J.J. Warmink
dr.ir. J.H Damveld

BZ Ingenieurs & Managers
ir. ing. P. van Dijk
ing. W.S. Zomer MSc

HDSR
ir. P. Nijenhuis

Problem -- Backward Internal Erosion Piping is a dike failure mechanism caused by a process by which seepage forces gradually erode cohesionless material from the foundation of dikes, thereby forming shallow pipes at the interface of the granular material and a cohesive cover layer. Filters are a new innovative reinforcement measure against piping, which works by blocking the soil particles in the seepage paths with an erosion-resistant permeable filter, preventing the formation of a full-grown pipe erosion channel. Water board HDSR is implementing a new filter solution type as part of a pilot project. Given the innovative nature of filter solutions, HDSR would like to increase their confidence as administrators in the long-term functioning of an implemented filter by monitoring.

Goal & Methodology-- For this research, the following research goal has been formulated: To design a measurement & monitoring strategy to monitor the continued functionality of a filter as an anti-piping measure during the management life cycle phase of a dike. A design science methodology has been used, which consists of three (iterative) phases: (1) problem investigation, setting up a theoretical framework and investigating the target group HDSR, (2) design based on set requirements and (3) validation using target group satisfaction and expert opinion interviews.

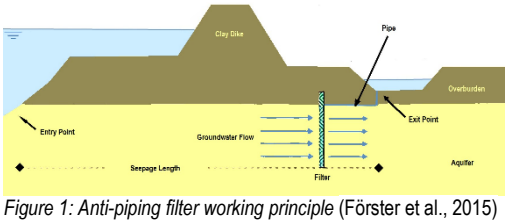

Figure 1: Anti-piping filter working principle (Förster et al., 2015)

Results and discussion -- The final result is presented in one diagram. Three filters are included: vertically inserted geotextile, coarse sand barrier and Prolock. The essence of this diagram is that when assessing possible monitoring options, these are measures part of many measures taken or assumptions made to decrease the failure of the filter. Considering all these measures that may or may not have been taken and the project and site-specific circumstances, a well-considered decision can be made for implementing a monitoring option. The diagram shows the different failure modes of filter solutions, including newly defined failure scenarios, the differences in these for the three filter types, the different risk mitigation measures available, and the monitoring possibilities, and have all been made insightful and comprehendible for water managers with dikes, specifically HDSR.

Conclusion -- It can be concluded that the monitoring strategy and associated diagram are of added value when setting up a monitoring plan for the various filters available, as the diagram contains information relevant to a dike manager. An important conclusion from the iterative design process is that a systematic understanding of how a filter functions, the failure modes and the corresponding risk mitigation measures are essential to arrive at well-founded decisions on measuring & monitoring of filters, to which this study's result contributes.

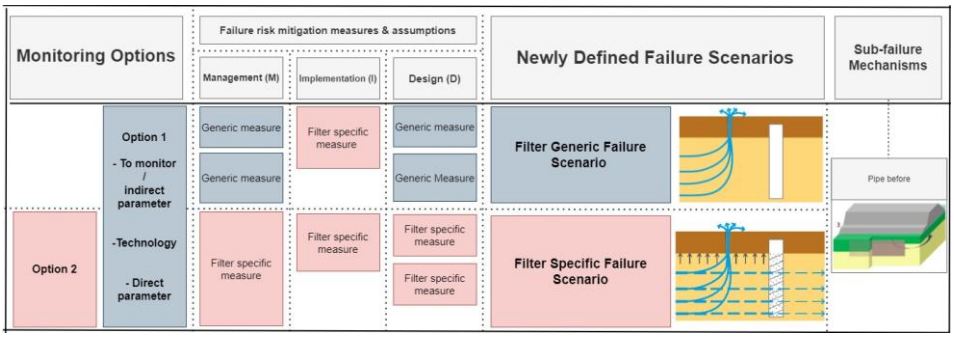

Figure 2: Conceptual Version of Monitoring Diagram without details: Grey = Filter Generic, Red = Filter Specific [Prolock]

Förster, U., Bezuijen, A., & van den Berg, S. (2015). Vertically inserted geotextile used for strengthening levees against internal erosion. Geotechnical Engineering for Infrastructure and Development: XVI Eur. Conf. Soil Mech. 1995-200