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Detection of Backward Erosion Using Multiple Geophysical Techniques

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Decades ago, dams have been built worldwide to store water for different usages such as agricultural and household among others. Most of these structures are earthen dams that have been constructed in the past and are still being used over their design age. The lack of inspection, maintenance and adequate designs initiate failures which cause flooding of villages and loss of lives. Internal erosion is classified as the major reason of earth dam failures after the breach of more than 54 % due to piping. The complex mechanism and the lack of adequate techniques to detect internal erosion at early stages have made failures of earth dams abrupt. Internal erosion is initiated when particles of erodible soil constituting the embankment or the foundation find their way into the downstream. The excess seepage velocity will erode the fine materials creating a seepage path through the body of the structure that would eventually lead to failure. Traditional geotechnical testing relies more on destructive techniques such as boreholes or Standard Penetration Testing (SPT). Most of the times, the structure cannot withstand these testing therefore the urge to develop geophysical approaches to detect and monitor internal erosion has increased with the increase of incidents in the world.
This research aims at studying the different stages of internal erosion using multi geophysical techniques (i.e. initiation, continuation, progression and breach). For this purpose, a small scale laboratory setup is developed to better understand the backward erosion mechanism. It constitutes of a weak zone in a controlled medium. Ambient seismic recordings and electrical resistivity monitoring are used to monitor the water seepage, detect the initiation and evolution of piping in the weak zone until complete failure and monitor the changes in seismic recordings with the changes of seepage velocities associated with the different H/L. The results obtained show the complementarity of seismic data with the electrical resistivity measurements and the ability of these non-destructive techniques to detect the different phases of internal erosion before reaching failure. Electrical resistivity results indicate the location of the weak zone and the resistivity values change with time prior to failure whereas seismic analyses illustrate the increase in the rate of the seismic activity and its energy towards the failure.