Imperial College London

UKRI Natural Environment Research Council

2024_18_Civil_COS: Improving the resilience of UK flood protection infrastructure using advanced numerical simulation

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Background: The UK has 9,000 km of flood embankments and 2,072 dams retaining large raised reservoirs. These large geostructures perform a crucial role to prevent flooding. Climate change is increasing the demand on these structures; significant increases in peak flow are projected over the next 100 years. These changes will significantly increase the risk of embankment collapse or breach. This project will exploit advanced numerical simulation tools, developed to look at scour around pipelines, to better understand how to protect these structures against erosion during flood events.

The models used to predict embankment breach all rely on a measure of soil erodibility. A recent scoping study by the UK Environment Agency concluded that there is incomplete understanding of soil erodibility and how the current established tests can be linked to the mechanics of erosion in-situ. This doctoral research project aims to improve measurement of soil erodibility in the UK by simulating the tests used to assess soil erodibility using advanced multi-phased, coupled numerical models.

Proposed Research: The research will comprise two main phases (1) an assessment of how erodibility is measured (2) linking these measurements to the mechanics of erosion

(1) How do we simulate soil erosion under flood conditions (Months 1 – 24)

The initial phase of the research will focus on simulating the various tests that have been proposed to measure soil erodibility. All of these tests involve water flowing against soil and movement of soil and are highly challenging to simulate. In terms of impact on embankments engineering, a key outcome of this research phase will be to understand why different tests give different predictions of erodibility. This work will link to recent experimental work in France and Spain. Our industrial partner, Dr. Mark Morris, from HR Wallingford has been involved in these studies.

(2) What are the mechanics of erosion? (Months 24 – 38)

This phase of the research will focus on developing the insight obtained in the modelling work to engineering application. The insight gained through these simulations in phase 1 will help designers assess how to incorporate the test data in breach prediction models which are essential to understand the potential large-scale implications of erosion. The key question to answer: is when is there surface erosion versus a head cut erosion?

(3) Thesis write-up (Months 39-42)

Prof. O'Sullivan will act as the lead supervisor. Dr. Mark Morris from HR Wallingford who worked on the EAs scoping study, along with Jean-Robert Courivaud (EDF) will act as external supervisors. The research will link into complementary ongoing research led by EDF and CNR, which also aligns with earlier work and interests of the US Army Corps of Engineers and Bureau of Reclamation.