

Reducing the risk of embankment failure under extreme conditions – Good practice review, R&D needs and IMPACT

Technical Summary: FD2411

Joint Defra / EA Flood and Coastal Erosion Risk Management R&D programme

Background to R&D project

The effective management of the 9,000+ km of flood embankments in England and Wales is a key activity for the Environment Agency and other operating authorities and owners. Although a general understanding of good practice in embankment design and management existed, little national guidance on management of flood embankments was available to practitioners at the time of the Autumn Floods 2000. Furthermore, the hazard of failure or overtopping of existing embankments is set to become greater with climate change. It is also apparent that best management practice for flood embankments needs to integrate the science from three distinct disciplines – hydraulic engineering; geotechnical engineering; and risk management.

Defra R&D Project FD2411 on *Reducing the risk of embankment failure under extreme conditions* has addressed two main objectives. Firstly to draw together guidance on good practice for management of flood embankments, and secondly to identify and prioritise research and other initiatives required to improve their future management.

The project funding also included (a) the UK contribution to the EC FP5 IMPACT project which has addressed the assessment and reduction of risks from extreme flooding caused by the failure of dams and flood embankments, and (b) investigation of soil fissuring and piping in flood embankments in the Humber Estuary at the Thorngumbald Managed Retreat site. The opportunity for the latter arose during the project.

Results of R&D project

Under the main work objectives, the project team gained a good understanding of the range of current practice. A practical framework for describing embankment management practice was then established, embodying risk and performance principles. A good practice guide was produced with a view to the future needs of the flood risk management industry. The guide is not a detailed design manual. A second report was produced which recommends prioritised actions that the Environment Agency and the research community should take to underpin and develop a risk and performance-based approach for the management of existing and future flood embankments.

Under the IMPACT project, the Defra funding supported (a) field and laboratory tests on embankment breach formation leading to embankment failure to provide high quality data for model development and validation (WP2), and (b) a case study on uncertainty associated with breach modelling (WP5). These Work Packages also contributed to the conclusions of the IMPACT project as a whole. At the time of completion, this work represented the state of the art worldwide in prediction of breach formation.



Data from the Thorngumbald site supported applied research at University of Birmingham into the processes of piping formation in real embankment material, and at University of Durham (and later Strathclyde University) on the processes and assessment of fine fissuring of clay embankments.

R&D Outputs and their Use

Guidance *Management of flood embankments – Good practice guide* (FD2411/TR1) is the principal output for flood risk management practitioners. The Guide aims to present an overview of issues that can affect flood embankment performance, and to provide guidance on good practice for dealing with many aspects of design, operation (including inspection) and management (including adaptation). It has four main parts comprising: A - Function and management of flood embankments; B - Performance and characterisation of flood embankments; C - Risk and risk management; and D - Good practice reference, and is well illustrated with photographs and figures. It links into EA Flood Risk Management and asset management concepts.

Technical reports *Reducing the risk of embankment failure under extreme conditions - Report 2: Framework for action* (FD2411/TR2) recommends twelve areas for action under the Defra / EA Joint Programme or Environment Agency FRM Asset Management operations to achieve improved management (and hence performance) of flood embankments. Several actions are now underway either as further research (e.g. the PAMS project) or under other Environment Agency initiatives.

Results from the EC IMPACT project provide a major scientific dataset and important scientific conclusions on breach modelling, uncertainty analysis and geophysical investigation for researchers and specialist practitioners. All reports are downloadable from www.impact-project.net, go to "Publications and Reports", and also on to "Specific Work Area Publications". Breach data have been further analysed under the current EU FLOODsite project and also utilised in updating HR Wallingford's DAMBREAK model.

The results from the Thorngumbald site are of underpinning science value. The research by University of Birmingham on pipe formation is reported in *Soil piping tests on Thorngumbald flood embankment* (FD2411/TR3). The investigation by Professor Mark Dyer of Strathclyde University of soil fissuring informed the development of the current project on *The influence of fine fissuring on flood embankment stability* under FRMRC Phase 1, and is disseminated in FRMRC UFMO Report UR11 (see www.floodrisk.org.uk).

This R&D Technical Summary relates to Defra R&D Project FD2411 and the following R&D outputs:

Defra Technical Reports: FD2411/TR1 *Management of flood embankments – Good practice guide* Published November 2007; FD2411/TR2 *Reducing the risk of embankment failure under extreme conditions - Framework for action* Published Nov 2003; FD2411/TR3 *Soil piping tests on Thorngumbald flood embankment* November 2007

See also outputs on the EC IMPACT project and the FRMRC websites as stated above.

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Technical Reports TR1, 2 and 3 may be downloaded from the Defra/EA Joint R&D FCERM Programme website (www.defra.gov.uk/envIRON/fcd/research). TR1 is also available via the Environment Agency's science publications catalogue (<http://publications.environment-agency.gov.uk/epages/eapublications.storefront>) on a print-on-demand basis.

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