Breach initiation and growth
Predictive Models

FLOODsite Task 6 has produced:
- Models for predicting wave induced breach initiation processes, and
- Improved science in the established predictive breach models BRES and HR BREACH.

These models may be used to support:
- Inundation modelling, which underpins flood risk assessments;
- Performance assessment as part of asset management (e.g. acceptable overflow or overtopping and consequences);
- Design of emergency repairs to limit and seal a breach;
- Emergency planners seeking to identify timing, magnitude and impact of potential flooding or developing evacuation measures.

Where to find reports and models:
- Access to key reports, examples and animations is via Task 6 area of the project website www.floodsite.net. Key FLOODsite reports include T06-06-03 and T06-08-02.

In Brief

The accuracy of predicting breach initiation and breach growth through flood embankments, embankment dams and coastal dikes affects the accuracy of flood risk analysis and the degree to which flood risk management activities may be refined. Better prediction of breach initiation and breach growth allows for a more reliable flood risk assessment and greater confidence in any flood risk management plans. However, the current degree of uncertainty in the prediction of breach initiation and formation processes is high in comparison to, say, the accuracy of modelling flow in a river.

Task 6 of the FLOODsite project had the objective of improving the understanding of breach initiation and development and hence to improve the accuracy with which breaching processes could be predicted.

The focus of the research areas were:
- Analysis of wave induced breach initiation processes, including initiation through wave impacts (exposed face) and through overtopping (landward face), and
- Analysis of embankment soil state and associated processes leading to development of the next generation of the established predictive breach models BRES and HR BREACH.

Fig 1. Breach field test (IMPACT project)
Wave Induced Breach Initiation

Wave action and overtopping (rather than overflowing) flow can lead to breach initiation and ultimately failure of the embankment or dike from either the landward or seaward side. Understanding of this process was limited and no models existed to allow prediction of these failure processes. The effects of wave action and overtopping are made worse if the embankment has cracks or fissures that allow the water to ingress or allow the impact of wave forces to propagate into, and remove soil from, the cracks.

A programme of research to investigate wave induced breach initiation processes was undertaken, including detailed analysis of wave action on cracked soils and wave action in relation to soil state. Preliminary and detailed numerical models were produced to predict the wave induced initiation processes.

This research culminated with the testing to destruction of a large section of a reconstructed sea dike in the Grosse Wellen Kanal wave flume at Hannover during Spring 2008 (see Fig 2). This provided data on failure processes at near prototype scale that were then used to refine and validate the earlier predictive models.

Fig 2. Breach development caused by overtopping

HR BREACH and BRES Models

Programmes of research were also undertaken to extend and improve existing breach models. The BRES model was developed to address cohesive as well as non cohesive materials; the HR BREACH model was refined and extended to include multiple zoned structures (both cohesive and non cohesive, headcut and surface erosion).

As part of this work a detailed review of the earlier European IMPACT project breach field and laboratory data was undertaken and model development built upon this and other data. Development and testing of the HR BREACH model was also undertaken in conjunction with the CEATI (Canadian Electrical Association Technologies Incorporated) Dam Safety Interest Group breach modelling project team, and hence links wider international expertise and practice to the FLOODsite work.

Fig 3. HR BREACH model predicting different stages of breach initiation and growth

Other Reports

More detailed information on the research into wave impact, wave overtopping and breach initiation and growth modelling can be found via the project website under FLOODsite Task 6. Example animations and guidance on how to obtain or access the different models are also available.

The FLOODsite project

FLOODsite is an interdisciplinary project integrating expertise from physical, environmental and social sciences, as well as spatial planning and management. The project has over 30 research tasks across seven themes, including pilot applications in Belgium, the Czech Republic, France, Germany, Hungary, Italy, the Netherlands, Spain and the UK. The EC has identified FLOODsite as one of its contributions to the European Flood Action Programme. Further details can be obtained as follows:

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