

# Beach Lowering in Front of Coastal Structures

Technical Summary: FD1916

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

### Background to R&D project

Toe scour is blamed for the failure of many coastal structures but toe scour holes are infrequently observed in the field. This leads some to believe that a beach will go through the same cycle of erosion and accretion, whether it has beach control structures or not. Many studies of toe scour have been carried out, but the results have been highly varied. This scoping study was commissioned to improve understanding of beach lowering in front of coastal defence structures. The objectives of the report were:

- To identify the generic elements and processes involved and the research and development needs;
- To provide preliminary guidance on the mitigation of scour.

### Results of R&D project

This scoping study has reviewed the present state of knowledge on the lowering of non-cohesive sediment beaches in front of coastal defence structures. It has concentrated mainly on toe scour, which is the short-term lowering of beach level close in front of a coastal defence structure.

In the past, toe scour has been reproduced in several small-scale laboratory experiments as a short-term wave-driven phenomenon caused by cross-shore transport of sand (or shingle). It is questionable whether such small-scale bedload transport experiments always provide reliable design guidance on toe scour depths at full scale. Moreover, case studies in the UK have often indicated that longshore transport plays an important and sometimes even dominant role in beach lowering in front of coastal structures.

Design relationships have mainly been derived for scour depths in sand beaches at vertical seawalls subject to normal incidence waves, but there is still no design equation for many cases. When there is no design guidance, toe scour can often be estimated from normal-incidence vertical wall cases, either by taking this as the likely worst case or by adjusting it according to rules-of-thumb.



Much of the design guidance for mitigation schemes is related to protective aprons at the toe of pre-existing structures and guidance on thickness, width and stone weight for revetment toes is provided in the scoping report. Alternative mitigation measures include rock dumping, gabions, mattresses, soil improvement and beach renourishment.

Key strands from the above are presented in the study report along with recommendations for further research, including:

- Further information on the performance of mitigation schemes is required to assess how successful different approaches are;
- A variety of approaches should be taken to address the wide range of time and space scales involved in beach lowering and steps taken towards the development of a probabilistic risk-based method of assessing the safety of coastal defence structures;
- The dynamic interaction between beach and structure should be investigated through research into the flow through structures and beaches, suffusion, settlement and liquefaction;
- The time development of scour through storms should be investigated using complimentary large-scale laboratory and field experiments.

Research into scour and the performance of structures could lead to cost savings if it shows that less conservative designs for coastal structures are appropriate. There are therefore considerable potential long-term returns from investment in beach lowering research, which will ultimately lead to improved guidance for coastal managers.

## R&D Outputs and their Use

The main outputs from the scoping study were Technical Report, a Project Record and a proposal for further research to form Phase 2. The report contains reviews of existing knowledge, methods for predicting beach lowering, and mitigation measures. It includes preliminary advice on scour mitigation, plus conclusions and a list of research needs, which have been used to define a larger research program, for Phase 2. The Project Record comprises Case Studies (Appdx 1) and Scour Depth Design Formulations (Appdx 2).

This R&D Technical Summary relates to R&D Project FD1916 and the following R&D outputs:

- **R&D Technical Report FD1916/TR – Beach lowering in front of coastal structures** Published September 2005.
- **R&D Project Record FD1916/PR1 – Appendices 1-3.** Published September 2005

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The above outputs may be downloaded from the Defra/EA Joint R&D FCERM Programme website ([www.defra.gov.uk/envIRON/fcd/research](http://www.defra.gov.uk/envIRON/fcd/research)). Copies are 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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