



## Coastal structures and waves

The Coastal structures and waves group focuses on research and consultancy in the field of wave-related issues and the conceptual design and testing of coastal structures. The multi-disciplinary teams tackle a diversity of technical aspects and site specific problems. Our effective solutions are supported by expert opinions, mathematical tools and results from high-quality laboratory measurements in wave flumes and wave basins. Our clients benefit from our research that underpins the technology which supports our advice on wave dynamics and structures.

### our activities

Our specialist consultancy is based on our in-depth knowledge of coastal processes and includes:

- design, testing and evaluation of breakwaters
- dikes (hydrodynamics, safety aspects, placed block revetments, breaching)
- jetties (wave forces)
- probabilistic design methods
- scour and bed-protections
- wave climate in coastal regions and harbours
- wave generation in flumes and basins
- wave modelling
- interaction between waves, currents, structures and morphodynamics.

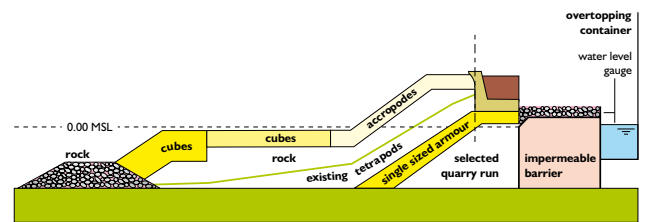
Our experienced staff for the experimental facilities (wave flumes and basins) with project-related instrumentation is well known for their swift actions and their capabilities to obtain reliable solutions in an efficient way based on modelling of physical processes on small-scale and full-scale.





Wave overtopping event on grass-dike in large wave

Our well-established software products benefit not only from their high standards of technology which has been demonstrated on a wide variety of international publications and congresses, but also from the verification based on high-quality data-sets from laboratory investigations and the validation and applications in consultancy practise. The problem solving skills and the access to unique tools of the Coastal structures and waves group are direct benefits to those who receive our services and to our partners in projects.

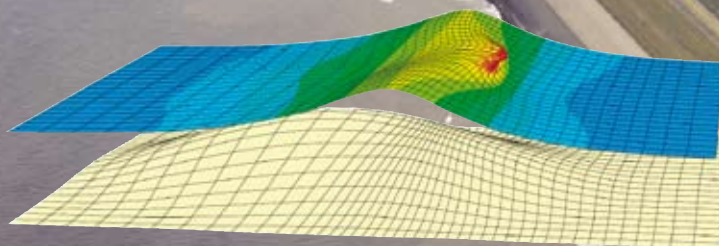


Cross-section of breakwater rehabilitation tested by the Coastal structures and waves group

### what we can offer

The Coastal structures and waves group provides for instance cost-effective hydraulic boundary conditions for all kinds of coastal engineering issues. Feasibility studies and independent advice on the consequences of coastal processes for coastal infrastructure are offered. To provide guidance to design processes use is also made of mathematical models and hydraulic facilities.

Our specialists have developed state-of-the-art numerical models to solve a wide variety of coastal engineering problems. The complexity of the problems and the need to obtain reliable risk-assessments stimulate our continuous efforts to develop high-standard tools to meet the present and future demands of our clients.



3D numerical modelling of waves

Three types of laboratory facilities to assess project-specific information on waves, currents and/or morphodynamics are frequently used by the Coastal structures and waves group:

- large Wave Flume for large and full-scale testing
- smaller Wave Flumes for small-scale testing
- multi-directional wave basin.

Our coastal facilities are equipped with second-order wave generation and active wave absorption. These techniques guarantee a proper representation of natural wave trains. Deltares (Delft Hydraulics) has developed, made-operational and applied these techniques in a large number of projects. They are the first of this kind in actual operation, world-wide. We have also implemented our techniques in a series of new wave generators for other international research institutes.

Rubble mound structures, caisson breakwaters, jetties, placed block revetments, intake and outfall structures, scour, bed-protections, wavecurrent interaction, wave propagation and penetration and wave power plants are examples of frequently studied coastal processes and coastal infrastructure.

#### our clients

Our national and international clients include the Commission of the European Union, US Office of Naval Research, government authorities (e.g. Ministry of Transport, Public Works and Water Management) research institutes and private companies such as multinationals, international consulting engineers, contractors and harbour authorities.



#### research and development

By simultaneously carrying out applied and fundamental research, we directly link the latest technological developments with practical knowhow. Our position between the academic world of fundamental research and the world of pressing practical demands enables us to funnel these developments directly to our clients. Our research is often carried out in close co-operation with private companies, as well as educational and scientific institutes.

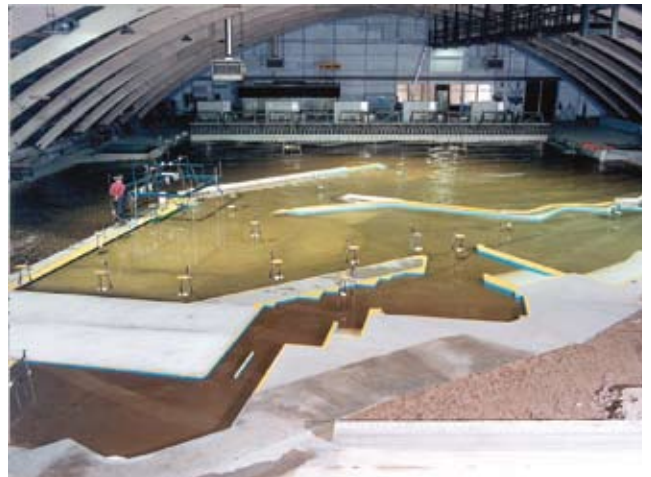


#### software systems

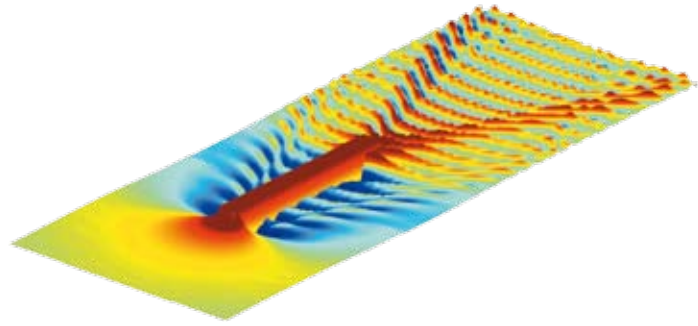
Deltares (Delft Hydraulics) develops, operates and maintains a wide range of dedicated software packages, reflecting the specialist knowledge which our institute has built up over many years.

Software packages developed and used by the Coastal structures and waves group are:

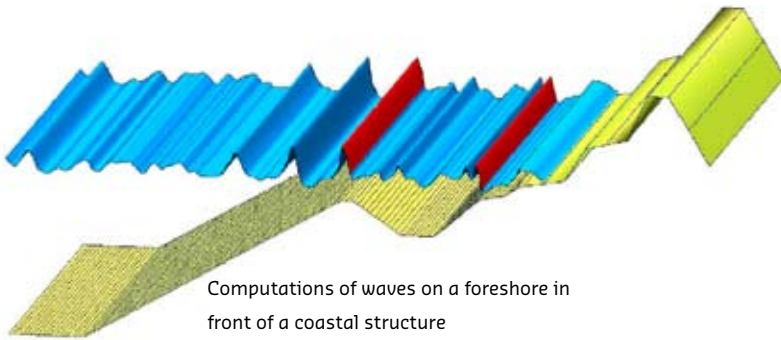
- BREAKWAT, for conceptual design of breakwaters. This contains, amongst other aspects, the hydrodynamic performance of coastal structures (e.g. wave run-up, wave overtopping and wave transmission) and the structural performance (e.g. stability of rubble mound structures)
- ANAMOS, for conceptual design of placed block revetments



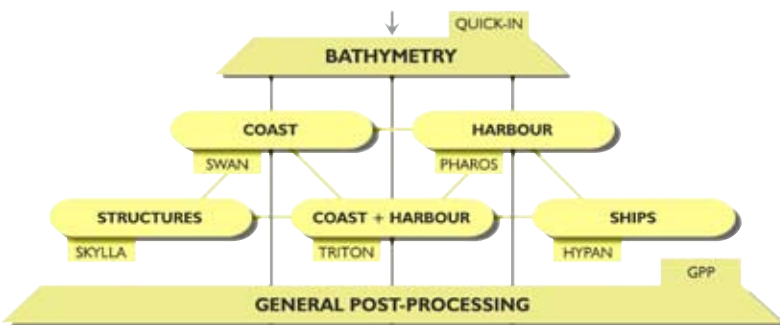
- DELFT-WAVES, suite of wave models for a wide variety of problems related to wave propagation in coastal regions (SWAN and TRITON), wave penetration in harbours (PHAROS and TRITON) and wave interaction with structures (SKYLLA)
- SWAN-CLIMATE: The spectral wave model SWAN with a package for statistical analysis of results for wave climate studies in coastal regions
- PHAROS: Mild-slope equation model for wave propagation of short- and long waves in harbours
- TRITON: Time-domain Boussinesq-type wave model for applications in coastal regions and harbours
- SKYLLA: Volume-of-Fluid Navier-Stokes model for wave interaction with coastal structures
- DELFT-AUKE, for wave generation and wave analysis in coastal research facilities (second-order wave generation with active wave absorption in wave flumes and wave basins)
- DELFT-3D, for 2D and 3D integrated modelling of processes related to waves, currents, orphodynamics and water quality.



Computations of wave propagation of ship-induced waves



Computations of waves on a foreshore in front of a coastal structure



A system of wave modules for a wide variety of wave related coastal engineering issues

*Deltares is the  
Dutch institute  
for national and  
international water and  
subsurface issues*

#### Background of the participating institutes

WL | Delft Hydraulics was actively involved with water-related issues worldwide, whilst GeoDelft focused on issues in the field of geo-engineering. The Subsurface and Groundwater unit of TNO was active in groundwater management, subsurface/soil remediation and the management and use of the subsurface domain.

The Department of Transport, Public Works and Water Management (Rijkswaterstaat) is engaged in providing flood protection and safeguarding adequate supplies of clean water for all users. Rijkswaterstaat has transferred knowledge development for delta issues to Deltares.

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# Deltares

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