

Breakwater design



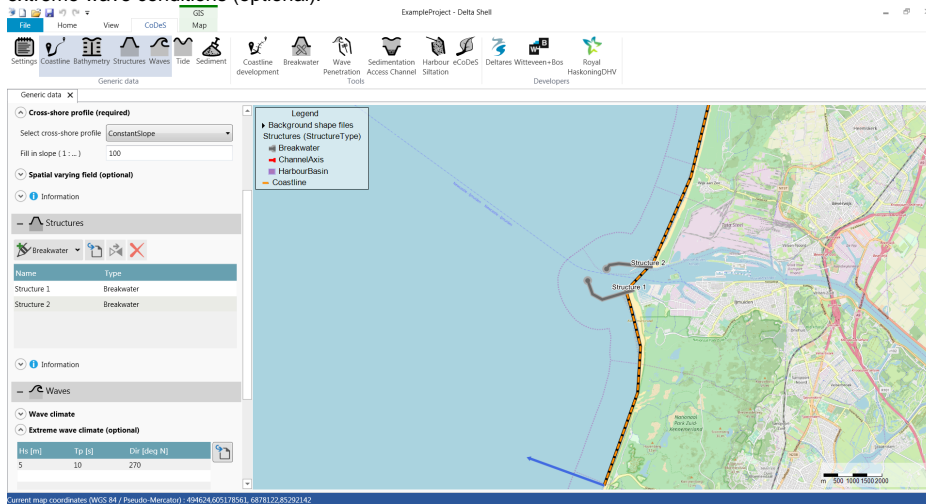
Introduction & summary

In this tool (breakwater design) you can compute required dimensions, overtopping, cross-sections and costs of rubble mound breakwaters. The tool requires at least a breakwater and bathymetry data (you can inspect the generic data availability in the top panel of the tool). Optionally, any generic wave data can also be used, in order to fill the wave condition fields.

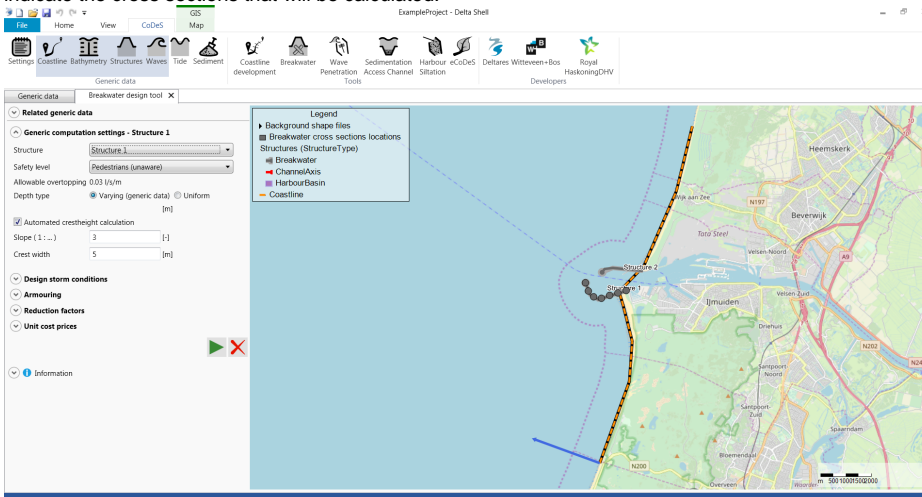
Computations of breakwater dimensions and costs are based on rough guidelines in the [Rock manual](#). Results of the breakwater tool should therefore be interpreted with a considerable range of uncertainty.

How to use the tool

1. Open a new project
2. Start in Generic Data by defining:
 - a. a Coastline,
 - a. a Cross-shore profile (both a slope and a spatial varying field are supported by this tool),
 - c. at least one breakwater structure. Make sure that the breakwaters intersect with the coastline,
 - d. extreme wave conditions (optional).



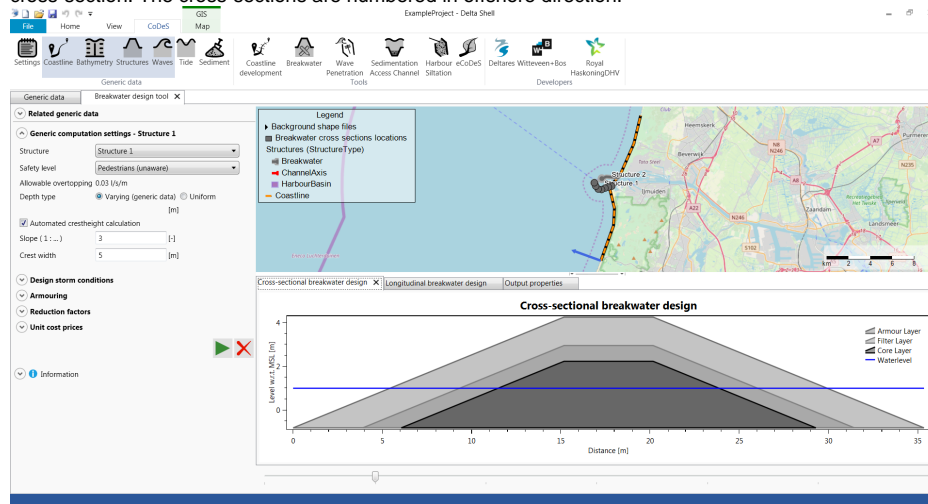
3. Open the Breakwater design tool.
4. Provide input according to the user input field description below. After selecting the breakwater, grey dots are shown along the breakwater to indicate the cross sections that will be calculated.



5. Press the play button to start the breakwater design calculation.
6. After the calculation, subwindows are presented below the map which hold the following information:

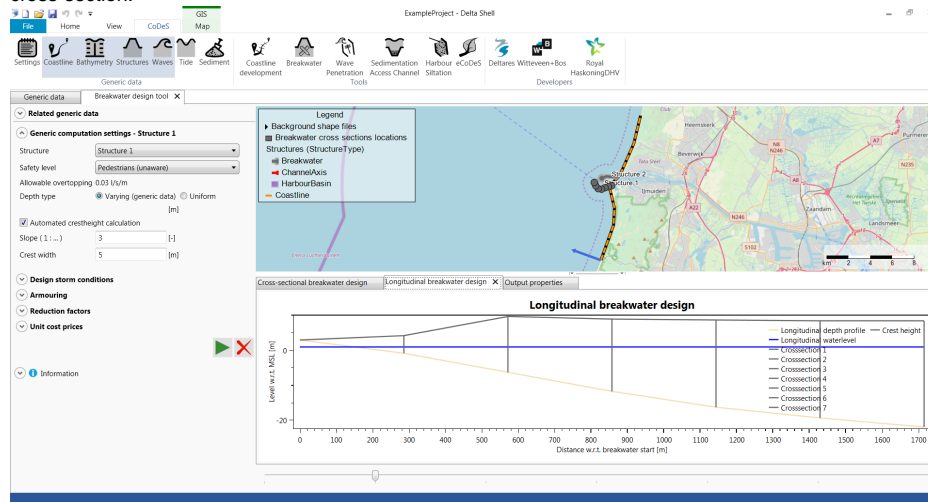
a. Cross-sectional breakwater design

For each cross-section along the breakwater (indicated by the grey dot), this plot shows the cross-sectional dimensions of the armour, filter and core layer. Also the water level during storm conditions is indicated. The slider below the plots allows for selecting a different cross-section. The cross-sections are numbered in offshore direction.



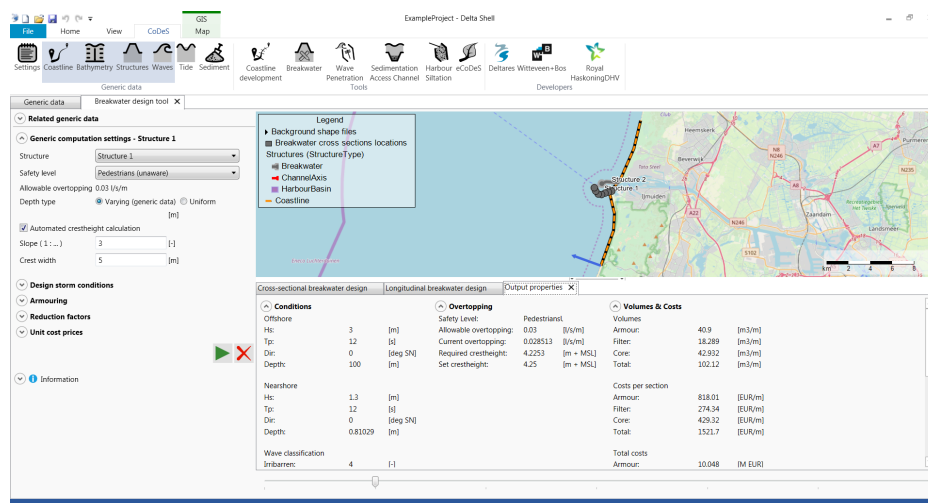
b. Longitudinal breakwater design

This plot shows the breakwater dimensions along the breakwater's longitudinal axis. The water level, the depth profile and the crest height are all indicated in this plot. At every cross-section a vertical line is shown, corresponding to the breakwater height at that specific cross-section.



c. Output properties

This panel shows a summary of the input and output parameters per cross-section. The slider below the plots allows for selecting a different cross-section.



7. Press the delete button to delete the output from the map.


User input fields

A number of user input fields are provided which can be used to adjust the calculation according to the local situation. Default values are provided for each input field. The following inputs are defined:

Generic computation settings

	Default Value	Unit	Min.	Max.	Brief Description
Structure					Select one of the breakwater structures.
Safety level					Select the design safety level which determines the amount of allowable wave overtopping.
Allowable overtopping	0.03	l/s/m	0.03	50	Based on the selected safety level, this shows the allowable overtopping for the breakwater design.
Depth type					Toggle between Varying and Uniform. In case of a Varying depth type, the bottom depth provided by Generic Data is used.
Uniform depth	10	m	0.01	9999	In case a uniform depth type is selected, provide the water depth value.
Automated crestheight calculation	True		True	False	In case this is selected, the crest height will be automatically calculated based on the design criteria. In case this option is not selected, provide a crest height.
Slope	3	-	0.25	100	Provide the outer slope of the breakwater (as 1: ..., e.g. 1:3). The inner and outer slopes are considered equal.
Crest width	5	m	0.01	999	Provide the width of the top of the breakwater (crest).
Crest height	0	m, MSL	0.01	999	In case the automated crest height calculation is switched off, provide the crest height of the breakwater.

Design storm conditions

Provide the design storm condition. By clicking on the  button, you can also select extreme wave conditions from the generic data.

	Default Value	Unit	Min.	Max.	Brief Description
Location	Offshore		Offshore	Nearshore	Indicate whether the design storm conditions are provided at an offshore or nearshore (at the breakwater toe). Using linear wave theory the wave height is transformed to nearshore conditions in case offshore storm conditions are provided.
H_s	3	m	0.01	20	Significant wave height during design storm conditions.
T_p	12	s	0.01	20	Wave peak period during design storm conditions.
Water level	1	m, MSL	-10	10	Provide the water level at the tip of the breakwater w.r.t. to MSL that is present during storm conditions.
Storm duration	6	hr	0.1	48	Total duration of the storm. This is used to calculate the total number of waves that is expected to reach the breakwater.
Breaker parameter	0.73	-	0.0001	1	Defines the wave height at which waves start to break. The maximum wave height is defined by the breaker parameter times the local waterdepth.
Offshore depth	100	m	0	9999	In case the design storm conditions are provided at an offshore location, provide the offshore depth of that location. Using linear wave theory , the wave height is transformed to nearshore conditions.

Armouring

	Default Value	Unit	Min.	Max.	Brief Description
Armour type	Rock	-			Currently only a rock armouring layer is supported.
Armour density	2650	kg/m ³	1000	5000	Density of the armour layer.
Water density	1025	kg/m ³	1000	1250	Density of the water, which should be in between 1000 kg/m ³ (e.g. fresh water) and 1025 kg/m ³ (e.g. salty water).
Layer coefficient	1	kt	0	1	
Notional permeability	0.4	P	0.01	0.9	
Damage number	2	S	1	17	

Reduction factors

	Default Value	Unit	Min.	Max.	Brief Description
Berm reduction	1	-	0	1	Reduce forces in case of expected wave breaking on a berm. A value of 0 indicates the absence of wave breaking due to a berm, a value of 1 indicates full reduction of wave breaking due to a berm.
Roughness reduction	0.4	-	0.1	1	Indicate whether the roughness of the armour material reduces wave run-up. 0.1 indicates the absence of wave-run up reduction (smooth surface) whilst 1 indicates full reduction (rough surface).
Angle of incidence	0	deg cross-shore	-90	90	Indicate whether the waves are approaching the breakwater under an angle.

Unit cost price

	Default Value	Unit	Min.	Max.	Brief Description
Unit rate armour	20	€/m ³	0	inf.	Provide the unit rate for the armour layer material which is used to calculate the cross-sectional breakwater costs.
Unit rate filter	15	€/m ³	0	inf.	Provide the unit rate for the filter layer material which is used to calculate the cross-sectional breakwater costs.
Unit rate core	10	€/m ³	0	inf.	Provide the unit rate for the core layer material which is used to calculate the cross-sectional breakwater costs.

Tool limitations

The following processes are not included in the tool: waves approaching under a cross shore varying angle, bed level changes caused by wave reflection, shoals causing wave breaking etc. Besides, the tool only provides linear cross-sections comprising of 3 default materials, without providing information on the breakwater toe or round heads. Results of the breakwater tool should therefore be interpreted with a considerable range of uncertainty.

Example cases

The following files (.dsproject) can be downloaded and loaded into CoDeS to serve as examples. They are not based on actual projects, but are intended as illustration.

Unzip the files to a convenient folder (but make sure the file structure does not change), and open the .dsproject file from within CoDeS.



Breakwater design.zip