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Borth Coastal Defence Scheme

3D Physical Model
26th July 2010

HR Wallingford:

1947 Company established as the British Government's Hydraulics Research Station

1982 Privatisation to create Hydraulics Research Ltd

1991 Company becomes HR Wallingford Ltd

2004 New physical modelling laboratory built

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Study Objectives

- Assess the stability of the proposed rock groynes and nearshore breakwaters under extreme wave and water level conditions;
- Assess the overtopping performance of the scheme under extreme wave and water level conditions;
- Predict the interaction of the reef structure with the beach, in both pre- and post-nourishment states, for morphologically representative conditions;
- Understand the changes to sediment movement of the combined scheme for morphologically representative conditions;
- Measure the effect of the reef on wave movements over and near it to inform a study of "surfability" by others;
- Determine the initial volumes of sand and shingle nourishment and assess the likely requirement for future sand and shingle re-nourishment;
- Optimise the layout of the of the defence structures designed in Phase 1 of the overall study to provide sufficient beach width and minimise overtopping.

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Physical Model

- 1:45 Scale
- Covering 1.5km of coastline
- Extending offshore to the -15mODN
- Includes mobile bed
- Tested under waves conditions from 255^0N – 285^0N

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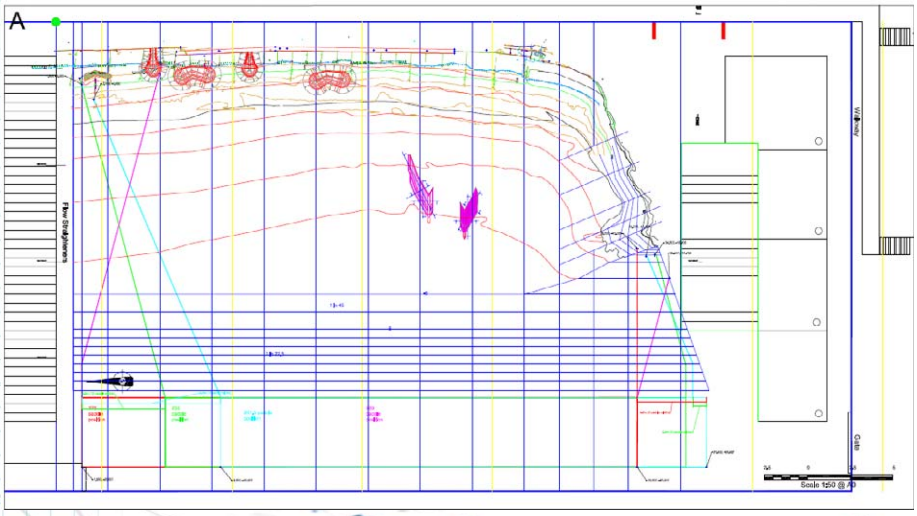
Basin layout overview



Page 5

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Bathymetry Construction and Calibration

Page 6

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Test Conditions

- **Morphological Test Conditions –** 1 in 1 yr wave condition run at MHW 1.81mODN
- **Surfability Test Conditions –** Short sequences of random waves at a range of water levels, wave heights & periods
- **Stability Test Conditions –** 1 in 1 yr & 1 in 10 yr wave heights at varying water levels to test the stability of the toe and the crest of the structures.
- **Overtopping Tests –** a matrix of wave conditions were tested to characterise the overtopping performance of the structures.

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Reef and Breakwater Construction

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Finished Breakwater and groyne

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Finished Reef Structures

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Test measurements

- 16 wave gauges – surface elevation
- 8 Overtopping Tanks
- Overhead video to assess surfing performance
- Photographic overlay for the stability assessment
- Dye & Anthracite tracing to determine sediment pathways
- Laser scanning to determine beach morphology

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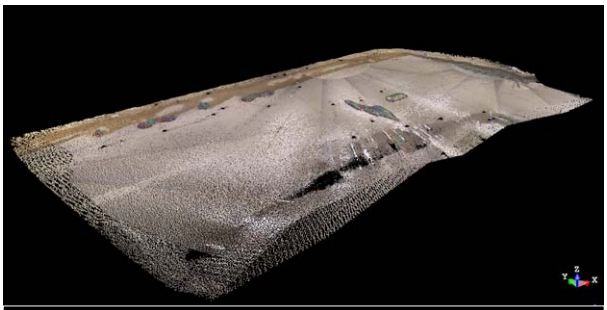
3D Laser Scanner



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Preliminary Results

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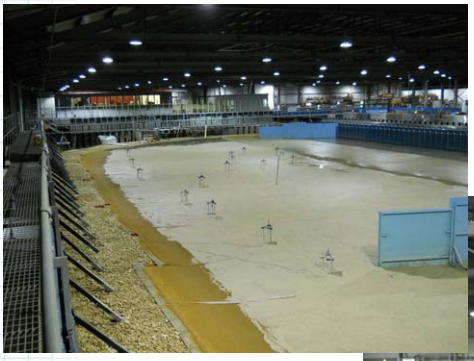
Testing Series 1 – Existing Conditions



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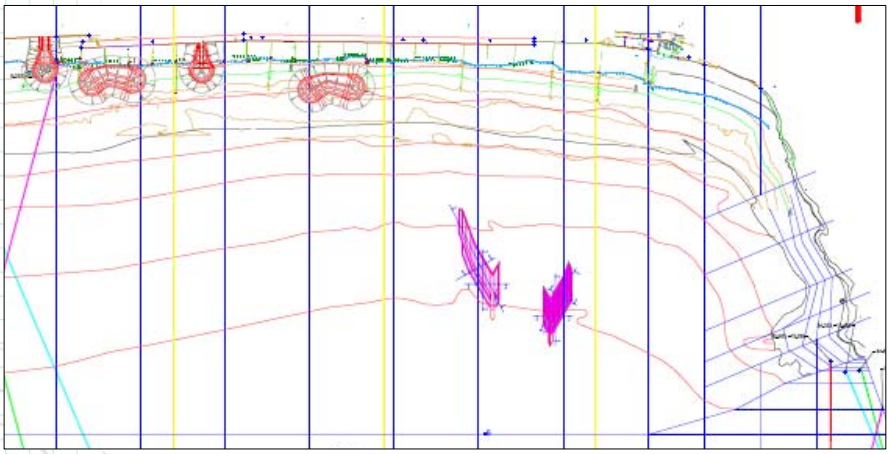
Test Series 2 – Morphology of structure layout 1



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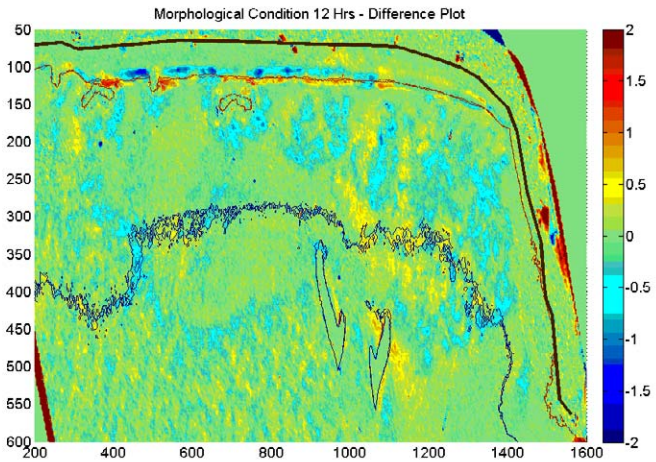
Test Series 2 - Results



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Test Series 3 - Surfability

- Tested under monochromatic and random waves
- Wave directions of 255^{0}N & 270^{0}N
- Video collected from overhead and hand held cameras

- South reef not performing as expected
- Permeability of the structure clearly important
- Steep inshore slope affecting the breaking

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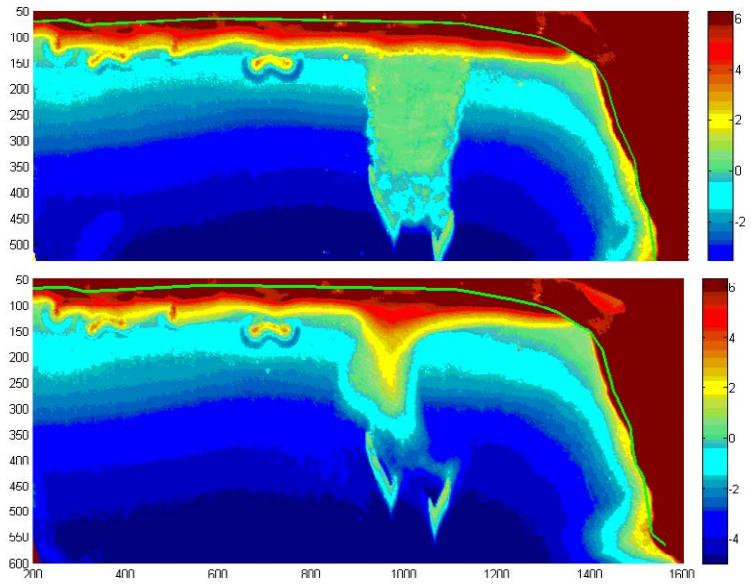
Test Series 4 - Stable Beach Plan Shape

The morphological condition was run at 12 hour intervals and the shoreline position was recorded at key locations until a quasi-equilibrium plan shape was reached

Waves run from 255^o & 285^o

Test Series 4 - Tombolo persistence



Sediment Pathways

Test Series 5 - Surfability Assessment II

- Modified the North Reef only
- Extended the rear slope by approximately 1/3
- Included ridges to simulate roughness profile of the geotextile sand bags

Test Series 6 – Stability of breakwaters & groynes

BEFORE **AFTER**

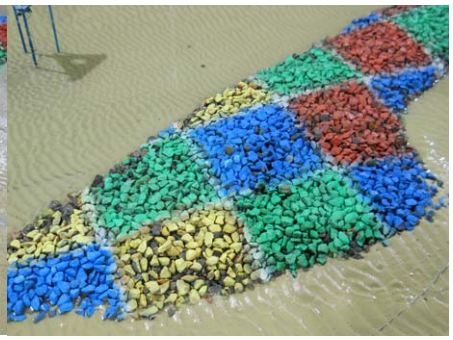
Preliminary results show that there is typically 1% - 2% damage

Test Series 7 – Surfability Assessment III

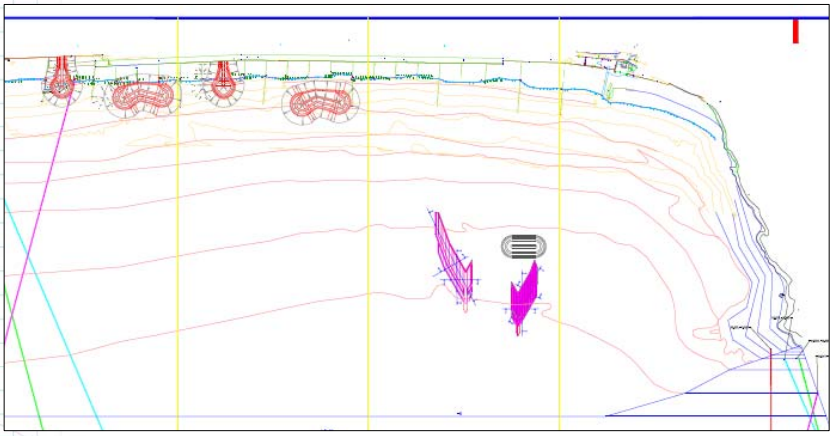
Test Series 8 – Stability of the offshore reef

Initial

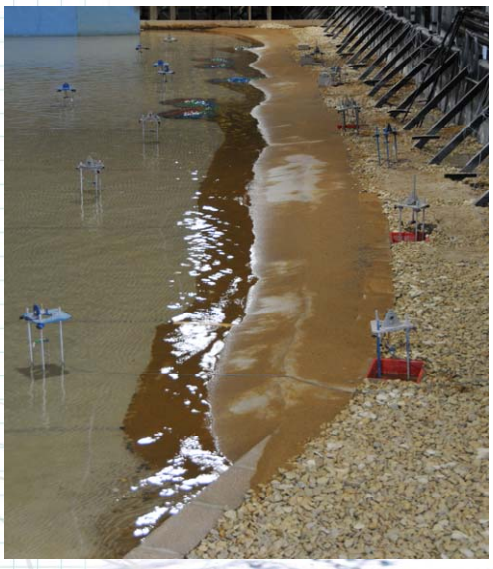
Final



Test Series 9 – Morphology of structure layout 2



Stable Beach Plan Shape



The morphological condition was run at 12 hour intervals and the shoreline position was recorded at key locations until a quasi-equilibrium plan shape was reached

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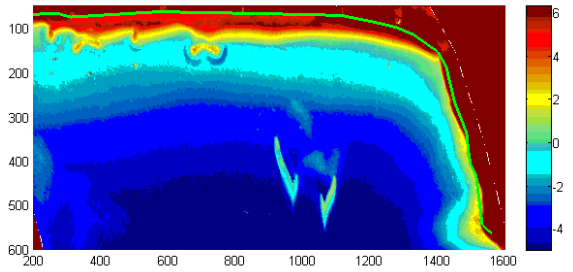
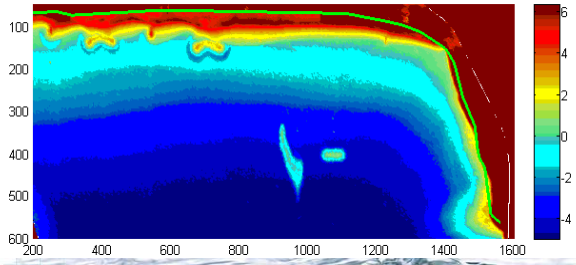
Final Beach Plan Shape



Structure Layout 1



Structure Layout 2

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Test Series 9 – Overtopping Performance

- Total of 23 tests – T_m=5s-9.8s, WL=2.5mODN-4.5mODN, H_s = 1.5m-4m
- Results will be used to derive an empirical relationship for wave overtopping
- Structure Layout 2 overtopping was reduced at overtopping tank 8
- The combination of wave period and WL is the critical parameter
- Joint probability analysis by RH will be used to assign correct return periods

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Questions ?

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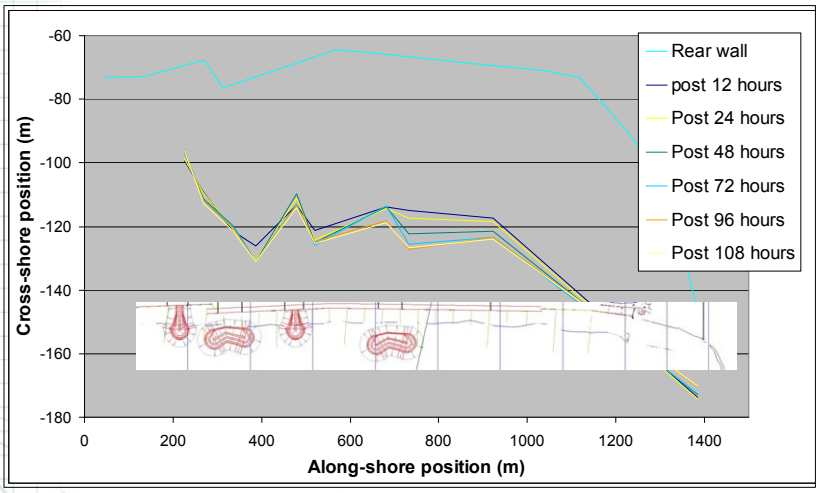
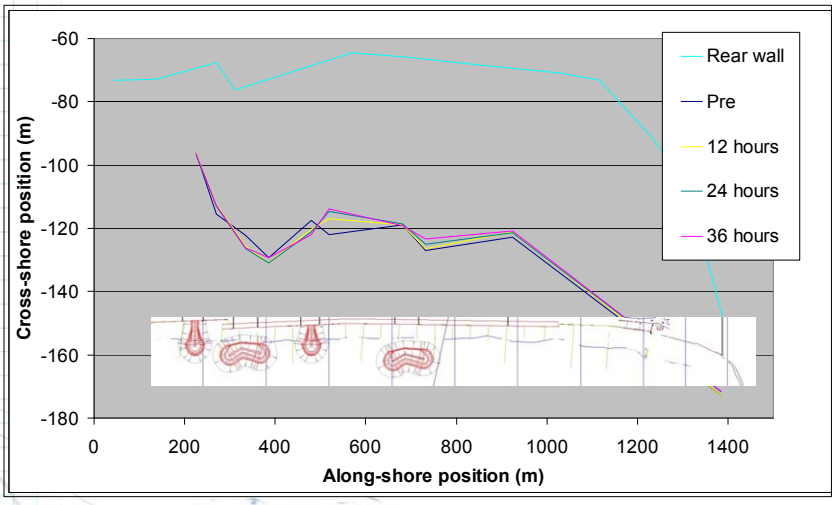
Shoreline Movement 255 deg N



Shoreline Movement 285 deg N



Test Series 4 - Results