Coasts, marine structures and breakwaters
Adapting to change

Proceedings of the 9th international conference organised by the Institution of Civil Engineers and held in Edinburgh on 16 to 18 September 2009

Edited by William Allsop
# Contents

## Conference opening

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progress towards a viable UK Marine renewable energy</td>
<td>2</td>
</tr>
<tr>
<td>I. G. Bryden</td>
<td></td>
</tr>
<tr>
<td>Historical experience of vertical breakwaters in the UK</td>
<td>14</td>
</tr>
<tr>
<td>N. W. H. Allsop</td>
<td></td>
</tr>
<tr>
<td>The sea versus Wick Breakwater 1863–77 – an instructive disaster</td>
<td>31</td>
</tr>
<tr>
<td>R. Paxton</td>
<td></td>
</tr>
<tr>
<td>Breakwater development in Spain. The last ten years</td>
<td>43</td>
</tr>
<tr>
<td>R. Gutierrez-Serret, J. M. Grassa and J. I. Grau</td>
<td></td>
</tr>
<tr>
<td>Session discussion</td>
<td>62</td>
</tr>
</tbody>
</table>

## Design optimisation

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost effectiveness of the renovation scenarios of the IJmuiden breakwaters</td>
<td>72</td>
</tr>
<tr>
<td>H. Janssen, D. Heineke and M. de Vries</td>
<td></td>
</tr>
<tr>
<td>Stochastic risk-based life cycle simulation of century old jetties at the mouth of the Columbia River, USA</td>
<td>84</td>
</tr>
<tr>
<td>H. R. Moritz and H. P. Moritz</td>
<td></td>
</tr>
<tr>
<td>Risk awareness – key to a sustainable design approach for breakwater armouring</td>
<td>96</td>
</tr>
<tr>
<td>J. S. Reedijk, M. Muttray and H. Bergmann</td>
<td></td>
</tr>
<tr>
<td>Reliability analysis of breakwater armour blocks of harbours in Korea</td>
<td>108</td>
</tr>
<tr>
<td>S.-W. Kim and K.-D. Suh</td>
<td></td>
</tr>
<tr>
<td>Session discussion</td>
<td>120</td>
</tr>
</tbody>
</table>

## Breakwaters

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single layer armour systems – toe, crest and roundhead details</td>
<td>128</td>
</tr>
<tr>
<td>P. Besley and M. Denechere</td>
<td></td>
</tr>
<tr>
<td>On the design of quasi-static Berm Breakwaters</td>
<td>142</td>
</tr>
<tr>
<td>O. J. Sayao and P. Lomonaco</td>
<td></td>
</tr>
</tbody>
</table>
Development of an Icelandic-type berm breakwater for the Oakajee port project in Western Australia
S. SIGUDARSON, R. MOCKE, O. SMARASON, B. CARLTON AND W. ALLSOP 156

Evolution of damage on roundheads protected with cubes and cubipod armour units
P. LOMONANCO, C. VIDAL, J. R. MEDINA AND M. E. GÓMEZ-MARTIN 169

Session discussion 181

Improving existing facilities

Isles of Scilly link harbour improvements, social and environmental issues in a unique island location
G. ROBERTSHAW, N. PINNINGTON, N. YEATES AND C. MOTTRAM 190

Extending the life of Brighton Marina breakwaters from 30 to 130 years
J. ORRELL, W. ALLSOP, J. SCRATCHARD, A. CHAPMAN, J. BROOMFIELD AND J. DAVEY 203

Restoration of St. Catherine's breakwater roundhead, Jersey, Channel Islands
S. HOLD 215

Session discussion 227

Use of concrete in maritime engineering

Introducing the new CIRIA manual on the use of concrete in the maritime environment
S. DUPRAY, K. GAMST, G. ROBERTSHAW, J. SIM AND W. ALLSOP 230

Review of the use of concrete in the manufacture of concrete armour units.
S. DUPRAY AND J. ROBERTS 245

Cube and cubipod armour unit drop tests and cost analysis

Application of the finite-discrete element method to dynamic stress development in armour units and armour layers
P. LATHAM AND J. XIANG 272

Physical modelling of the mechanical and hydrodynamic behaviour of reinforced concrete floating breakwaters: Application in Baiona (Galicia, Spain)
E. PEÑA, F. SÁNCHEZ-TEMBLEQUE, J. FERRERAS, O. PIÑÓN, J. A. RODRÍGUEZ AND P. URQUIJO 285

Session discussion 297
Innovation in construction

Rehabilitation of the old cube breakwater of Port of Poti — Georgia with Xbloc® armour units
P. Bakker 304

Installation of Caisson breakwater at Costa Azul, Mexico
W. Hibbs, P. Bowers and M. Young and J. Dingwall 316

Dredging innovations for Dames Point Container Terminal, Jacksonville
P. Starr and H. Frederick 328

Innovation in the Extension to the Port of Gijón
J. L. Diaz-rato, M. De Miguel Riestra and J. M. Retamero 340

Session discussion 352

Coastal management

Our Living Coast — a strategic overview
A. Baptiste and J. Hutchison, 356

One hundred and beyond: using shoreline management plans
J. G. L. Guthrie, N. J. Cooper, S. Rowe, P. Patterson, T. Oakes, K. Thomas, P. Briggs and S. Lombardo 368

UK Shoreline Management Planning — enlightened or occult
P. C. Barber 379

Louisiana’s comprehensive Master Plan for a sustainable coast: a response to hurricanes Katrina and Rita in 2005
J. Porthouse, A. Hosking, N. Johnson and B. Hamer 392

Session discussion 404

Armour unit placement

An overview of the construction of the Core-loc™ armoured breakwater at Newbiggin-by-the-Sea, Northumberland
J. Paulsen and A. Wareing 412

Innovative technique for single layer armour unit placement
P. van Geldren and S. Auld 425

Armour unit placement and positioning in 3D real time
A. Mouquet 437

Post-construction monitoring of a Core-loc™ breakwater using Tripod-based LiDAR
J. Podoski, G. W. Bawden, S. Bond, T. D. Smith and J. Foster 448

Session discussion 460
Erosion risk

Storm damage and rehabilitation of coastal structures on the east coast of South Africa
D. Phelp, M. Rossouw, A. Mather and G. Vella 464

Coastal erosion in Uruguay
G. López, R. Alonso, R. Mosquera and L. Teixeira 476

A Rock and a Hard Place: managing coastal erosion risk at Trow Quarry, South Shields
N. Cooper, A. Wainwright and D. Leggett 488

Cliff recession process modelling as a basis for set-back definition
T. G. Carter, B. E. Cottrell, L. F. S. Brewster, J. L. Carvalho and A. S. Poschmann 498

Successful minimisation of cliffing on recharged mixed shingle beaches
I. Thomas, K. She and J. Booth 513

Session discussion 525

Development of ports and harbours

Breakwater construction at new port in Punta Langosteira, A Coruña, Spain. Execution process and technical innovation
E. M. Alonso, F. N. Arquero and V. B. González 532

The new Marina of Rodi Garganico: design, construction and monitoring
L. Franco, R. Cifra, P. Capolei, D. Caricari and O. Mazzola 544

Expansion of Jebel Ali Port
D. V. Padron, S. Misra, P. Rasch, D. Shen, A. Driscoll, E. Tanagho and A. A. Abbar 556

Design to Construct
G. B. H. Spaan and A. Hibma 568

Closing plenary: adapting to change

Energy and carbon costing of breakwaters
T. Bruce and J. Chick 582

The construction and commissioning of the Mutriku multiple oscillating water column breakwater
T. Heath 591

Rebuilding East Anglia’s beaches
S. Hayman 602
Coastal flooding in Scotland: past, present and future
T. Ball, L. M. Booth, R. W. Duck, A. Edwards, K. Hickey and A. Werrity 614

Planning and renewables

Developing standards & guidelines for marine energy devices
J. W. Griffith 628

The development of technology evaluation protocols for the equitable evaluation of marine renewable energy converters
D. Ingram, G. H. Smith, J. L. Villate, C. Jonstone and C. B. Ferreira 638

Tidal power from the estuaries of NW England

Analysis of the wave energy resource at the European Marine Energy Centre
M. Folley, B. Elsaesser and T. Whittaker 660

Seawalls

Optimisation of a step-berm embankment
J. Melby, E. C. Burg, W. G. Henderson and D. C. McVan 672

Flare-shaped revetments: installation experience & results on sensitivity of design to climate change
I. Irie, Y. Hamazaki, K. Murakami and T. Toyoda 684

Development of guidance for the management of the toe of coastal defence structures
M. Wallis, R. Whitehouse and N. Lyness 696

The role of water and beach levels in seawall abrasion in the macro-tidal high energy environment of Southeast England
U. Dornbusch 708

Session discussion 720

Renewable schemes

Construction planning for the Greater Gabbard offshore wind farm
D. Summers 726

Development of wave energy breakwater at Sliadar, Isle of Lewis
C. Patterson, R. Dunsire and S. Hillier 738