Dealing with Waves and Coastal Structures

Simon Burchett
Associate Director
Presentation overview

- BS 6349 Part 1-2
- BS 6349 Part 7
- EN 1991-1-8 (and ISO 21650)
BS 6349 and the Eurocodes

BS 6349 Part 1-2
BS 6349 Part 1-2

- Current status
- What has changed?
- Waves, currents and coastal structures
- Precursor to new Eurocode............
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – General</td>
<td>1-1 – Planning and design for operations (2013)</td>
</tr>
<tr>
<td>2 – Environmental considerations</td>
<td>1-2 – Assessment of actions (2016) + FACTORS</td>
</tr>
<tr>
<td>3 – Operational considerations</td>
<td>1-3 – Geotechnical design (2012)</td>
</tr>
<tr>
<td>4 – Sea state</td>
<td>1-4 – Materials (2013)</td>
</tr>
<tr>
<td>5 – Loads, movements and vibrations</td>
<td></td>
</tr>
<tr>
<td>6 – Geotechnical considerations</td>
<td></td>
</tr>
<tr>
<td>7 – Materials</td>
<td></td>
</tr>
</tbody>
</table>

Sea State (a very extensive section)

Loads movements and vibrations

BS 6349: “Maritime Works”
Advancing on Firm Foundations
Part 1 Section 4 (Sea state) included:

- Waves
- Currents
- Water-levels
Part 1 Section 5 (Loads) included:
- Wind, waves, currents, water-levels
- Snow and ice
- Earthquakes
- Berthing and mooring
- Container and cargo handling
BS 6349-1-2

- Actions from other parts
  - E.g. Part 7
- New Guidance
  - (PIANC, CIRIA)
- New Standards
  - (ISO, EN, ROM, EAU)
- New Technology
  - Wave data & modelling (spectral)
  - Cargo handling, berthing & mooring
The new Part 1-2
- 1 – General
- 2 – Combinations of actions & structural design
- 3 – Waves and water level conditions
- 4 – Actions, loads & hydraulic responses
- Informative Annexes (approx ½)
Wave characteristics

- Think ahead
- Spectral/ non-spectral
- Form and motion
- Nearshore processes
- Breaking

Offshore wave climate

- Sources
- Understanding
- Satellite based models
- Empirical hindcasts
- Measured
- VOS
- Extrapolation

13 Wave characteristics

13.1 General

The assessment of wave conditions should be performed with an appreciation that a real sea is often a complex and irregular surface comprising many waves of different heights, periods and directions superimposed on one another. The designer should choose a method of simulating or representing the real wave conditions which is appropriate to the issue being considered and the stage of design. The method used should take into account whether the waves are in deep, nearshore (transitional) or shallow water and the likely spectral shape and wave form of the sea state.
BS 6349-1-2

Wave transformation
- General
- Channel effects
- Bathymetry
- Morphology

Design event probability
- Life Vs risk
- Independent
- Dependent
Wave-structure interaction

- **Breakwaters/ walls**
- **Harbours**

Numerical & physical models

- **CFD**
- **2D/ 3D**
BS 6349-1-2

Current actions

- Propeller wash
- Vertical slender structures
- Flow induced oscillations
BS 6349-1-2

Wave actions
- Slender structures
- Vertical/ inclined cylindrical
- Sub-sea elements

Large structures
- Wave action on walls
- Wave action on horizontal structures
- Wave action on crest walls
- Wave action on floating bodies

Dealing with waves and coastal structures
Simon Burchett
BS 6349-1-2 - Acknowledgements

Initial thinking:
- William Allsop
- Jan De Waal
- Terry Hedges
- Dick Thomas

Partial factors:
- Steve Osborn
- Adrian Douglas
- David Smith
- Graeme Walker

Sea-state:
- Jo Evans
- Simon Burchett
- John Fenton
- Mark Calverley
- Dominic Hames
- Peter Hunter
- Peter Hawkes

Hydraulic/ environmental actions:
- Simon Burchett
- Simon Everitt
- Giovanni Cuomo
- Ian Cruickshank
- Gareth Evans

Operational actions:
- Steve Osborn
- Chris Boysons
- David Veale
- Mark McBride
- Jack Pappin
- Ziggy Lubkowski
- Edmund Booth
- Helge Frandsen
- Roger Allen
- Andy Cook
- Peter Stebbings

BS 6349: “Maritime Works”
Advancing on Firm Foundations
BS 6349 and the Eurocodes

BS 6349 Part 7
(Breakwaters)
BS 6349-7

- Existing Part 7
- Scope of revision
- Other considerations

13th February 2017

BS 6349: “Maritime Works”
Advancing on Firm Foundations
existing part 7

- very widely used
- drew on considerable experience of UK Engineers
- drafted during a time of change
- science/technology
- design approaches
- practical lessons learned
Scope of revision

- What should it cover?
  - Breakwaters for maritime works
  - Sea-walls/ revetments for maritime works?
  - Sea-walls/ revetments/ breakwaters for coastal/ flood defence?
  - Rubble-mound – rock/ conc/ reshaping/ bermed
  - Vertical – block-wall/ RC caisson
  - Wave screens? Floating breakwaters/ attenuators?
  - Other coastal structures?

- Buoyancy analysis?
- RC detailing?
- Rock durability testing?
- Concrete mix design?
Other considerations

- Changes since 1991?
- Survey technology, e.g. posi-block
- CIRIA 2010 – maritime concrete
- PIANC WG’s
- DEFRA/ EA 2012 – toe structures
- Single-layer systems – tighter standards?

- Health and safety
BS 6349-7

Resource availability?
- Materials – rock?
- Construction experience?
- Single-layer/ GPS positioning?

Seismic/ geotech response

Standard compatibility
- ISO 21650
- EN 13383
- EN 1991-1-8
BS 6349 and the Eurocodes

EN 1991-1-8
(Coastal structures)
New Eurocode (coastal structures)

- Background
- Current status
New Eurocode (coastal structures)

- Eurocodes are being amended and extended (2nd generation)
- E.g. new Eurocode on structural glass
- ‘Vienna Agreement’ – Eurocodes not to be developed independently or duplicate ISO’s, e.g.:
  - Icing of structures
  - Actions from waves and currents on coastal structures
New Eurocode (coastal structures)

- Eurocodes – 450 technical committees, e.g.:
  - CEN/ TC 268 ‘Cryogenic vessels’
  - CEN/ TC 364 ‘High chairs’
  - CEN/ TC 409 ‘Beauty salon services’
  - CEN/ TC 377 ‘Air traffic management’
  - CEN/ TC 250 ‘Structural Eurocodes’
    - CEN/TC250/SC1.T7
    - EN 1991-1-8 (Waves and currents)
    - CEN/TC250/SC1/WG6
New Eurocode (coastal structures)

- EN 1990 – Basis of structural design
- EN 1991 – Actions on structures
- EN 1992 – Concrete structures
- EN 1993 – Steel structures
- EN 1994 – Composite structures
- EN 1995 – Timber structures
- EN 1996 – Masonry structures
- EN 1997 – Geotechnical design
- EN 1999 – Aluminium structures
- EN 1998 – Earthquake resistance

Dealing with waves and coastal structures
Simon Burchett

BS 6349: “Maritime Works”
Advancing on Firm Foundations

13th February 2017
New Eurocode (coastal structures)

EN 1991-1-8: Wave and current actions on coastal structures
EN 1991-2: Traffic loads on bridges
EN 1991-3: Actions induced by cranes
EN 1991-4: Actions in silos and tanks

The odd one out?
Informal poll:

1) Who is aware of ISO 21650:2007 ‘Wave and current actions on coastal structures’?

2) Who has made use of ISO 21650?
New Eurocode (coastal structures)

- ISO 21650 – content/ scope
- Water-levels/ waves/ currents
- Waves/ currents on structures
- Waves on breakwaters
- Waves on vert/comp breakwaters
- Waves on dykes and seawalls
- Waves/currents on cylinders
- Waves & floating breakwaters
- Waves on screens
- Probabilistic analysis
- Uncertainties
- Reliability assessment
- 14 pages (+ 85pp informative annexes)

Other guidance exists, e.g. BSI and PIANC

BS 6349: “Maritime Works”
Advancing on Firm Foundations
New Eurocode (coastal structures)

- SC1.T7 – response to mandate M/515
- Task name: EN 1991-1-8 (Waves and currents)
- Deliverable: Conversion of ISO 21650:2007 to EN-ISO 21650
- Outline scope:
  - Be as clear as possible
  - Use simple routes through doc
  - Avoid additional empirical rules
- Task description:
  - Redraft ISO in “Eurocode style” – adjust foreword & intro
  - Consider stakeholder comments
  - Decide whether some annexes become normative
  - Include, if relevant, up-to-date complementary info
- Key benefit:
  - ‘As a result the whole package of design of maritime works will become an integral part of the Eurocodes family’
Justification/need:
- ‘Residential projects toward sea side have become common’
- ‘EN for structural design exists’
- ‘EN for geotechnical design exists’
- ‘What about wave and current actions?’
- ‘To achieve a complete standard covering all coastal structures, complexity is high’
- ‘Floating structures proposed for residential areas, have a high degree of (non-linear) dynamic behaviour – should be included?’
- ‘Unclear definition of scope, mandate needs to be updated, some types of structures to be held outside scope, to be based on rather than conversion of ISO’
- Focus on buildings as opposed to maritime infrastructure
New Eurocode (coastal structures)

- EN 1991-1-8 is coming
- We can shape it
  - Share experience/ lessons learned
  - Share concerns/ identify opportunities
  - Offer expertise in a specialist subject
  - Offer general expertise

- Contact:
  - simon.burchett@wspgroup.com