BS EN 1997 – WHERE ARE WE WITH EUROCODE 7?

David Norbury
Director - David Norbury Ltd

The Eurocode scream!
Or is this an opportunity?

Eurocode 7 (EN 1997)

- Part 1 published 2004
  - National Annex published
- Part 2 published 2007
  - NA public comment closed. Publication soon
- National Standards can coexist with EN 1997 until March 2010
- After that – withdrawal or supercession

EC7 Part 1 - GENERAL RULES

1 General
2 Basis of geotechnical design
3 Geotechnical data
4 Supervision of construction, monitoring and maintenance
5 Fill, dewatering, ground improvement and reinforcement
6 Spread foundations
7 Pile foundations
8 Anchorages
9 Retaining structures
10 Hydraulic failure
11 Overall stability
12 Embankments

EC 7 Part 2

1 General
2 Planning of GI
3 Soil and rock sampling and groundwater measurements
4 Field tests in soil and rock
5 Laboratory tests on soil and rock
6 Ground Investigation report
Annexes + NATIONAL ANNEX
   - A – B Planning
   - C – K Field Testing
   - L – W Laboratory testing
EC 7 Part 2

1. General
2. Planning of GI
3. Soil and rock sampling and groundwater measurements
4. Field tests in soil and rock
5. Laboratory tests on soil and rock
6. Ground Investigation report
   PLUS:
   ANNEXES A to X

AIM OF INVESTIGATIONS

- Geotechnical investigations shall provide sufficient data concerning the ground and the ground-water conditions at and around the construction site for a proper description of the essential ground properties and a reliable assessment of the characteristic values of the ground parameters to be used in design calculations.

INVESTIGATION POINTS SPACING

<table>
<thead>
<tr>
<th>Structure/example</th>
<th>Spacing</th>
<th>Arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-rise and industrial</td>
<td>15m - 40m</td>
<td>Grid</td>
</tr>
<tr>
<td>Large-area</td>
<td>60m</td>
<td>Grid</td>
</tr>
<tr>
<td>Linear</td>
<td>20 - 200m</td>
<td>-</td>
</tr>
<tr>
<td>Special</td>
<td>2 - 6</td>
<td>Per foundation</td>
</tr>
<tr>
<td>Dams and weirs</td>
<td>25 - 75m</td>
<td>Along vertical sections</td>
</tr>
</tbody>
</table>

INVESTIGATION DEPTHS

SHALLOW FOUNDATIONS

- For high-rise and civil engineering projects: \( z \geq 6 \) m, \( z \geq 3.0 \) b
- For raft foundations: \( z \geq 1.5 \) b
- On competent strata with known geology: \( z \) may be reduced to 2m
- With uncertain geology, at least one borehole should go to \( z \geq 5 \) m
  - \( z \) is depth of investigation below base of foundation
  - \( b \) is width of foundation

PILE FOUNDATIONS

- Depth of investigation points: \( z \geq 5 \) m, \( z \geq b \), \( z \geq 3 \) D_b
- On competent strata with known geology: \( z \) may be reduced to 2m
- With uncertain geology, at least one borehole should go to \( z_b \geq 5 \) m
  - \( z \) is depth of investigation below lowest point of foundation
  - \( b \) is width of group (smaller side)
  - D_b is base diameter

NUMBERS OF TESTS – per stratum

<table>
<thead>
<tr>
<th>Test</th>
<th>Range</th>
<th>No experience</th>
<th>Medium experience</th>
<th>Extensive experience</th>
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<tbody>
<tr>
<td>PSD</td>
<td>4 - 8</td>
<td>2 - 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water content</td>
<td>All samples of Quality Class 1 to 3</td>
<td></td>
<td></td>
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<tr>
<td>Strength index</td>
<td>All samples of Quality Class 1 to 3</td>
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<tr>
<td>Consistency Limits</td>
<td>3 - 5</td>
<td>1 - 3</td>
<td></td>
<td></td>
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<tr>
<td>Density</td>
<td>&gt;0.02 Mg/m²</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>c_u</td>
<td>&lt;0.02 Mg/m²</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Max &gt; 2 min</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Max &lt; 1.25 min</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>r &lt; 0.95</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>r &gt; 0.98</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

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REPORTING

- Geotechnical Design Report (GDR)
- Part 1, 2.8
  - The Geotechnical Design Report (GDR) shall record the assumptions, data, methods of calculation and results of the verification of safety and serviceability
- Geotechnical Investigation Report (GIR)
- Part 2, 6
  - The GIR will comprise part of the GDR

GROUND INVESTIGATION REPORT

- The results of a geotechnical investigation shall be compiled in the Ground Investigation Report
- The GIR shall consist of:
  - a presentation of all available geotechnical information including geological features and relevant data;
  - a geotechnical evaluation of the information, stating the assumptions made in the interpretation of the test results.
- The GIR may include derived values.
- The GIR shall state known limitations of the results.
- The GIR should propose necessary further field and laboratory investigations, with comments justifying the need for this further work.

PRESENTATION

- The presentation of geotechnical information shall include documentation of the methods, procedures and results including all relevant reports of:
  - desk studies
  - field reconnaissance
  - field investigations, such as sampling and measurement
  - field tests
  - laboratory tests
- The results of the field and laboratory investigations shall be presented and reported according to the requirements defined in the EN and/or ISO standards applied in the investigations

THE EUROCODE 7 SUITE

- THE ATTACHMENTS
- A series of Standards on:
  - Execution of geotechnical works
  - Qualifications
  - Drilling and sampling
  - Field tests
  - Laboratory tests
  - Soil and rock description and classification

EXECUTION STANDARDS

<table>
<thead>
<tr>
<th>EN 1536: 1999</th>
<th>Bored piles</th>
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<tbody>
<tr>
<td>EN 1537: 1999</td>
<td>Ground anchors</td>
</tr>
<tr>
<td>EN 1538: 2000</td>
<td>Diaphragm walls</td>
</tr>
<tr>
<td>EN 12063: 1999</td>
<td>Sheet-pile walls</td>
</tr>
<tr>
<td>EN 12699: 2000</td>
<td>Displacement piles</td>
</tr>
<tr>
<td>EN 12715: 2000</td>
<td>Grouting</td>
</tr>
<tr>
<td>EN 12716: 2001</td>
<td>Jet grouting</td>
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<tr>
<td>EN 14199: 2005</td>
<td>Micropiles</td>
</tr>
<tr>
<td>EN 14475: 2006</td>
<td>Reinforced fill</td>
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<tr>
<td>EN 14679: 2005 &amp; 6</td>
<td>Deep mixing</td>
</tr>
<tr>
<td>EN 14731: 2005</td>
<td>Ground treatment by deep vibration</td>
</tr>
<tr>
<td>EN 15237: 2007</td>
<td>Vertical drainage</td>
</tr>
</tbody>
</table>

STANDARDS

- 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT
- 22476 - FIELD TESTING
- 22477 - GEOTECHNICAL STRUCTURE TESTS
- 22482 - GEO-HYDRAULIC TESTS
- 17892 - LABORATORY TESTING
- 14688 & 14689 - SOIL AND ROCK DESCRIPTION

/1 Technical principles for execution
/2 Qualification criteria for enterprises and personnel - TS
/3 Conformity assessments of enterprises and personnel by third parties - TS

PUBLISHED
INFORMATION BEFORE SAMPLING AND MEASUREMENT

At least the following information shall be available before starting
a) objective of the sampling and measurements
b) location of the planned boreholes or excavations or groundwater measurements
c) orientation, inclination and acceptable deviations in boreholes
d) surveying requirements, and expected geological and hydrogeological conditions
e) required accuracy and uncertainty of measurements
f) frequency of measurements
g) environmental and safety risks
h) possible risks, e.g. services, traffic, ordnance, contamination

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SAMPLE QUALITY CLASSES

• All samples are “disturbed” at least to some extent
• Category A sampling methods
  – “no” disturbance of structure, void ratio, water content or chemistry
  – eg thin wall pushed, rotary core or block samples
• Category B sampling methods
  – Constituents in original proportions and water content
  – General arrangement of constituents and layers intact
  – eg thick walled driven, Mostap
• Category C sampling methods
  – Structure, layers and water content changed
  – eg SPTs, window samples, bulk bags, grab samples

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USE OF SAMPLES

<table>
<thead>
<tr>
<th>Sample category</th>
<th>A</th>
<th>A, B</th>
<th>A, B, C</th>
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</thead>
<tbody>
<tr>
<td>Type of soil</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Sequence of layers</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Strata boundaries</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water content</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Index, PSD</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density, strength, permeability</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressibility, shear strength</td>
<td>U100 = Class B</td>
<td></td>
<td></td>
</tr>
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</table>

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COMPETENCE – 22475/2
AUDIT – 22475/3

• Defines the required competencies of the
  – Responsible Expert
  – Qualified Driller
  – Enterprise (or company)
• Frequency of third party assessment

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STANDARDS

• 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT
• 22476 - FIELD TESTING
• 22477 - GEOTECHNICAL STRUCTURE TESTS
• 22802 - GEO-HYDRAULIC TESTS
• 17892 - LABORATORY TESTING
• 14688 & 14689 - SOIL AND ROCK DESCRIPTION

/1 Cone penetration tests
/2 Dynamic probing
/3 Standard Penetration test IMP
/4 Menard Pressuremeter
/5 Flexible dilatometer
/6 Self boring p/meter
/7 Borehole Jacking test
/8 Full displacement p/meter
/9 Field vane test
/10 Weight sounding test
/11 Flat dilatometer test
/12 Mechanical CPT cone
/13 Plate Loading test

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22476/2 and /3 - DYNAMIC PROBING and SPT

- IMPLEMENTED 2007
- BS1377 Part 9 Clause 3.2 (DP) and
- BS1377 Part 9 Clause 3.3 (SPT)

WERE WITHDRAWN
Do not refer to these

Hammer Calibration

- Energy ratio = % ratio of actual to theoretical energy of the hammer
- Energy losses occur. Therefore the energy ratio of the equipment has to be known if the N values are going to be used for the quantitative evaluation of foundations or comparison of results.
- A certificate of the calibration of the energy ratio immediately below the driving head or anvil shall be available
- Q – what use are designers going to make of Er?

Standards

- 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT
- 22476 - FIELD TESTING
- 22477 - GEOTECHNICAL STRUCTURE TESTS
- 22282 - GEO-HYDRAULIC TESTS
- 17892 - LABORATORY TESTING
- 14688 & 14689 - SOIL AND ROCK DESCRIPTION

Pile tests
/1 Static axial compression Voted
/2 Static axial tension WD
/3 Transverse tension WD
/4 Dynamic axial compression WD
/5 Testing of anchors Voted
/6 Testing of nails WD
/7 Testing of reinforced fill WD
/8 Static testing New item

Standards

- 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT
- 22476 - FIELD TESTING
- 22477 - GEOTECHNICAL STRUCTURE TESTS
- 22282 - GEO-HYDRAULIC TESTS
- 17892 - LABORATORY TESTING
- 14688 & 14689 - SOIL AND ROCK DESCRIPTION

/1 General rules
/2 Water permeability test in borehole without packer
/3 Water pressure test in rock
/4 Pumping tests
/5 Infiltrometer tests
/6 Closed packer systems
ENQUIRY CARRIED OUT IN 2008

Standards

- 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT
- 22476 - FIELD TESTING
- 22477 - GEOTECHNICAL STRUCTURE TESTS
- 22282 - GEO-HYDRAULIC TESTS
- 17892 - LABORATORY TESTING
- 14688 & 14689 - SOIL AND ROCK DESCRIPTION

/1 Water content
/2 Density of fine grained soils
/3 Density of solid particles
/4 Particle size distribution
/5 Oedometer test
/6 Fall cone test
/7 Compression test
/8 Unconsolidated triaxial test
/9 Consolidated triaxial test
/10 Direct shear test
/11 Permeability test
/12 Atterberg limits
ALL TS – being published in UK

Standards

- 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT
- 22476 - FIELD TESTING
- 22477 - GEOTECHNICAL STRUCTURE TESTS
- 22282 - GEO-HYDRAULIC TESTS
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- 14688 & 14689 - SOIL AND ROCK DESCRIPTION

/1 Description 2002
/2 Classification 2003

14689 - ROCKS
/1 Description and Classification 2004
IMPLEMENTED
SOIL DESCRIPTION

- Improvements by defining all terms
- No word order prescribed
- No % terms for secondary constituents
- Plasticity terms included – low and high
- ‘silty CLAY’ and ‘clayey SILT’ replace ‘CLAY/SILT’
- More organic soils terms
- Six angularity terms
- Consistency terms by hand test only = CHANGE
- Some other differences but no conflict

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ROCK DESCRIPTION

- Improvements by defining all terms
- Terms generally ISRM, not BS
  - Strength terms
  - Roughness terms
  - Aperture terms
- Weathering classifications are those discarded in 1999

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ROCK STRENGTH $q_{uv}$ MPa

<table>
<thead>
<tr>
<th>TERM</th>
<th>2007</th>
<th>1999</th>
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<tbody>
<tr>
<td>Extremely weak</td>
<td>0.6 – 1.0 in UK</td>
<td>-</td>
</tr>
<tr>
<td>Very weak</td>
<td>1 – 5</td>
<td>&lt;1.25</td>
</tr>
<tr>
<td>Weak</td>
<td>5 – 25</td>
<td>1.25 – 5</td>
</tr>
<tr>
<td>Medium strong</td>
<td>25 – 50</td>
<td>5 – 12.5</td>
</tr>
<tr>
<td>Strong</td>
<td>50 – 100</td>
<td>12.5 - 50</td>
</tr>
<tr>
<td>Very strong</td>
<td>100 – 250</td>
<td>50 - 100</td>
</tr>
<tr>
<td>Extremely strong</td>
<td>&gt; 250</td>
<td>100 – 200</td>
</tr>
</tbody>
</table>

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CURRENT SITUATION

Over the next few years, there are a large number of mostly normative new Standards coming out which have to be implemented and followed

Progress being tracked on [www.dnorbury.co.uk](http://www.dnorbury.co.uk)

Practitioners will now need many Standards to hand to ensure their practice is compliant.

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IMPLEMENTATION

- New Standards - be aware of existence
- Read and understand
- Update specification clauses
- Inform and Train staff
- Notify clients
- Deploy procedures into practice
- Update recording and reporting templates
- Adjust interpretation routines as necessary
- Implementation achieved – months?

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HOW MANY STANDARDS?

<table>
<thead>
<tr>
<th>Standards</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td>Eurocodes</td>
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</tr>
<tr>
<td>Part 0 - 9</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
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<td>Eurocodes 7</td>
<td>Parts 1 - 2</td>
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<tr>
<td>National Annexes</td>
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<td>Test Standards</td>
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<td>22475</td>
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</tr>
<tr>
<td>14688</td>
<td>1 2 3</td>
</tr>
</tbody>
</table>

YES THAT IS 61

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• 61 Standards on the shelf = THE SCREAM
• So what is the progress element?

Impact of Eurocode 7 Part 2

“...the greater general emphasis on the assessment of deformation is likely to lead to a greater need for SI providers to consider ground deformation parameters”
• Opportunity to raise standards in scope and precise targeting of investigation and its aims
• Go out and communicate with clients
• Improve market for technical work quality