

# **EC7 IMPLEMENTATION - WHERE ARE WE TODAY?**

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**Is this the  
Eurocode  
scream?**

**Or is this an  
opportunity?**



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## EUROCODE 7

- **EN 1997 -1 Design rules**
  - Characteristic and design values of ground parameters
  - General rules for site investigation
  - Rules for the design of main types of geotechnical structures
  - Some assumptions on execution procedures
- **EN 1997-2 Geotechnical investigation and testing**
  - Detailed rules for site investigations
  - Test specifications
  - Derivation of ground properties and geotechnical model of the site

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## Eurocode 7 (EN 1997)

- Part 1 published 2004
  - National Annex published 2007
- Part 2 published 2007
  - National Annex published 2009
- National Standards can coexist with EN 1997 until 31 March 2010 = NOW
- After that – withdrawal or supersession

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## AFFECTED BS

- BS 8002:1994 – Earth retaining structures
- BS 8004:1986 – Foundations
- BS 8006:1995 – Strengthened/reinforced soils
- BS 8008:1996 – Construction and descent of machine-bored shafts
- BS 8081:1989 – Ground anchorages
- BS 6031:2009 – Earthworks **HAS BEEN REVISED**

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## 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  | Anchorage   | <b>PLUS:</b>          |
| 9  | Retaining structures                                    | <b>Annexes A to J</b> |
| 10 | Hydraulic failure                                       | <b>NATIONAL ANNEX</b> |
| 11 | Overall stability                                       |                       |
| 12 | Embankments   |                       |

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## CHANGE TO DESIGN PROCEDURE

- “Working State design” takes over from “Limit State design”
- Working state design: Analyse the expected working state, then apply margins of safety
- Limit state design: Analyse various unexpected states at which the structure reaches an unacceptable limit

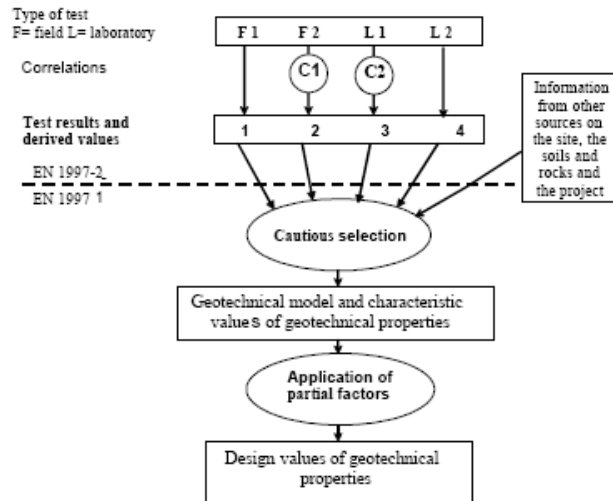
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## LIMIT STATE AND PARTIAL FACTORS

- Ultimate Limit States
  - failure of structure or ground
  - serious and expensive
  - must be very unlikely
- Serviceability Limit States
  - Inconvenient, discomfort
  - less expensive
  - should be rare but may be allowable
- Partial Factors (>100)
  - no longer use lumped factors as in working state design

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## DESIGN PARAMETERS



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## DERIVATION

The “derived value” of a geotechnical parameter is defined in Eurocode 7 as  
*“the value ... obtained by theory, correlation or empiricism from the test”*

**Test results directly (includes theory of test)**

**Test results indirectly**

**Converted test results using correlations**

**Adjusted test results using theory or empiricism**

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## EN 1997

- Characteristic value is the 5% fractile (EN 1990)
- Eurocode 7 “re-defines” the characteristic value of a geotechnical parameter as ‘*a cautious estimate of the value affecting the occurrence of the limit state*’
- The selection of characteristic values for geotechnical parameters shall be based on derived values ... complemented by well-established experience.

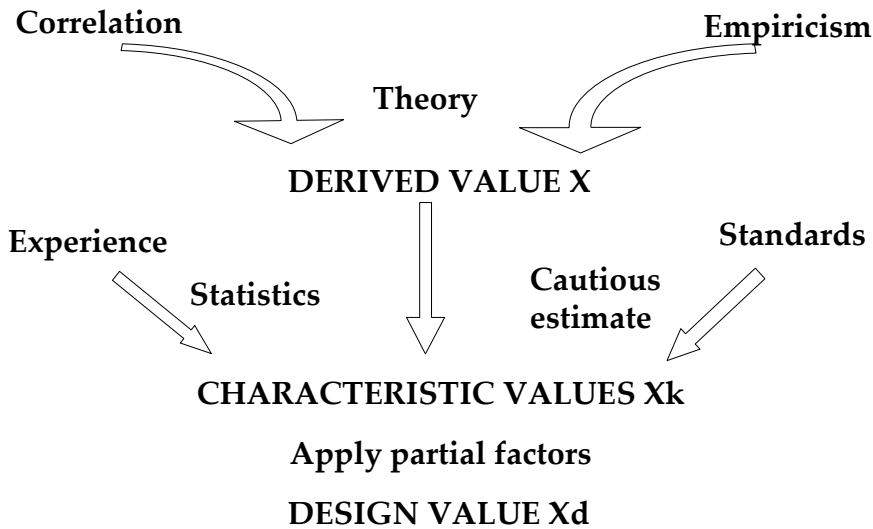
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## CHARACTERISATION

- Value may be 5% fractile, mean, cautious best estimate
- Assessment can use caution, statistical methods, published standard values, experience
- No such thing as *the* characteristic value of a geotechnical parameter
- There are potentially several characteristic values, which can be different for each limit state being considered

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## OBTAINING DESIGN PROPERTIES



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## IMPLEMENTATION

- Are we ready to implement Part 1?
- In order to implement Part 1, we need to also implement Part 2
- Where are we with Part 2?

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## 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
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## 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

| Structure/example        |  | Spacing   | Arrangement                |
|--------------------------|--|-----------|----------------------------|
| High-rise and industrial |  | 15m - 40m | Grid                       |
| Large-area               |  | 60m       | Grid                       |
| Linear                   | roads, railways,<br>channels, pipelines,<br>dikes, tunnels,<br>retaining walls | 20 - 200m | -                          |
| Special                  | bridges, stacks,<br>machinery<br>foundations                                   | 2 - 6     | Per foundation             |
| Dams and weirs           |  | 25 - 75m  | Along vertical<br>sections |

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## INVESTIGATION DEPTHS SHALLOW FOUNDATIONS

- For high-rise and civil engineering projects  $z \geq 6m, z \geq 3.0 b$
  - For raft foundations  $z \geq 1.5 b$
  - On competent strata with known geology  $z$  may be reduced to 2m
- where
    - $z$  is depth of investigation below base of foundation
    - $b$  is width of foundation

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## INVESTIGATION DEPTHS PILE FOUNDATIONS

- Depth of investigation points  $z \geq 5m, z \geq b, z \geq 3 D_b$
- On competent strata with known geology  $z$  may be reduced to 2m
  - where
    - $z$  is depth of investigation below lowest point of foundation
    - $b$  is width of group (smaller side)
    - $D_b$  is base diameter

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## 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**

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|   |  |          |
|---|--|----------|
| <b>D</b>                                    | David Norbury<br>Engineering Geologist | <b>N</b> |
| <h2>EXECUTION STANDARDS</h2>                |  |          |
| EN 1536: 1999                               | Bored piles                            |          |
| EN 1537: 1999                               | Ground anchors                         |          |
| EN 1538: 2000                               | Diaphragm walls                        |          |
| EN 12063: 1999                              | Sheet-pile walls                       |          |
| EN 12699: 2000                              | Displacement piles                     |          |
| EN 12715: 2000                              | Grouting                               |          |
| EN 12716: 2001                              | Jet grouting                           |          |
| EN 14199: 2005                              | Micropiles                             |          |
| EN 14475: 2006                              | Reinforced fill                        |          |
| EN 14679: 2005 & 6                          | Deep mixing                            |          |
| EN14731: 2005                               | Ground treatment by deep vibration     |          |
| EN15237: 2007                               | Vertical drainage                      |          |
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|   |   |                        |
|---|---|------------------------|
| <b>D</b>  | David Norbury<br>Engineering Geologist  | <b>N</b>               |
| <h2>STANDARDS</h2>  |   |                        |
| <ul style="list-style-type: none"> <li>• 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT</li> <li>• 22476 - FIELD TESTING</li> <li>• 22477 - GEOTECHNICAL STRUCTURE TESTS</li> <li>• 22282 - GEO-HYDRAULIC TESTS</li> <li>• 17892 - LABORATORY TESTING</li> <li>• 14688 &amp; 14689 - SOIL AND ROCK DESCRIPTION</li> </ul> | <ul style="list-style-type: none"> <li>/1 Technical principles for execution</li> <li>/2 Qualification criteria for enterprises and personnel – TS</li> <li>/3 Conformity assessments of enterprises and personnel by third parties – TS</li> </ul> | <b>ALL IMPLEMENTED</b> |
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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

| Sample category                 | A | A, B                  | A, B, C |
|---------------------------------|---|-----------------------|---------|
| Type of soil                    | Y | Y                     | Y       |
| Sequence of layers              | Y | Y                     | Y       |
| Strata boundaries               | Y | Y                     |         |
| Water content                   | Y | Y                     |         |
| Index, PSD                      | Y | Y                     |         |
| Density, strength, permeability | Y | <b>U100 = Class B</b> |         |
| Compressibility, shear strength | Y |                       |         |

**Consider using UT100 –  
meets Ar<15% criterion,  
but still driven**

**see Gosling and Baldwin 2010**

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## COMPETENCE – 22475/2 AUDIT – 22475/3

- Defines the required competencies of the
  - Responsible Expert
  - Qualified Driller = Lead Driller
  - Enterprise (or company)
- Frequency of third party assessment
- Standards being published as BS

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## STANDARDS

- |  |   |  |
|--|---|--|
| <ul style="list-style-type: none"> <li>• 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT</li> <li>• <b>22476 - FIELD TESTING</b></li> <li>• 22477 - GEOTECHNICAL STRUCTURE TESTS</li> <li>• 22282 - GEO-HYDRAULIC TESTS</li> <li>• 17892 - LABORATORY TESTING</li> <li>• 14688 &amp; 14689 - SOIL AND ROCK DESCRIPTION</li> </ul> | <ul style="list-style-type: none"> <li>/1 Cone penetration tests</li> <li>/2 Dynamic probing</li> <li>/3 Standard Penetration test</li> <li>/4 Menard Pressuremeter</li> <li>/5 Flexible dilatometer</li> <li>/6 Self boring p/meter</li> <li>/7 Borehole Jacking test</li> <li>/8 Full displacement p/meter</li> <li>/9 Field vane test</li> <li>/10 Weight sounding test</li> <li>/11 Flat dilatometer test</li> <li>/12 Mechanical CPT cone</li> <li>/13 Plate Loading test</li> </ul> | <ul style="list-style-type: none"> <li>Voted</li> <li>IMP</li> <li>IMP</li> <li>Voted</li> <li>Voted</li> <li>Voted</li> <li>Voted</li> <li>Voted</li> <li>Voted</li> <li>TS</li> <li>TS</li> <li>Voted</li> <li>WD</li> </ul> |
|--|---|--|

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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

Implementation - see Hepton and Gosling, 2008

## 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 | <b>Pile tests</b>             |       |
| • 22476 - FIELD TESTING                                | /1 Static axial compression   | Voted |
| • 22477 - GEOTECHNICAL STRUCTURE TESTS                 | /2 Static axial tension       | WD    |
| • 22282 - GEO-HYDRAULIC TESTS                          | /3 Transverse tension         | WD    |
| • 17892 - LABORATORY TESTING                           | /4 Dynamic axial compression  | WD    |
| • 14688 & 14689 - SOIL AND ROCK DESCRIPTION            | /5 Testing of anchorages      | Voted |
|  | /6 Testing of nails           | WD    |
|  | /7 Testing of reinforced fill | WD    |
|  | /8 Statnamic testing          | WD    |

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## STANDARDS

- |  |   |
|--|---|
| • 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT | /1 General rules                                      |
| • 22476 - FIELD TESTING                                | /2 Water permeability test in borehole without packer |
| • 22477 - GEOTECHNICAL STRUCTURE TESTS                 | /3 Water pressure test in rock                        |
| • 22282 - GEO-HYDRAULIC TESTS                          | /4 Pumping tests                                      |
| • 17892 - LABORATORY TESTING                           | /5 Infiltrimeter tests                                |
| • 14688 & 14689 - SOIL AND ROCK DESCRIPTION            | /6 Closed packer systems                              |
- ENQUIRY WAS IN 2008**

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## STANDARDS

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT</li> <li>• 22476 - FIELD TESTING</li> <li>• 22477 - GEOTECHNICAL STRUCTURE TESTS</li> <li>• 22282 - GEO-HYDRAULIC TESTS</li> <li>• <b>17892 - LABORATORY TESTING</b></li> <li>• 14688 &amp; 14689 - SOIL AND ROCK DESCRIPTION</li> </ul> | <ul style="list-style-type: none"> <li>/1 Water content</li> <li>/2 Density of fine grained soils</li> <li>/3 Density of solid particles</li> <li>/4 Particle size distribution</li> <li>/5 Oedometer test</li> <li>/6 Fall cone test</li> <li>/7 Compression test</li> <li>/8 Unconsolidated triaxial test</li> <li>/9 Consolidated triaxial test</li> <li>/10 Direct shear test</li> <li>/11 Permeability test</li> <li>/12 Atterberg limits</li> </ul> <p style="text-align: center;"><b>ALL TS – being raised to<br/>normative under UK convenor</b></p> |
|--|--|

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## STANDARDS

- |  |   |                |      |                   |      |                                   |      |
|--|---|----------------|------|-------------------|------|-----------------------------------|------|
| <ul style="list-style-type: none"> <li>• 22475 - SAMPLING METHODS AND GROUNDWATER MEASUREMENT</li> <li>• 22476 - FIELD TESTING</li> <li>• 22477 - GEOTECHNICAL STRUCTURE TESTS</li> <li>• 22282 - GEO-HYDRAULIC TESTS</li> <li>• 17892 - LABORATORY TESTING</li> <li>• <b>14688 &amp; 14689 - SOIL AND ROCK DESCRIPTION</b></li> </ul> | <p><b>14688 - SOILS</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">/1 Description</td> <td style="text-align: right;">2002</td> </tr> <tr> <td>/2 Classification</td> <td style="text-align: right;">2003</td> </tr> </table> <p><b>14689 - ROCKS</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">/1 Description and Classification</td> <td style="text-align: right;">2004</td> </tr> </table> <p style="text-align: center;"><b>IMPLEMENTED in 2007</b></p> | /1 Description | 2002 | /2 Classification | 2003 | /1 Description and Classification | 2004 |
| /1 Description   | 2002  |                |      |                   |      |                                   |      |
| /2 Classification  | 2003  |                |      |                   |      |                                   |      |
| /1 Description and Classification  | 2004  |                |      |                   |      |                                   |      |

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## 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 $q_u$ , MPa

| TERM                      | 2007              | 1999                     |
|---------------------------|-------------------|--------------------------|
| • <b>Extremely weak</b>   | • 0.6 – 1.0 in UK | • -                      |
| • <b>Very weak</b>        | • 1 – 5           | • <1.25                  |
| • <b>Weak</b>             | • 5 – 25          | • 1.25 – 5<br>• 5 – 12.5 |
| • <b>Medium strong</b>    | • 25 – 50         | • 12.5 - 50              |
| • <b>Strong</b>           | • 50 – 100        | • 50 - 100               |
| • <b>Very strong</b>      | • 100 – 250       | • 100 – 200              |
| • <b>Extremely strong</b> | • > 250           | • > 200                  |

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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

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## 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.

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## 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

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## 2.8 GEOTECHNICAL DESIGN REPORT

- The assumptions, data, methods of calculation and results of the verification of safety and serviceability shall be recorded
- The Geotechnical Design Report should include all appropriate items, with cross reference to the Ground Investigation Report and to other detailed documents
- An extract containing the supervision, monitoring and maintenance requirements for the structure shall be provided to the owner/client

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## REPORTING ROLES

- GIR/ GDR ≠ Factual/ Interpretative
- Can GIR = Ground Conditions report?
- SI specialists not to prepare GDR?
- Perhaps a preliminary GDR

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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

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## HOW MANY STANDARDS?

|                     |             | TOTAL                         |
|---------------------|-------------|-------------------------------|
| Eurocodes           | EC 0 - 9    | 1 2 3 4 5 6 7 8 9 10          |
| Eurocode 7          | Parts 1 - 2 | 1 2                           |
| National Annexes    |             | 1 2                           |
| Execution Standards |             | 1 2 3 4 5 6 7 8 9 10 11 12    |
| Test Standards      |             |                               |
|                     | 22475       | 1 2 3                         |
|                     | 22476       | 1 2 3 4 5 6 7 8 9 10 11 12 13 |
|                     | 22477       | 1 2 3 4 5 6 7 8               |
|                     | 22282       | 1 2 3 4 5 6                   |
|                     | 17892       | 1 2 3 4 5 6 7 8 9 10 11 12    |
|                     | 14688       | 1 2 3                         |

**YES THAT IS 61**

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## IS THIS THE SCREAM?

- 61 Standards on the shelf
- Only 26 yet published
- Leaving 35 yet to arrive
- Only 19 remaining for Vote

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

## 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