April 2010 – the death of British Standards

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Outline of talk

- What happens in April 2010?
- What we lose
- What we gain
- Technical differences (structural)
- Technical differences (geotechnical)
- What help is there?
- Conclusion

What happens in April 2010?

April 2010 – the death of British Standards

Eurocodes are coming. Are you ready?

'The Eurocodes and their National Annexes will replace existing British Standards in March 2010. Their use will be mandatory for all public buildings and recommended for private buildings from this date'

Introduction to BSI's conference on
'Preparing for Eurocodes – managing the change'
October 2009

- According to a BSI survey in June 2009: over 30% of the construction sector are already using Eurocodes

Highways Agency Eurocodes strategy

'The use of current National Standards will continue to be permitted until BSI withdraws them. Once … withdrawn … the Agency will specify that highway structures shall only be designed in accordance with Eurocodes'

www.highways.gov.uk/business/1198.aspx

What we lose

April 2010 – the death of British Standards

List of British Standards that are to be withdrawn on 31st March 2010

- Loads
  - BS 6399 Loading for buildings (parts 1-3)
- Concrete
  - BS 8110 Structural use of concrete (parts 1-3)
  - BS 8007 (CP) Design of concrete structures for retaining aqueous liquids
- Steel
  - BS 5950 Structural use of steelwork in building (parts 1-9)
  - BS 449-2 Specification for the use of structural steel in building
  - BS 4604 Specification for the use of high strength grip bolts in structural steelwork (parts 1-2)
  - BS 7608 (CP) Fatigue design and assessment of steel structure

List of British Standards that are to be withdrawn on 31st March 2010

- Timber
  - BS 5268 Structural use of timber (parts 2-7)
- Masonry
  - BS 5628 (CP) Use of masonry (parts 1-3)
  - BS 8000-3 Workmanship on building sites. (CP) Masonry
- Aluminium
  - BS 8118 Structural use of aluminium (parts 1-2)
- Bridges
  - BS 5400 Steel, composite and concrete bridges (parts 1-10)
- Towers, masts and chimneys
  - BS 8100 Lattice, towers and masts (parts 1-4)
  - BS 4076 Specification for steel chimneys

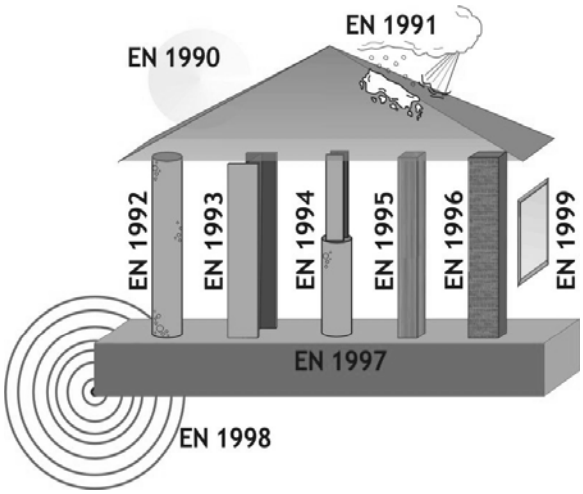
List of British Standards that are to be withdrawn on 31st March 2010

- Geotechnics
  - BS 8002 (CP) Earth retaining structures
  - BS 8004 (CP) Foundations
  - BS 8081 (CP) Ground anchorages
- But many more are being revised ...
  - BS 5930 (CP) Site investigations
  - BS 6031 (CP) Earthworks
  - BS 6349 (CP) Marine structures
  - BS 8006 (CP) Strengthened/reinforced soils and other fills
  - BS 8102 (CP) Protection of structures against water from the ground

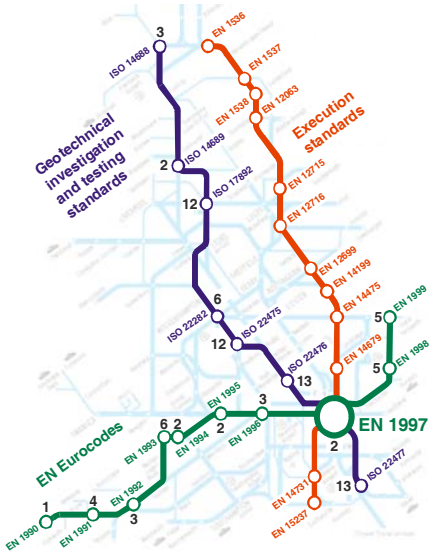
What we gain

April 2010 – the death of British Standards

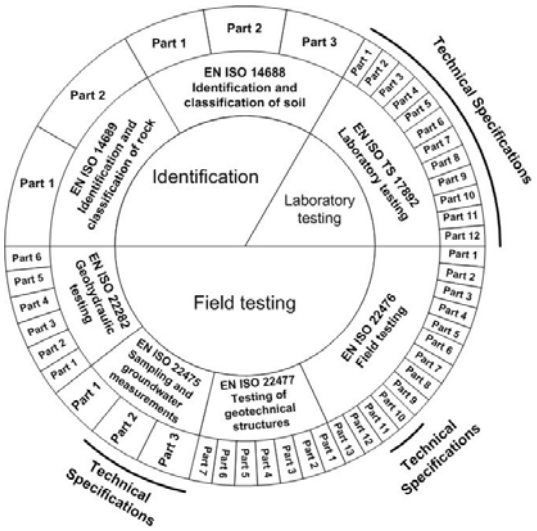
The Eurocode programme



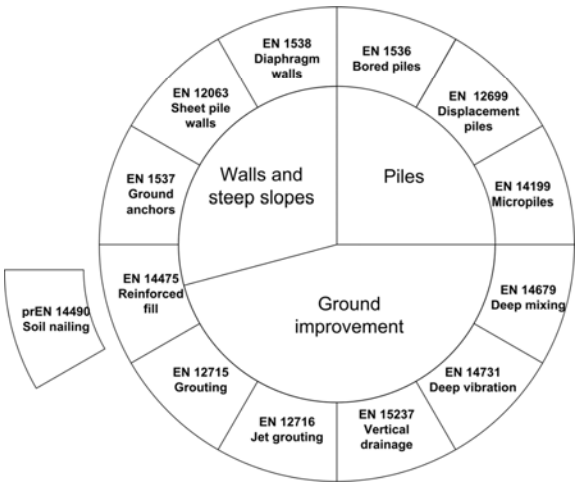
Eurocode 7's 'connecting' standards



Geotechnical investigation and testing



Execution of special geotechnical works



Technical differences (structural)

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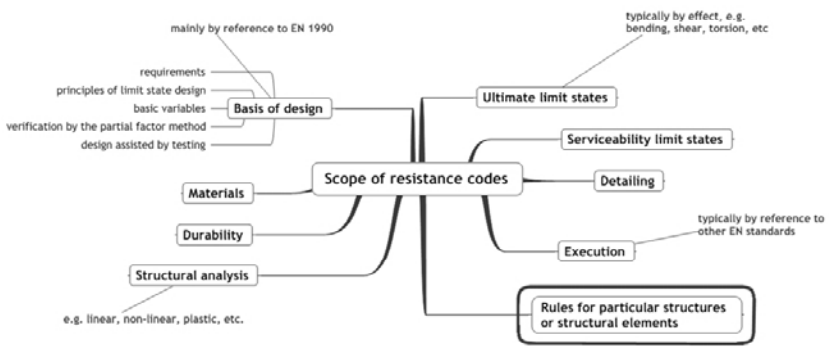
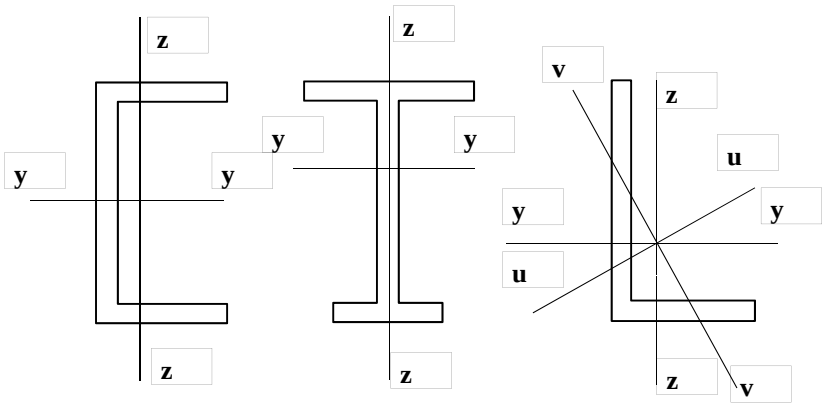
Contents of the ‘resistance’ standards



Key differences from British Standards

- Eurocodes deal with phenomena, not element types
  - ULS: bending, shear, torsion, punching, fatigue
  - SLS: stress limitation, crack control, minimum reinforcement, deflection control
- Second order analysis is default (but first order will usually suffice)
- Extensive use of subscripts, some helpful, some tedious
  - N_{Ed} = axial force in a member
  - N_{Rd} = resistance to axial force
  - $A_{c,eff,loc}$ = effective compression area due to plate sub-panel local buckling
- "MPa" preferred to "N/mm^2" for units of stress

Member sign convention is now compatible with software, i.e. x-x along member



Key features of Eurocode 2

- Design based on cylinder strength (≈0.8 × cube strength)
  - e.g. C40/50 = 40 MPa cylinder (f_{ck}), 50 MPa cube strength
- High strength grades covered
  - up to C90/105 for buildings, C70/85 for bridges
- Stress blocks given, design formulae based on them are not
- Steel reinforcement
  - Partial material factor γ_s = 1.15
  - Young's modulus E = 200 GPa
  - Coefficient of thermal expansion = 10 ×10-6 K^{-1}
- Un-cracked linear elastic analysis permitted for all limit states
- Plastic analysis
  - allowed for buildings if "sufficient rotation capacity"
  - not allowed for bridges (except for accidental situations)

Similar to current practice

"Those familiar with the methods in BS 8110 will find the Eurocode procedures not too dissimilar to current practice but inevitably they will need to go through a learning curve.

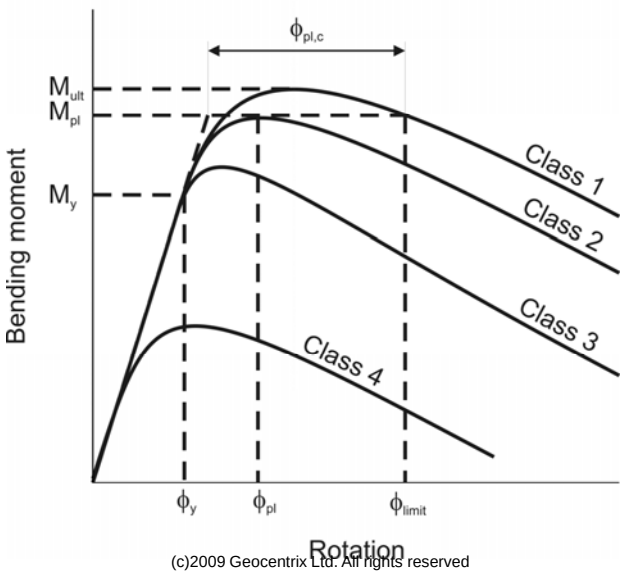
"On the whole the designs resulting from the two codes are likely to be reasonably comparable."

Nary Narayanan
Proc. ICE, Civil Engineering Special Issue (2001)

Key features of Eurocode 3

- Yield strength varies with thickness (as in BSs 5400 and 5950)
- Steel properties
  - Young's modulus E = 210 GPa for structural steel
    - c.f. 200 GPa for rebar in EN 1992
  - Poisson's ratio n = 0.3
  - Unit mass (mass density) = 7850 kg/m3
  - Coefficient of thermal expansion = 12 ×10-6 K^{-1}
- Partial material factors
  - yield, γ_{M0} = 1.0
  - shear buckling, γ_{M1} = 1.0 (buildings), 1.1 (bridges)
  - fracture in tension, γ_{M2} = 1.25
- Section classification
  - for Class 1 or 2 cross-sections, based on plastic stress block
  - for Class 3 or 4 cross-sections, based on elastic stress block

Classification of steel cross-sections



Eurocode 3 offers greater versatility

"The scope of Eurocode 3 is very wide in terms of types of structures, forms of construction and methods of design and materials.

"In relation to common types of building using hot-rolled sections, the differences in results are only minor, though the design procedures are sometimes more tedious.

"By presenting all the rules for as wide a variety of steel design as possible in a consistent format, the specialist steel designer will be given a great versatility than ever before."

Colin Taylor
Proc. ICE, Civil Engineering Special Issue (2001)

Impact of 'resistance' standards

- Initial shock due to number of documents and "scatter" of rules
- Some "state of the art" design methods differ, but many methods as previous UK practice
- Most day-to-day rules are similar to British Standard equivalents

"Different (to use), not more difficult"

Chris Hendy
NCE Conf. on Building Better Bridges, London (2005)

Technical differences (geotechnical)

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Limit state Principles

Structural design is based on limit state principles:

"A distinction shall be made between ultimate and serviceability limit states"

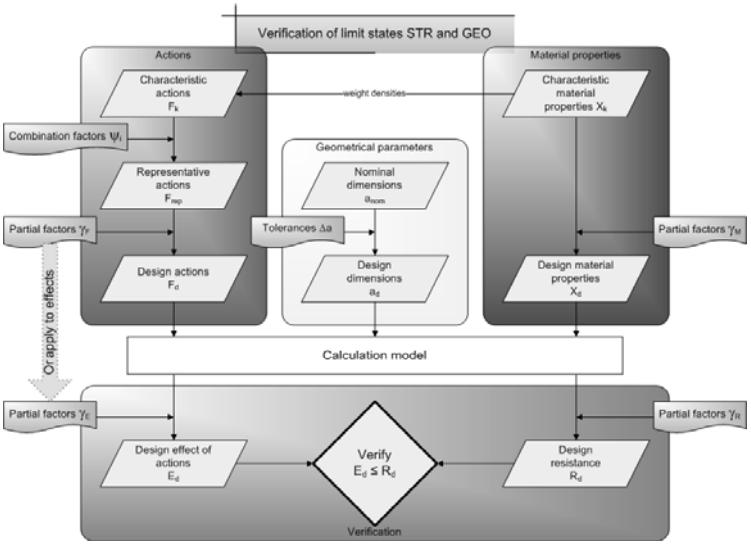
EN 1990 §3.1(1)P

Geotechnical design is now based on limit state principles:

"For each geotechnical design situation it shall be verified that no relevant limit state, as defined in EN 1990 … is exceeded"

EN 1997-1 §2.1(1)P

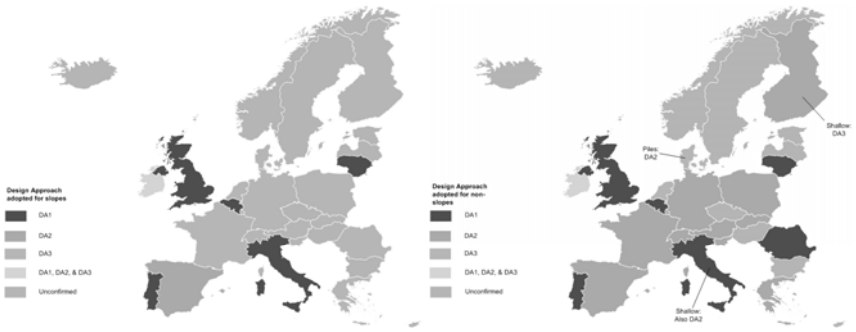
Verification of geotechnical strength



Design Approaches for STR/GEO

Design Approach			
1		***2***	***3***
Combination 1	***Combination 2***		
Actions	Material properties	Actions (or effects) & resistances	Structural actions (or effects) & material properties
A1 + M1 + R1	A2 + M2 + R1	A1 + M1 + R2	A1/A2 + M2 + R3

National choice of Design Approach



Notable change to the Design Manual for Roads and Bridges (DMRB)

- DMRB can no longer reproduce and modify sections of Standards
- It can only contain information that is complementary to the Eurocodes …
- … along with non contradictory requirements

'For safety reasons, design to a mixture of National Standards and Eurocodes will not be permitted'

www.highways.gov.uk/business/1198.aspx

What help is there?

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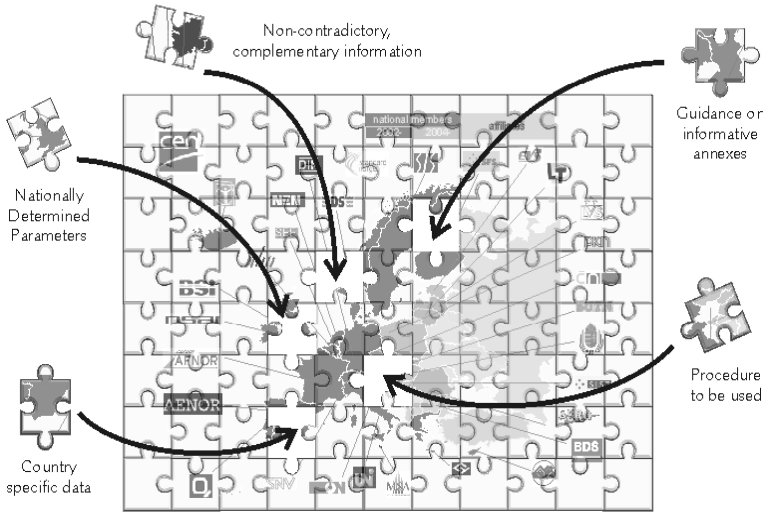
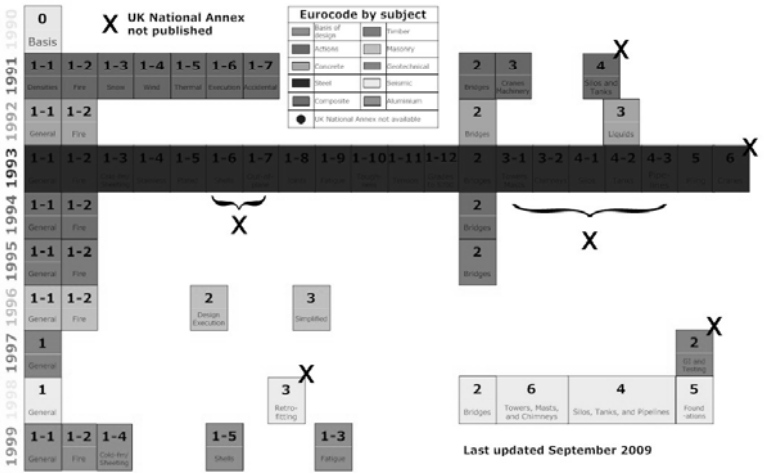
Contents of a Eurocode

- CEN publishes text of Eurocode (EN)
- National Standards Bodies (NSBs) may add…
  - National Title Page
  - National Foreword
  - National Annex
- Eurocode published by CEN
  - EN 1990
- "National" code published by NSB
  - BS EN 1990 (in UK)
  - DIN EN 1990 (in Germany)
  - NF EN 1990 (in France)

National Annex completes the Eurocode jigsaw



Status of UK National Annexes (September 2009)



Published Documents

'Supporting document produced by committee for information only … includes guidance, reports and recommendations'

BSI guide to standardization (2005)

- Adoptions of CEN, CENELEC, ISO or IEC publications that are themselves not standards (e.g. Technical Reports)
- Derived from British Standards that conflict with ENs but are still needed by industry
- Developed by national committees but do not go through the whole development process in strict conformity with BS

'This is a catch-all category for standards-type documents that do not have the same status as a BS'

BSI Website

UK Published Documents for Eurocodes

PD	Year	†	For BS EN	Subject	
6687	2006	BP	1992-1	Concrete	Design of concrete structures (general)
6687-2	2007	R	1992-2		Concrete bridges
6688-1-2	2007	BP	1991-1-2	Actions	Actions on structures exposed to fire
6688-1-7	2009	R	1991-1-7		Accidental actions
6694-1	DPC	R	1997-1	Geotech.	Geotechnical design (subject to traffic loading)
6695-1-9	2008	R	1993-1-9	Steel	Design of steel structures for fatigue
6695-1-10	2009	R	1993-1-10		Material toughness and through-thickness properties
6695-2	2008	R	1993-2		Steel bridges
6696-2	2007	R	1994-2	Composite	Composite steel and concrete bridges
6698	2009	R	1998-2	Earthquake	Design of structures for earthquake resistance

†BP = 'Background paper to the UK National Annex(es) …'

R = 'Recommendations for the design of structures …'

Future Published Documents

PD	Year	†	For BS EN	Subject	
6687-1	11/09	BP	1992-1 & -3	Concrete	Design of concrete structures (general)
6688-1-1	?	BP	1991-1-1	Actions	Densities, self-weight, imposed loads for buildings
6688-1-4	9/09	BP	1991-1-4		Wind actions
6688-1-5	12/09	BP	1991-1-5		Thermal actions
6688-2	12/09	R	1992-2 ?		?
6693-1	12/09	?		Timber	?
6693-2	12/09	?			?
6702-1	09/09	?		Aluminium	?
6705-3	09/09	?			?

†BP = 'Background paper to the UK National Annex(es) …'

R = 'Recommendations for the design of structures …'

PD 6694-1 Recommendations for the design of structures subject to traffic loading to BS EN 1997-1

1. General
2. Basis of design
3. Spread foundations
4. Piled foundations
5. Gravity retaining structures and bridge abutments
6. Embedded walls
7. Integral bridges
8. Buried concrete structures
9. Bibliography

A. Diagrams showing load cases to be considered for buried concrete structures

Highways Agency's Design Manual for Roads and Bridges

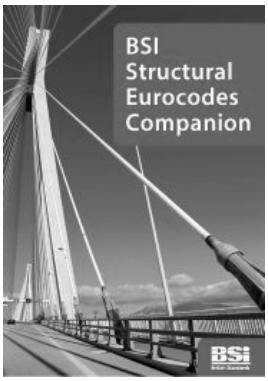
- DMRB can no longer reproduce and modify sections of Standards
- Only contain information complementary to the Eurocodes
- Along with additional (non contradictory) requirements

- 50 existing BDs and BAs … some information will be
  - superseded
  - retained in a form complementary to the Eurocodes
  - withdrawn (as out-of-date)

'This will result in there being fewer, more-focused DMRB parts for the design of highway structures'

BSI Structural Eurocodes Companion

- 64-page 'companion guide' to the Structural Eurocodes
- Guide written by leading industry experts
- Delivers practical and timely advice on how the new codes will work and how they might benefit construction professionals
- Available free-of-charge from the BSI website



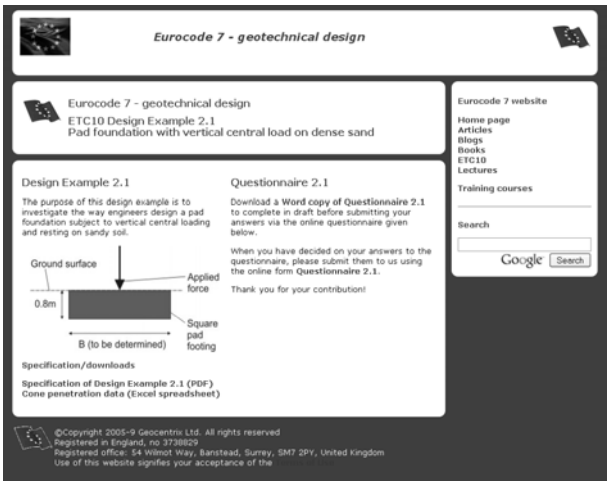
‘Decoding Eurocode 7’ book www.decodingeurocode7.com

- Book published August 2008
- Key features
  - Covers ENs 1997-1 and -2, plus relevant parts of other Eurocodes
  - Also covers associated execution and testing standards
  - Explains key principles
  - Illustrates application rules with real-life case studies
  - Material extensively tested on training courses over 5 years
- Authors Andrew Bond (Geocentrix) and Andy Harris (Geomantix)
- Published by Taylor and Francis in hardback, with colour section
- ISBN: 9780415409483

‘Decoding the Eurocodes’ blog www.eurocode7.com

- Web log started May 2006
- Aim to post articles at least once a month, on following subjects:
  - BGA
  - Books
  - BSI
  - Eurocode 3
  - Eurocode 7
  - ICE
  - IStructE
  - Seminars
  - Singapore
  - Structural Eurocodes
  - Training courses

ETC10 'Design example 2'
www.eurocode7.com/etc10



Conclusion

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Of vital importance

'The Eurocodes will become the Europe wide means of designing Civil and Structural engineering works and so … they are of vital importance to both the design and construction sectors of the Civil and Building industries'

'Introduction to Eurocodes'

European Commission website
(http://ec.europa.eu)

'The Eurocode Scream' by Jack Offord (with apologies to Munch)