The Structural Eurocodes; their future and EN 1990 and EN 1991

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Visiting Professor, Imperial College, London
Scope of presentation

- Brief introduction to the Eurocodes and their objectives and status
- Implementing Eurocodes – progress so far
- Impact of implementation
- Timetable for implementation
- EN 1990 & EN 1991
- Management decisions
- Commission recommendations on implementation and the future
- What needs to be done for the profession
- Benefits and threats arising from implementation
The Eurocodes

- 10 sets of design codes with 58 Parts separated into packages
- Packages include buildings, bridges, towers and masts, silos and tanks.
- The head code EN 1990 applies to all types of structures.
The following structural Eurocodes, each generally consisting of a number of parts, some of which relate to bridges, will be released in EN form between 2002 and 2006

- EN 1990  Eurocode: Basis of structural design
- EN 1991  Eurocode 1: Actions on structures
- EN 1992  Eurocode 2: Design of concrete structures
- EN 1993  Eurocode 3: Design of steel structures
- EN 1994  Eurocode 4: Design of composite steel and concrete structures
- EN 1995  Eurocode 5: Design of timber structures
- EN 1996  Eurocode 6: Design of masonry structures
- EN 1997  Eurocode 7: Geotechnical design
- EN 1998  Eurocode 8: Design structure for earthquake resistance
- EN 1999  Eurocode 9: Design of aluminium structures
The Eurocodes

• 10 sets of design codes with 58 Parts separated into packages
• Packages include buildings, bridges, towers and masts, silos and tanks.
• The head code EN 1990 applies to all types of structures.
LINKS BETWEEN THE EUROCODES

- **EN 1990**: Structural safety, serviceability and durability
- **EN 1991**: Actions on structures
- **EN 1992** → **EN 1993** → **EN 1994**: Design and detailing
- **EN 1995** → **EN 1996** → **EN 1999**: Geotechnical and Seismic design
Example of the European standardisation system for the construction of bridges

- **EN 1990**
  - Basis of Structural design
  - Combinations of actions

- **Product Standards**
  - EN 1337
  - Bearings

- **EN 1997**
  - Geotechnical Design

- **EN 1998**
  - Design of structures for earthquake resistance

- **EN 1991**
  - Self-weights + Imposed loads + Climatic actions + Accidental actions +

- **Design Eurocodes**
  - EN 1992, EN 1993
  - EN 1994, EN 1995

- **Execution Standards**
  - EN 13670
  - Concrete
  - EN 1090
  - Steel

- **Material Standards**
  - EN 201-1
  - Concrete
  - EN 10025
  - Steel
The Eurocodes

- Recognised by authorities of the member states as a basis for specifying contracts for the execution of construction works and related engineering services in the area of public works (relates to Council Directives on Public Procurement)

- Provide compliance of building and civil engineering works with the Essential Requirements on Mechanical resistance and stability and part of Safety in case of fire. as set out the Council Directive on Construction Products and are a framework for drawing up harmonised technical specifications for construction products
The Eurocodes are foreseen to:

• improve the functioning of the single market for products and engineering services, by removing obstacles arising from different nationally codified practices for the assessment of structural reliability

• improve the competitiveness of the European construction industry, and the professionals and industries connected to it, in countries outside the European Union
Implementing Eurocodes – Progress so far

<table>
<thead>
<tr>
<th>Status of Eurocode Parts</th>
<th>No</th>
<th>38</th>
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<tbody>
<tr>
<td>- Made Available by CEN for publication by NSBs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Positively voted and awaiting publication</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>- At voting stage</td>
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<td></td>
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<tr>
<td>- Under development</td>
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<tr>
<td><strong>TOTAL</strong></td>
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GOING FORWARD – TIMETABLE FOR IMPLEMENTATION

• All 58 Eurocode Parts should become available as EN Eurocodes by 2006

• After a Eurocode becomes an EN, under CEN rules there will be a period of co-existence with the appropriate National Code (up to 3 years from when the final part of a package becomes available), after which the National Code will be withdrawn
GOING FORWARD – TIMETABLE FOR IMPLEMENTATION - DATES OF WITHDRAWAL OF BSI CODES OF PRACTICE

Conflicting National Standards shall be withdrawn at the end of the co-existence period after all of the EN Eurocodes, together with their National Annexes, in a particular package are available.

Estimates: National Codes for buildings: 2009/10
National Codes for bridges: 2009/10

Note: It is the stated aim for some Member States to implement by 2007.
IMPLEMENTATION OF EUROCODES - OBJECTIVES OF NATIONAL ANNEX

“Eurocodes recognise the responsibility of Regulatory and other Relevant Authorities in each Member State and have safeguarded their right to determine values related to safety matters at National level where these continue to vary from State to State”

This is through the National Annex
Elements of the national publication of a European Standard

ISO/CEI Directives
Part 3 (supplement)

a National title page
b National foreword
c EN title page
d EN text
e EN Annex(es)
f National annex
Programme for Publication for EN 1990 to EN 1999 (10-01-06)

Key to Tables

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<tr>
<td>Published</td>
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<td>Positively Voted - Awaiting Publication</td>
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<td>At formal vote</td>
<td>Green</td>
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<td>Under development</td>
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# Programme for Publication for EN 1990 & EN 1991

## Eurocode: Basis of Structural Design

<table>
<thead>
<tr>
<th>Eurocode</th>
<th>Title</th>
<th>Date of Avail</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 1990</td>
<td>Basis of Structural Design with Annex A1 for buildings</td>
<td>April 02</td>
</tr>
<tr>
<td>Annex A2 of EN 1990</td>
<td>Basis of Structural Design with Annex A2 for bridges</td>
<td>Dec 05</td>
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</tbody>
</table>

## Eurocode 1: Actions on structures

<table>
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<tr>
<th>Eurocode</th>
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<tbody>
<tr>
<td>EN 1991-1-1</td>
<td>Densities, self-weight and imposed loads</td>
<td>April 02</td>
</tr>
<tr>
<td>EN 1991-1-2</td>
<td>Actions on structures exposed to fire</td>
<td>Nov 02</td>
</tr>
<tr>
<td>EN 1991-1-3</td>
<td>Snow Loads</td>
<td>July 03</td>
</tr>
<tr>
<td>EN 1991-1-4</td>
<td>Wind actions</td>
<td>May 05</td>
</tr>
<tr>
<td>EN 1991-1-5</td>
<td>Thermal actions</td>
<td>October 03</td>
</tr>
<tr>
<td>EN 1991-1-6</td>
<td>Actions during execution</td>
<td>July 05</td>
</tr>
<tr>
<td>EN 1991-1-7</td>
<td>Accidental actions</td>
<td>May 06</td>
</tr>
<tr>
<td>EN 1991-2</td>
<td>Traffic loads on bridges</td>
<td>Sept 03</td>
</tr>
<tr>
<td>EN 1991-3</td>
<td>Actions induced by cranes and machinery</td>
<td>May 06</td>
</tr>
<tr>
<td>EN 1991-4</td>
<td>Actions in silos and tanks</td>
<td>Feb 06</td>
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# Programme for Publication for EN 1992, & EN 1993

## Eurocode 2: Design of Concrete Structures

<table>
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<tbody>
<tr>
<td>EN 1992-1-1</td>
<td>General rules and rules for buildings</td>
<td>Dec 04</td>
</tr>
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<td>EN 1992-1-2</td>
<td>Structural fire design</td>
<td>Dec 04</td>
</tr>
<tr>
<td>EN 1992-2</td>
<td>Reinforced and prestressed concrete bridges</td>
<td>Nov 05</td>
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<td>EN 1992-3</td>
<td>Liquid retaining and containment structures</td>
<td>April 06</td>
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## Eurocode 3: Design of Steel Structures

<table>
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<th>Eurocode</th>
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<tbody>
<tr>
<td>EN 1993-1-1</td>
<td>General rules and rules for buildings</td>
<td>May 05</td>
</tr>
<tr>
<td>EN 1993-1-2</td>
<td>Structural fire design</td>
<td>April 05</td>
</tr>
<tr>
<td>EN 1993-1-3</td>
<td>Cold formed thin gauge members and sheeting</td>
<td>March 06</td>
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<tr>
<td>EN 1993-1-4</td>
<td>Stainless steels</td>
<td>March 06</td>
</tr>
<tr>
<td>EN 1993-1-5</td>
<td>Strength and stability of planar plated structures without transverse loading</td>
<td>March 06</td>
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<tr>
<td>EN 1993-1-6</td>
<td>Strength and stability of shell structures</td>
<td>March 06</td>
</tr>
<tr>
<td>EN 1993-1-7</td>
<td>Plated structural elements transversely loaded</td>
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<tr>
<td>Eurocode</td>
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</tr>
<tr>
<td>--------------</td>
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<td>EN 1993-1-8</td>
<td>Design of joints</td>
<td>May 05</td>
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<td>EN 1993-1-9</td>
<td>Fatigue strength of steel structures</td>
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<td>EN 1993-1-10</td>
<td>Fracture toughness and through thickness properties</td>
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<td>EN 1993-1-11</td>
<td>Tension components made of steel</td>
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<td>EN 1993-2</td>
<td>Steel bridges</td>
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<td>EN 1993-3-1</td>
<td>Towers and masts</td>
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<td>EN 1993-3-2</td>
<td>Chimneys</td>
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<td>Silos, tanks and pipelines - silos</td>
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<td>EN 1993-4-3</td>
<td>Silos, tanks and pipelines - pipelines</td>
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<tr>
<td>EN 1993-5</td>
<td>Piling</td>
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<td>Cranes supporting structures</td>
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### Programme for Publication for EN 1994, & EN 1999

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<td>EN 1994-1-2</td>
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<td>Sept 05</td>
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<td>EN 1994-2</td>
<td>Composite bridges</td>
<td>Nov 05</td>
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### Eurocode 4: Design of Composite Concrete and Steel Structures

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<td>EN 1994-1-1</td>
<td>General rules and rules for buildings</td>
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<td>EN 1994-1-2</td>
<td>Structural fire design</td>
<td>Sept 05</td>
</tr>
<tr>
<td>EN 1994-2</td>
<td>Composite bridges</td>
<td>Nov 05</td>
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### Eurocode 9: Design of Aluminium Structures

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<td>EN 1999-1-1</td>
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<td>Structural fire design</td>
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<td>EN 1999-1-3</td>
<td>Fatigue</td>
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<td>EN 1999-1-4</td>
<td>Trapezoidal sheeting</td>
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<td>EN 1999-1-5</td>
<td>Shell structures</td>
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</tr>
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<td>Title</td>
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</tr>
<tr>
<td>------------</td>
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</tr>
<tr>
<td>EN 1995-1-1</td>
<td>General rules and rules for buildings</td>
<td>Nov 04</td>
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<td>EN 1995-1-2</td>
<td>Structural fire design</td>
<td>Nov 04</td>
</tr>
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<td>EN 1995-2</td>
<td>Timber bridges</td>
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**Eurocode 6: Design of Masonry Structures**

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<td>EN 1996-1-1</td>
<td>Rules for reinforced and unreinforced masonry</td>
<td>Nov 05</td>
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<td>EN 1996-1-2</td>
<td>Structural fire design</td>
<td>May 05</td>
</tr>
<tr>
<td>EN 1996-2</td>
<td>Masonry – selection and execution</td>
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<tr>
<td>EN 1996-3</td>
<td>Masonry - simplified calculations</td>
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## Programme for Publication for EN 1997, & EN 1998

### Eurocode 7: Geotechnical Design

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<td>EN 1997-1</td>
<td>General requirments</td>
<td>Nov 04</td>
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<td>EN 1997-2</td>
<td>Ground investigations</td>
<td>Aug 06</td>
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### Eurocode 8: Design of Structures for Earthquake Resistance

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<tr>
<td>EN 1998-1</td>
<td>General rules, seismic actions and rules for buildings</td>
<td>Dec 04</td>
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<td>EN 1998-2</td>
<td>Bridges</td>
<td>Nov 05</td>
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<tr>
<td>EN 1998-3</td>
<td>Assessment and retrofitting of buildings</td>
<td>June 05</td>
</tr>
<tr>
<td>EN 1998-4</td>
<td>Silos, tanks and pipeline</td>
<td>June 06</td>
</tr>
<tr>
<td>EN 1998-5</td>
<td>Foundations, retaining structures and geotechnical aspects</td>
<td>Nov 04</td>
</tr>
<tr>
<td>EN 1998-6</td>
<td>Towers and masts</td>
<td>June 05</td>
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</tbody>
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EN 1990: Eurocode: Basis of Structural Design

AN INNOVATIVE STRUCTURAL SAFETY CODE OF PRACTICE
LINKS BETWEEN THE EUROCODES

EN 1990
- Structural safety, serviceability and durability

EN 1991
- Actions on structures

EN 1992
EN 1995
EN 1993
EN 1996
EN 1994
EN 1999
- Design and detailing

EN 1997
EN 1998
- Geotechnical and Seismic design
EN 1990: BASIS OF STRUCTURAL DESIGN

For the design of buildings and civil engineering works every Eurocode part from,
• EN 1991: Eurocode 1: Actions on Structures, and
• The design Eurocodes EN 1992 to EN 1999
has to be used together with EN 1990

EN 1990 provides the material independent and safety related
• information required for the design of buildings, and
• civil engineering works for the Eurocodes suite.
EN 1990 : BASIS OF STRUCTURAL DESIGN:
CONTENTS

Foreword
Section 1 : General
Section 2 : Requirements
Section 3 : Principles of limit states
Section 4 : Basic variables
Section 5 : Structural analysis and design assisted by testing
Section 6 : Verification by the partial factor method

Annex A(n);(N) : Application for buildings (1); bridges (2)
Annex B (I) : Management of structural reliability for construction works
Annex C (I) : Basis for partial factor design and reliability analysis
Annex D (I) : Design assisted by testing
EN 1990: BASIS OF STRUCTURAL DESIGN

Objectives of EN 1990: Basis of Design

EN 1990 establishes principles and requirements for the
• Safety
• Serviceability
• Durability
of structures; and describes
• The basis for their design and verification, and
• Gives guidelines for related aspects of structural reliability
THE REQUIREMENTS

• Fundamental requirements (safety; serviceability; robustness and fire)
• Reliability differentiation
• Design working life
• Durability
• Quality Assurance
The fundamental requirements in EN 1990 for the reliability of construction works include:

**Structural safety**: A structure shall be designed and executed in such a way that it will, during its intended life with appropriate degrees of reliability, and in an economic way sustain all actions likely to occur during execution and use. Safety of people, the structure and contents.

**Serviceability**: A structure shall be designed and executed in such a way that it will, during its intended life with appropriate degrees of reliability and in an economic way remain fit for the use for which it is required. Functioning, comfort and appearance of the structure.
The fundamental requirements in EN 1990 for the reliability of construction works include:

**Robustness:** A structure shall be designed and executed in such a way that it will not be damaged by events such as:

- Explosions
- Impact and
- Consequences of human errors
to an extent disproportionate to the original cause

*Note:* The events to be taken into account are those agreed for an individual project with the client and the relevant authority.
The fundamental requirements in EN 1990 for the reliability of construction works include:

**Fire**: “In the case of fire, the structural resistance shall be adequate for the required period of time”

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**GOETEBORG DISCO FIRE**

30.10.1998

*Disco approved for 150 people with 2 stairwells serving as escape ways*

⇒ **BUT DISCO WAS OVERCROWDED**
and **FIRE OCCURRED WITH ONE STAIRWELL USED FOR STORAGE OF CHAIRS!!**

⇒ **INSUFFICIENT ESCAPE MEANS**
& **NO SMOKE DETECTION**
⇒ ⇒ **63 YOUNG PEOPLE DIED**
EN 1990: BASIS OF STRUCTURAL DESIGN

THE REQUIREMENTS

- Fundamental requirements (safety; serviceability; robustness and fire)
- **Reliability differentiation**
- Design working life
- Durability
- Quality Assurance
The choice of the levels of reliability for a particular structure should take account of the relevant factors, including:

- the possible cause and/or mode of attaining a limit state;
- the possible consequences of failure in terms of risk to life, injury, potential economical losses;
- public aversion to failure;
- the expense and procedures necessary to reduce the risk of failure.
### EN 1990: Definition of Consequences Classes

<table>
<thead>
<tr>
<th>Consequences Class</th>
<th>Description</th>
<th>Examples of buildings and civil engineering works</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CC3</strong></td>
<td><strong>High</strong> consequence for loss of human life, or economic, social or environmental consequences <strong>very great</strong></td>
<td>Grandstands, bridges, public buildings where consequences of failure are high (e.g. a concert hall)</td>
</tr>
<tr>
<td><strong>CC2</strong></td>
<td><strong>Medium</strong> consequence for loss of human life, economic, social or environmental consequences <strong>considerable</strong></td>
<td>Residential and office buildings, public buildings where consequences of failure are medium (e.g. an office building)</td>
</tr>
<tr>
<td><strong>CC1</strong></td>
<td><strong>Low</strong> consequence for loss of human life, and economic, social or environmental consequences <strong>small or negligible</strong></td>
<td>Agricultural buildings where people do not normally enter (e.g. for storage), greenhouses</td>
</tr>
</tbody>
</table>
Depending upon the consequences of failure, the main tools selected in EN1990 Annex B for the management of structural reliability of construction works are:

- differentiation by $\beta$ (reliability index) values; at this stage, this is a specialist activity;
- modification of partial factors;
- design supervision differentiation;
- inspection during execution
EN 1990: PROBABILITIES OF FAILURE ASSOCIATED WITH LIMIT STATES

Value associated with $\beta = 3.8$ (ULS, 50 years reference period)

Value associated with $\beta = 1.5$ (SLS, 50 years reference period)
## Accepted risks of death due to exposure to various hazards

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Risk ($\times 10^{-6}$ p.a.)</th>
<th>Hazard</th>
<th>Risk ($\times 10^{-6}$ p.a.)</th>
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</thead>
<tbody>
<tr>
<td>Building hazards</td>
<td></td>
<td>Occupations (UK)</td>
<td></td>
</tr>
<tr>
<td>Structural failure (UK)</td>
<td>0.14</td>
<td>Chemical and allied industries</td>
<td>85</td>
</tr>
<tr>
<td>Building fires (Australia)</td>
<td>4</td>
<td>Ship building and marine engineering</td>
<td>105</td>
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<td></td>
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<td>Agriculture</td>
<td>110</td>
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<td></td>
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<td>Construction industries</td>
<td>150</td>
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<td></td>
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<td>Railways</td>
<td>180</td>
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<td></td>
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<td>Coal mining</td>
<td>210</td>
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<tr>
<td></td>
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<td>Quarrying</td>
<td>295</td>
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<td>Mining (non-coal)</td>
<td>750</td>
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<tr>
<td></td>
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<td>Offshore oil and gas (1967-1976)</td>
<td>1650</td>
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<td>Deep sea fishing (1959-1978)</td>
<td>2800</td>
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<tr>
<td>Natural hazards (U.S)</td>
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<td>Careers (1977)</td>
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<tr>
<td>Hurricanes (1901-1972)</td>
<td>0.4</td>
<td>Cave exploration (1970-1978)</td>
<td>45</td>
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<tr>
<td>Tornadoes (1953-1971)</td>
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<td>Glider flying (1970-1978)</td>
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<td>Lightning (1969)</td>
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<td>Scuba diving (1970-1978)</td>
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<td>Earthquakes (California)</td>
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<td>Hang gliding (1977-1979)</td>
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<td>Parachuting (1978)</td>
<td>1900</td>
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<tr>
<td>General accidents (U.S)</td>
<td></td>
<td>All causes (U.K. 1977)</td>
<td></td>
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<tr>
<td>1969</td>
<td></td>
<td>Whole population</td>
<td>12000</td>
</tr>
<tr>
<td>Poisoning</td>
<td>20</td>
<td>Woman aged 30</td>
<td>600</td>
</tr>
<tr>
<td>Drowning</td>
<td>30</td>
<td>Man aged 30</td>
<td>1000</td>
</tr>
<tr>
<td>Fires and burns</td>
<td>40</td>
<td>Woman aged 60</td>
<td>10000</td>
</tr>
<tr>
<td>Falls</td>
<td>90</td>
<td>Man aged 60</td>
<td>20000</td>
</tr>
<tr>
<td>Road accidents</td>
<td>300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a Risk expressed as a probability of death for typical exposed person per calendar year

**Risk expressed as probability of death for typical exposed person per calendar year**
Accepted risks of death due to Structural Failure

Public perception does not accept fatalities and injuries due to structural failure (at home, at the work place, during recreational and other activities etc), for the design working life of a structure compared to fatalities arising from other hazards and events.
THE REQUIREMENTS

- Fundamental requirements (safety; serviceability; robustness and fire)
- Reliability differentiation
- Design working life
- Durability
- Quality Assurance
The fundamental requirements for design working life states:

The design working life is the assumed period for which a structure is to be used for its intended purpose with anticipated maintenance but without major repair being necessary.

A design working life of

- 50 years for buildings
- 120 years for bridges and

is recommended in the UK National Annex to EN 1990.
<table>
<thead>
<tr>
<th>Design working life category</th>
<th>design working Indicative life (years)</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>Temporary structures (1)</td>
</tr>
<tr>
<td>2</td>
<td>10 to 30</td>
<td>Replaceable structural parts, e.g. gantry girders, bearings</td>
</tr>
<tr>
<td>3</td>
<td>15 to 25</td>
<td>Agricultural and similar structures</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>Building structures and other common structures, not listed elsewhere in this table</td>
</tr>
<tr>
<td>5</td>
<td>120</td>
<td>Monumental building structures, highway and railway bridges, and other civil engineering structures</td>
</tr>
</tbody>
</table>

(1) Structures or parts of structures that can be dismantled with a view of being re-used should not be considered as temporary
EN 1990 : BASIS OF STRUCTURAL DESIGN

THE REQUIREMENTS

• Fundamental requirements (safety; serviceability; robustness and fire)
• Reliability differentiation
• Design working life
• Durability
• Quality Assurance
ULTIMATE LIMIT-STATE:
- the safety of the structure
- the safety of people
- In special circumstances the protection of the contents

- loss of equilibrium of the structure or any part of it, considered as a rigid body
- failure by excessive deformation, transformation of the structure or any part of it into a mechanism, rupture, loss of stability of the structure or any part of it, including supports and foundations
- failure caused by fatigue or other time-dependent effects

SERVICEABILITY LIMIT-STATE
- Functioning of the structure or structural members under normal use,
- comfort of people,
- appearance of construction works
Design Situations

Design situations shall be classified as follows:

- **persistent design situations**, which refer to the conditions of normal use
- **accidental design situations**, which refer to exceptional conditions applicable to the structure or to its exposure, e.g. to fire, explosion, impact or the consequences of localised failure
- **seismic design situations**, which refer to conditions applicable to the structure when subjected to seismic events
- **transient design situations** which refer to temporary conditions applicable to the structure, e.g. during execution or repair
EN 1990: REDUCTION COEFFICIENTS ($\psi$)

The reduction coefficients ($\psi$), are applied to the characteristic load values which are appropriate to cases where

- Rare
- Frequent, or
- Quasi-permanent

occurring events are being considered
EN 1990: VARIABLE ACTIONS

- Characteristic value $Q_k$
- Combination value $\psi Q_k$
- Frequent value $\psi Q_k$
- Quasi-permanent value $\psi Q_k$

 instantaneous value of $Q$

Time

$\Delta t_1$, $\Delta t_2$, $\Delta t_3$
Verifications of static equilibrium and resistance

Individual verifications are performed

**Ultimate limit states of static equilibrium (EQU):**

\[ E_{d,dst} \leq E_{d,stab} \]

**Ultimate limit states of resistance (STR/GEO):**

\[ E_d \leq R_d \]
EN1990 : BASIS OF STRUCTURAL DESIGN

Ultimate limit states
Ultimate limit states of STR/GEO - Fundamental combination for persistent and transient design situations

Expression (6.10)

\[ \sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_P P + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \]

Expressions (6.10a) and (6.10b)

\[
\begin{cases}
\sum_{j \geq 1} \gamma_{G,j} G_{k,j} + \gamma_P P + \sum_{i \geq 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \\
\sum_{j \geq 1} \xi_j \gamma_{G,j} G_{k,j} + \gamma_P P + \gamma_{Q,1} Q_{k,1} + \sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}
\end{cases}
\]

\[ 0.85 \leq \xi_j \leq 1.00 \]
EN 1990 vs BSI for one variable action
EN 1991: Eurocode 1: Actions on Structures
EN 1991 – EUROCODE 1 – ACTIONS ON STRUCTURES

- EN 1991-1-1 Densities, self-weight and imposed loads (positive vote – published 2002)
- EN 1991-1-2 Actions on structures exposed to fire (positive vote – published 2003)
- EN 1991-1-3 Snow loads (positive vote – published 2003)
- EN 1991-1-4 Wind loads (positive vote – published 2005)
- EN 1991-1-5 Thermal actions (positive vote – published 2004)
- EN 1991-1-6 Actions during execution (positive vote – published 2005)
- EN 1991-1-7 Accidental actions due to impact and explosions (positive vote – published in mid 2006)
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 1991-3</td>
<td>Actions induced by cranes and machinery (positive vote – published mid 2006)</td>
</tr>
<tr>
<td>EN 1991-4</td>
<td>Actions in silos and tanks (positive vote – published mid 2006)</td>
</tr>
</tbody>
</table>
EN 1991 – EUROCODE 1 Parts covered in this presentation

- **EN 1991-1-1** Densities, self-weight and imposed loads
- **EN 1991-1-3** Snow loads
- **EN 1991-1-4** Wind loads
- **EN 1991-1-7** Accidental actions due to impact and explosions
EN 1991-1-1: Densities, self-weight and imposed loads; covers

- Densities Of Construction And Stored Materials
- Self-weight Of Construction Works
- Imposed Loads on Buildings
- Tables For Nominal Density Of Construction Materials, And Nominal Density And Angles Of Repose For Stored Materials
- Vehicle Barriers And Parapets For Car Parks
EN 1991-1-1: Clauses on Imposed loads on buildings

<table>
<thead>
<tr>
<th>Categories of loaded areas</th>
<th>$q_k$ [kN/m$^2$]</th>
<th>$Q_k$ [kN]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Floors</td>
<td>1.5 to 2.0</td>
<td>2.0 to 3.0</td>
</tr>
<tr>
<td>- Stairs</td>
<td>2.0 to 4.0</td>
<td>2.0 to 4.0</td>
</tr>
<tr>
<td>- Balconies</td>
<td>2.5 to 4.0</td>
<td>2.0 to 3.0</td>
</tr>
<tr>
<td>Category B</td>
<td>2.0 to 3.0</td>
<td>1.5 to 4.5</td>
</tr>
<tr>
<td>Category C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- C1</td>
<td>2.0 to 3.0</td>
<td>3.0 to 4.0</td>
</tr>
<tr>
<td>- C2</td>
<td>3.0 to 4.0</td>
<td>2.5 to 7.0 (4.0)</td>
</tr>
<tr>
<td>- C3</td>
<td>3.0 to 5.0</td>
<td>4.0 to 7.0</td>
</tr>
<tr>
<td>- C4</td>
<td>4.5 to 5.0</td>
<td>3.5 to 7.0</td>
</tr>
<tr>
<td>- C5</td>
<td>5.0 to 7.5</td>
<td>3.5 to 4.5</td>
</tr>
<tr>
<td>Category D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- D1</td>
<td>4.0 to 5.0</td>
<td>3.5 to 7.0 (4.0)</td>
</tr>
<tr>
<td>- D2</td>
<td>4.0 to 5.0</td>
<td>3.5 to 7.0</td>
</tr>
</tbody>
</table>

NOTE: Where a range is given in this table, the value may be set by the National annex. The recommended values, intended for separate application, are underlined. $q_k$ is intended for the determination of general effects and $Q_k$ for local effects. The National annex may define different conditions of use of this Table.
Load arrangements EN 1990 & EN 1991-1-1

Mid span bending moment of a floor structure

Chess board arrangement

Simplification in EN 1991-1-1
EN 1991-1-1: Reduction factors $\alpha_n$ and $\alpha_A$

$$\alpha_n = \frac{2 + (n - 2)\psi_0}{n}, \quad \alpha_A = \frac{5}{7}\psi_0 + \frac{A_0}{A}$$

$\alpha_n$ Columns

$\alpha_A$ Slabs, beams
EN 1991-1-1: Remarks on imposed load

• Effect of actions that cannot exist simultaneously should not be considered together (EN 1990).
• For the design of a column loaded by from several storeys, the load should be distributed uniformly.
• For local verification concentrated load $Q_k$ should be considered to act alone.
• Reduction factors $\psi$ and $\alpha_n$ should not be considered together.
• For the design of a floor structure within one storey, the imposed load shall be considered at the most unfavourable part of the influence area.
EN 1991-1-1: Annex A (informative) Tables for nominal density of construction materials, and nominal density and angles of repose for stored materials

- Table A.1 - Construction materials-concrete and mortar
- Table A.2 - Construction materials-masonry
- Table A.3 - Construction materials-wood
- Table A.4 - Construction materials-metals
- Table A.5 - Construction materials- other materials
- Table A.6 - Bridge materials
- Table A.7 - Stored materials - building and construction
- Table A.8 - Stored products – agricultural
- Table A.9 - Stored products - foodstuffs
- Table A.10 - Stored products - liquids
- Table A.11 - Stored products - solid fuels
- Table A.12 - Stored products - industrial and general
EN 1991-1-1: ANNEX A: Table A.1 - Construction materials-concrete and mortar

<table>
<thead>
<tr>
<th>Materials</th>
<th>Density $\gamma$ [kN/m$^3$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>concrete (see EN 206)</td>
<td></td>
</tr>
<tr>
<td>lightweight</td>
<td></td>
</tr>
<tr>
<td>density class LC 1.0</td>
<td>9.0 to 10.0 $^{1,2)}$</td>
</tr>
<tr>
<td>density class LC 1.2</td>
<td>10.0 to 12.0 $^{1,2)}$</td>
</tr>
<tr>
<td>density class LC 1.4</td>
<td>12.0 to 14.0 $^{1,2)}$</td>
</tr>
<tr>
<td>density class LC 1.6</td>
<td>14.0 to 16.0 $^{1,2)}$</td>
</tr>
<tr>
<td>density class LC 1.8</td>
<td>16.0 to 18.0 $^{1,2)}$</td>
</tr>
<tr>
<td>density class LC 2.0</td>
<td>18.0 to 20.0 $^{1,2)}$</td>
</tr>
<tr>
<td>normal weight</td>
<td>24.0$^{1,2)}$</td>
</tr>
<tr>
<td>heavy weight</td>
<td>$&gt;^{1,2)}$</td>
</tr>
<tr>
<td>mortar</td>
<td></td>
</tr>
<tr>
<td>cement mortar</td>
<td>19.0 to 23.0</td>
</tr>
<tr>
<td>gypsum mortar</td>
<td>12.0 to 18.0</td>
</tr>
<tr>
<td>lime-cement mortar</td>
<td>18.0 to 20.0</td>
</tr>
<tr>
<td>lime mortar</td>
<td>12.0 to 18.0</td>
</tr>
</tbody>
</table>

1) Increase by 1kN/m$^3$ for normal percentage of reinforcing and pre-stressing steel
2) Increase by 1kN/m$^3$ for unhardened concrete

NOTE See Section 4
EN 1991 – EUROCODE 1 Parts covered in this presentation

- EN 1991-1-1  Densities, self-weight and imposed loads
- EN 1991-1-3  Snow loads
- EN 1991-1-4  Wind loads
- EN 1991-1-7  Accidental actions due to impact and explosions
EN 1991-1-3: Snow loads: Ground snow load map: European Climatic Regions
Ground Snow load map – Alpine Region
France, Italy, Austria, Germany and Switzerland

Alpine Region: Snow Load at Sea Level

Zone N° kN/m² (A=0)

- 0.7
- 1.3
- 1.9
- 2.9

250 0 250 500 Kilometers
EN 1991-1-3: Snow Map for Greece

Greece: Snow Load at Sea Level
Nature of the load
The design shall recognise that snow can be deposited on a roof in many different patterns.

Properties of a roof or other factors causing different patterns can include:

• the shape of the roof;
• its thermal properties;
• the roughness of its surface;
• the amount of heat generated under the roof;
• the proximity of nearby buildings;
• the surrounding terrain;
• the local meteorological climate, in particular its windiness, temperature variations, and likelihood of precipitation (either as rain or as snow).
EN 1991-1-2: Determination of Snow Load on the Roof – Definitions of undrifted and drifted snow on roof

**undrifted snow load on the roof**
load arrangement which describes the uniformly distributed snow load on the roof, affected only by the shape of the roof, before any redistribution of snow due to other climatic actions.

**drifted snow load on the roof**
load arrangement which describes the snow load distribution resulting from snow having been moved from one location to another location on a roof, e.g. by the action of the wind.
Drifted snow load on roofs

The National Annex may specify the use alternative drift patterns dependent on climatic variation (maritime or continental) for particular roof shapes. The alternatives apply for specific locations:

- where all the snow usually melts and clears between the individual weather systems and where moderate to high wind speeds occur during the individual weather system. (Annex B: maritime)
- where the snow that fall is more persistent and where snow falling in calm conditions may be followed by further snow, carried by another weather system driven by wind and there may several repetitions of these events before there is any significant thawing (Main text: continental)
EN 1991-1-3: Determination of Snow Load on the Roof – Shape coefficients

• EN 1991-1-3 gives shape coefficients for
  – Undrifted and Drifted load cases
  – Roof shapes
    • Mono-pitched
    • Pitched
    • Multi-span
    • Cylindrical
  – Continental climates
  – Persistent/transient situations

• Annex B gives shape coefficients for
  – Drifted load cases (multi-span roofs; roofs close to taller buildings; drifting at projections)
  – Maritime climates
EN 1991-1-3: Determination of Snow Load Shape coefficients: drifting, multi-span roofs

Drifted load case
(Section 5 – Continental climate)

\[
\bar{\alpha} = \frac{\alpha_1 + \alpha_2}{2}
\]

\[
\mu_1(\alpha_1) \quad \mu_2(\bar{\alpha}) \quad \mu_1(\alpha_2)
\]

Exceptional Drifted load case
(Annex B – Maritime climate)
EN 1991 – EUROCODE 1 Parts covered in this presentation

- EN 1991-1-1 Densities, self-weight and imposed loads
- EN 1991-1-3 Snow loads
- **EN 1991-1-4** Wind loads
- EN 1991-1-7 Accidental actions due to impact and explosions
EN 1991-1-4: Wind Actions: Major areas of disagreement – Nationally Determined Parameters

Impossible to get consensus on all parts of EN1991-1-4

There are 47 clauses or Notes where a recommended procedure is given but where National Choice is allowed, plus six informative annexes

It is expected that Member States will adopt the recommended procedures in most cases, except where issues of safety or economy arise.
EN 1991-1-4
Terrain categories
(Annexe A)

Category 0
Sea or coastal area exposed to the open sea

Category I
Lakes or flat and horizontal area with negligible vegetation and without obstacles

Category II
Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights

Category III
Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)

Category IV
Area in which at least 15% of the surface is covered with buildings and their average height exceeds 15 m
EN 1991-1-4: Section 7: Pressure and force coefficients

List of pressure/force coefficients (no directional values)

- Vertical walls
- Flat roofs
- Monopitch roofs
- Duopitch roofs
- Hipped roofs
- Multispan roofs
- Vaulted roofs and domes
- Canopy roofs
- Free-standing walls
- Signboards
- Rectangular structural elements
- Polygonal structural elements
- Circular cylinders
- Spheres
- Lattice structures and scaffoldings
- Flags
- Multiskin facades and roofs
- Internal pressures
EN 1991-1-4: Section 7: Pressure and force coefficients for duopitch roof

Table 7.4a — External pressure coefficients for duopitch roofs

<table>
<thead>
<tr>
<th>Pitch Angle $\alpha$</th>
<th>Zone for wind direction $\phi = 0^\circ$</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$C_{p,e,10} \quad C_{p,e,1} \quad C_{p,w,10} \quad C_{p,w,1} \quad C_{p,e,10} \quad C_{p,e,1} \quad C_{p,w,10} \quad C_{p,w,1}$</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$-45^\circ$</td>
<td>-0.6 -0.6 -0.8 -0.7 -1.0 -1.5</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$-30^\circ$</td>
<td>-1.1 -2.0 -1.5 -0.8 -0.6 -0.8</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$-15^\circ$</td>
<td>-2.5 -2.8 -1.3 -2.0 -0.9 -1.2</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$-5^\circ$</td>
<td>-2.3 -2.5 -1.2 -2.0 -0.8 -1.2</td>
<td>0.2</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$5^\circ$</td>
<td>-1.7 -2.5 -1.2 -2.0 -0.6 -1.2</td>
<td>-0.6</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$15^\circ$</td>
<td>-0.9 -2.0 -1.5 -0.3 -0.4</td>
<td>0.2</td>
<td>0.0</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$30^\circ$</td>
<td>-0.5 -1.5 -0.5 -1.5 -0.2</td>
<td>0.4</td>
<td>0.0</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$45^\circ$</td>
<td>-0.0 -0.0 -0.0 -0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$60^\circ$</td>
<td>+0.7 +0.7 +0.7 +0.6</td>
<td>0.0</td>
<td>0.0</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>$75^\circ$</td>
<td>+0.8 +0.8 +0.8 +0.8</td>
<td>-0.2</td>
<td>-0.2</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

External pressure coefficients

- upwind face
- downwind face

$\theta = 0^\circ$

$e/4$

$e/10$

$b$
Examples of bridge cross-sections covered by the EN 1991-1-7
EN 1991-1-4 vs UK Practice Roof cladding pressure comparisons

Maximum roof cladding pressure

- BS6399 Urban terrain
- EN1991-1-4 Urban terrain
- BS6399 Rural terrain
- EN1991-1-4 Rural terrain

Location

- London
- Swansea
- Birmingham
- Glasgow
- Belfast
- Inverness
EN 1991 – EUROCODE 1 Parts covered in this presentation

- EN 1991-1-1 Densities, self-weight and imposed loads
- EN 1991-1-3 Snow loads
- EN 1991-1-4 Wind loads
- EN 1991-1-7 Accidental actions due to impact and explosions
EN 1991-1-7 – Strategies for Accidental Design Situations

ACCIDENTAL DESIGN SITUATIONS

- STRATEGIES BASED ON IDENTIFIED ACCIDENTAL ACTIONS
  - e.g. explosions and impact
- STRATEGIES BASED ON LIMITING THE EXTENT OF LOCALISED FAILURE

  - DESIGN THE STRUCTURE TO HAVE SUFFICIENT ROBUSTNESS
  - PREVENTING OR REDUCING THE ACTION
    - e.g. protective measures
  - DESIGN STRUCTURE TO SUSTAIN THE ACTION
  - ENHANCED REDUNDANCY
    - e.g. alternative load paths
  - KEY ELEMENT DESIGNED TO SUSTAIN NOTIONAL ACCIDENTAL ACTION $A_d$
  - PRESCRIPTIVE RULES
    - e.g. integrity and ductility
EN 1991-1-7: Accidental Actions due to impact on Buildings and Bridges

- Impact from vehicles on buildings supporting substructures for bridges
- Impacts from vehicles on bridge superstructures
- Impact from ships on supporting substructures
- Impact from fork lift trucks
- Impact from derailed trains
- Hard landings by helicopters
Examples of accidental actions and situations
Ronan Point - 1968
### Consequence classes

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Examples of buildings &amp; civil engineering works</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC3</td>
<td>High consequences for loss of human life, or economic, social or environmental consequences very great</td>
<td>Grandstands, public buildings where consequences of failure are high</td>
</tr>
<tr>
<td>CC2</td>
<td>Medium consequences for loss of human life, economic, social or environmental consequences considerable</td>
<td>Residential and office building, public buildings where consequences of failure are medium</td>
</tr>
<tr>
<td>CC1</td>
<td>Low consequences for loss of human life, and economic, social or environmental consequences small or negligible</td>
<td>Agricultural buildings where people do not normally enter (e.g. storage buildings). greenhouses</td>
</tr>
</tbody>
</table>
## EN 1991-1-7: Categorisation of Building Types

### Table A.1 - Categorisation of consequences classes.

<table>
<thead>
<tr>
<th>Consequence class</th>
<th>Example of categorisation of building type and occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Single occupancy houses not exceeding 4 storeys. Agricultural buildings. Buildings into which people rarely go, provided no part of the building is closer to another building, or area where people do go, than a distance of $1\frac{1}{2}$ times the building height.</td>
</tr>
<tr>
<td><strong>2</strong> Lower Risk Group</td>
<td>5 storey single occupancy houses. Hotels not exceeding 4 storeys. Flats, apartments and other residential buildings not exceeding 4 storeys. Offices not exceeding 4 storeys. Industrial buildings not exceeding 3 storeys. Retailing premises not exceeding 3 storeys of less than 1 000 m$^2$ floor area in each storey. Single storey educational buildings. All buildings not exceeding two storeys to which the public are admitted and which contain floor areas not exceeding 2000 m$^2$ at each storey.</td>
</tr>
<tr>
<td><strong>2</strong> Upper Risk Group</td>
<td>Hotels, flats, apartments and other residential buildings greater than 4 storeys but not exceeding 15 storeys. Educational buildings greater than single storey but not exceeding 15 storeys. Retailing premises greater than 3 storeys but not exceeding 15 storeys. Hospitals not exceeding 3 storeys. Offices greater than 4 storeys but not exceeding 15 storeys. All buildings to which the public are admitted and which contain floor areas exceeding 2000 m$^2$ but not exceeding 5000 m$^2$ at each storey. Car parking not exceeding 6 storeys.</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>All buildings defined above as Class 2 Lower and Upper Consequences Class that exceed the limits on area and number of storeys. All buildings to which members of the public are admitted in significant numbers. Stadia accommodating more than 5 000 spectators</td>
</tr>
</tbody>
</table>
## EN 1991-1-7: Recommended strategies for various classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Building Type and Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provided the building has been designed and constructed in accordance with the rules given in EN1992 to 1999 for satisfying stability in normal use, no further specific consideration is necessary.</td>
</tr>
<tr>
<td>2 LRG</td>
<td>Provide effective horizontal ties, or effective anchorage of suspended floors to walls</td>
</tr>
</tbody>
</table>
| 2 Higher Risk Group | Provide effective horizontal ties, together with:  
  - effective vertical ties, in all supporting columns and walls, or alternatively,  
  - ensure that upon the notional removal of each supporting column and each beam supporting a column, or any nominal section of load-bearing that the building remains stable and that any local damage < a certain limit.  
Where the notional removal of such columns and sections of walls would result in an extent of damage in excess of a given limit, then such elements should be designed as a "key element". |
| 3     | A systematic risk analysis of the building should be undertaken taking into account all the normal hazards that may reasonably be foreseen, together with any abnormal hazards. |
EN 1991-1-7: Nationally Determined Parameters

All values for impact loads, explosion pressures etc are given as indicative values, with final choices to be made in the National Annex.
IMPLEMENTATION OF EUROCODES AND OBJECTIVES OF NATIONAL ANNEX

“Eurocodes recognise the responsibility of Regulatory and other Relevant Authorities in each Member State and have safeguarded their right to determine values related to safety matters at National level where these continue to vary from State to State”

This is through the National Annex
Elements of the national publication of a European Standard

ISO/CEI Directives
Part 3 (supplement)

a National title page
b National foreword
c EN title page
d EN text
e EN Annex(es)
f National annex
Annex to a Eurocode Part containing the National Determined Parameters (NDPs) to be used for the structural design of buildings and civil engineering works in Member States
NATIONALLY DETERMINED PARAMETER IN THE NATIONAL ANNEX

• Values and/or classes where alternatives are given in the EN Eurocode
• Values to be used where a symbol only is given in the EN Eurocode
• Country specific data (geographical, climatic etc) e.g. a snow map
• The procedure to be used where alternative procedures are given in the EN Eurocode
### A1.2.2 Values of $\psi$ factors

(1) Values of $\psi$ factors should be specified.

**NOTE** The $\psi$ values may be set by the National Annex. Recommended values of $\psi$ factors for the more common actions may be obtained from Table A1.1.

<table>
<thead>
<tr>
<th>Action</th>
<th>$\psi_0$</th>
<th>$\psi_1$</th>
<th>$\psi_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imposed loads in buildings, category (see EN 1991-1-1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category A: domestic, residential areas</td>
<td>0,7</td>
<td>0,5</td>
<td>0,3</td>
</tr>
<tr>
<td>Category B: office areas</td>
<td>0,7</td>
<td>0,5</td>
<td>0,3</td>
</tr>
<tr>
<td>Category C: congregation areas</td>
<td>0,7</td>
<td>0,7</td>
<td>0,6</td>
</tr>
<tr>
<td>Category D: shopping areas</td>
<td>0,7</td>
<td>0,7</td>
<td>0,6</td>
</tr>
<tr>
<td>Category E: storage areas</td>
<td>1,0</td>
<td>0,9</td>
<td>0,8</td>
</tr>
<tr>
<td>Category F: traffic area, vehicle weight $\leq$ 30kN</td>
<td>0,7</td>
<td>0,7</td>
<td>0,6</td>
</tr>
<tr>
<td>Category G: traffic area, $30kN &lt;$ vehicle weight $\leq$ 160kN</td>
<td>0,7</td>
<td>0,5</td>
<td>0,3</td>
</tr>
<tr>
<td>Category H: roofs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Snow loads on buildings (see EN 1991-1-3)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Finland, Iceland, Norway, Sweden</td>
<td>0,70</td>
<td>0,50</td>
<td>0,20</td>
</tr>
<tr>
<td>- Remainder of CEN Member States, for sites located at altitude $H &gt; 1000$ m a.s.l.</td>
<td>0,70</td>
<td>0,50</td>
<td>0,20</td>
</tr>
<tr>
<td>- Remainder of CEN Member States, for sites located at altitude $H \leq 1000$ m a.s.l.</td>
<td>0,50</td>
<td>0,20</td>
<td>0</td>
</tr>
<tr>
<td>Wind loads on buildings (see EN 1991-1-4)</td>
<td>0,6</td>
<td>0,2</td>
<td>0</td>
</tr>
<tr>
<td>Temperature (non-fire) in buildings (see EN 1991-1-5)</td>
<td>0,6</td>
<td>0,5</td>
<td>0</td>
</tr>
</tbody>
</table>

**NOTE** The $\psi$ values may be set by the National annex.

* For countries not mentioned below, see relevant local conditions.
NATIONALLY DETERMINED PARAMETER IN THE NATIONAL ANNEX

- Values and/or classes where alternatives are given in the EN Eurocode
- Values to be used where a symbol only is given in the EN Eurocode
- Country specific data (geographical, climatic etc) e.g. a snow map
- The procedure to be used where alternative procedures are given in the EN Eurocode
Climatic Regions

- Alpine Region
- Central East
- Central West
- Greece
- Iberian Peninsula
- Iceland
- Mediterranean Region
- Norway
- Sweden, Finland
- UK, Eire
Determination of $S_k$

$$S_k = (0.15 + [0.1Z + 0.05]) + ((A - 100)/525))$$

$S_k$ = Characteristic ground snow load (kN/m$^2$)

$Z$ = Zone number (obtained from map)

$A$ = Site altitude (m)
NATIONALLY DETERMINED PARAMETER IN THE NATIONAL ANNEX

• Values and/or classes where alternatives are given in the EN Eurocode
• Values to be used where a symbol only is given in the EN Eurocode
• Country specific data (geographical, climatic etc) e.g. a snow map
• The procedure to be used where alternative procedures are given in the EN Eurocode
Ultimate limit states of STR/GEO - Fundamental combination for persistent and transient design situations

Expression (6.10)

$$\sum_{j \geq 1} \gamma_{G,j} G_{k,j}'''' + ''\gamma_{P,P}'''' + ''\gamma_{Q,1} O_{k,1}'''' + ''\sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}$$

Expressions (6.10a) and (6.10b)

$$\begin{cases} \sum_{j \geq 1} \gamma_{G,j} G_{k,j}'''' + ''\gamma_{P,P}'''' + ''\sum_{i \geq 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \\ \sum_{j \geq 1} \xi_j \gamma_{G,j} G_{k,j}'''' + ''\gamma_{P,P}'''' + ''\gamma_{Q,1} O_{k,1}'''' + ''\sum_{i > 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \end{cases}$$

$$0.85 \leq \xi \leq 1.00$$
OTHER GUIDANCE ALLOWED IN THE NATIONAL ANNEX

- Decisions on the application of informative annexes
- Reference to non-contradictory complementary information to assist the user to apply the Eurocodes
European Commission formally recommends Eurocodes

in this issue:

- EU Code of Practice for Earthquakes
- Eurocode 1 fire and smoke design for building}

Eurocodes are harmonised technical specifications on the assessment and design of structures, aimed at ensuring safety, durability, and performance. The European Commission has formally recommended the use of Eurocodes, aiming to improve the Structural Engineering Industry across Europe.
COMMISSION RECOMMENDATIONS ON USE OF EUROCODES FOR EU MEMBER STATES

• To adopt Eurocode for designing construction works
• To select NDPs for their territory, and urged to use recommended values
• To compare NDPs, assess the impact on any technical differences and reduce divergence
• To refer to Eurocodes, in their provisions on structural construction products
• To undertake, in collaboration, appropriate research relating to Eurocodes ensuring an ongoing increased level of security and protection to the citizen; hazard identification; assessment of existing structures; designing for sustainability
• Urged to promote instructions on use of Eurocodes
POTENTIAL BENEFITS FOR THE CONSTRUCTION INDUSTRY WITH THE IMPLEMENTATION OF THE EUROCODES & ACTIVITIES FOR BRE INVOLVEMENT

• A common understanding regarding the design of construction works between owners, operators and users, designers, contractors and manufacturers of construction products;

• A common design criteria and methods to fulfil the specified requirements for mechanical resistance, stability and resistance to fire, including aspects of durability and economy;

• Opportunities for marketing and use of structural components and kits in concrete in Member States;
POTENTIAL BENEFITS FOR THE CONSTRUCTION INDUSTRY WITH THE IMPLEMENTATION OF THE EUROCODES & ACTIVITIES FOR BRE INVOLVEMENT (Cont.)

- Opportunities for marketing and use of construction materials and products, the properties of which enter into design calculations, in Member States;
- A common basis for research and development in Europe;
- To allow the preparation of common design aids and software;
- Benefit the European construction industry including civil engineering firms, contractors, designers and product manufacturers in their worldwide activities, and increasing their competitiveness.
Welcome to Eurocodes Expert

Welcome to Eurocodes Expert, an Institution of Civil Engineers (ICE) initiative to help clients, designers, contractors and suppliers understand and use the new European structural design codes.

Why the Eurocodes are important?

- the 10 Eurocodes are being published from 2002 to 2005 and will begin replacing most European national codes from 2007.
- the codes are mandatory for European public works and are set to become the de-facto standard for the private sector - both in Europe and worldwide.
- they are designed to help the European construction industry become more competitive and improve structural safety.

How Eurocodes Expert can help

According to experts, Eurocodes require designers to think in a different way and use more supporting guidance and software. Eurocodes Expert aims to be the primary reference for all users, advising them on the latest developments, training events and support resources.
MANAGEMENT DECISIONS REGARDING USING THE EUROCODES

Business Decisions

The single, most important decision an organisation has to make is:

WHEN TO IMPLEMENT THE EUROCODES IN THE ORGANISATION
MANAGEMENT DECISIONS REGARDING USING THE EUROCODES

Business Decisions require consideration of:

- **Timing** (Availability of Eurocodes with National Annex; Withdrawal of BSI codes; Acceptance by Government and client authorities; nature of business)
- **Office Procedures** (Technical differences; Training; Availability of background documentation; QA requirements)
- **Availability of suitable IT**
- **Competition** (Strategically the right time to implement considering - cost, and - short, medium and long term prospects)
Eurocodes – Impact of implementation - Opportunities?

The Eurocodes will:

• Open European Markets
• Open World Markets
• Encourage Innovative Design
IMPLEMENTATION – WHY?

• The Eurocodes represent the most wide ranging change to codification of civil and structural design ever experienced
• Their transparency during development
• The Eurocodes are the most technically advanced suite of civil and structural design codes in the world
• UK influence during the development of the Eurocodes has been significant
• The Eurocodes present significant opportunities for export of European design expertise and products
Implementation – Getting the UK Construction Industry Ready

- **Awareness campaign**
- Education, training and continuing professional development courses and events.
- Guidance material (Designer guides; Handbooks; Worked examples etc)
Eurocodes News

Half of Eurocodes now published

Eurocodes Expert gets UK government backing

European Commission formally recommends Eurocodes
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SCI provides training and support in the following areas:

- In depth technical steel design courses run throughout the UK and Eire.
- Bespoke training at company premises, to address company business objectives and development.
- Support material for Academe
- For information visit [www.steel-sci.org/courses](http://www.steel-sci.org/courses) Or call 01344 872776
Implementation – Getting the UK Construction Industry Ready

• Awareness campaign
• Education, training and continuing professional development courses and events.
• Guidance material (Designer guides; Handbooks; Worked examples etc)
Eurocodes Guides
IMPLEMENTATION - CONCERNS and BENEFITS

- Will the Eurocodes maintain adequate levels of safety together with acceptable economy
- Will Eurocodes encourage or stifle innovation
- Their Usability, and acceptance by the profession
- Plans for care and maintenance of the Eurocodes in the future
- Cost of implementation
- Competitiveness of UK industry
Eurocodes – Impact of implementation – the Construction Industry

- Implications of EC legislation
  - CPD
  - Public procurement directives

- Larger international organisations – market forces and international competition will encourage them to early implementation.

- Small National organisations (smaller consultancies and smaller manufacturers of structural products). The impact will be severe and comparatively costly.
Implementation of the Eurocodes in the UK

• The latest date for implementation is late 2009/early 2010

• Organisations may need to use the Eurocodes earlier for
  - Public Works projects
  - For granting CE marks
  - For projects in the rest of Europe and the rest of the world

• There is a strong need for the UK construction industry to be ready for implementation
The Eurocodes have arrived.

57 parts have been voted positively

All 58 parts should have positive votes by end of 2006
Thank you for your attention