INTRODUCTION TO EUROCODES

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Introduction

- The structural Eurocodes are European suite of codes for structural design, developed over twenty-five years (Started since 1975)
- By 2010 they have effectively replaced the current British Standard as the primary basis for designing buildings and civil engineering structures in the UK.
- Claimed to be the most technically advanced structural design codes in the world.

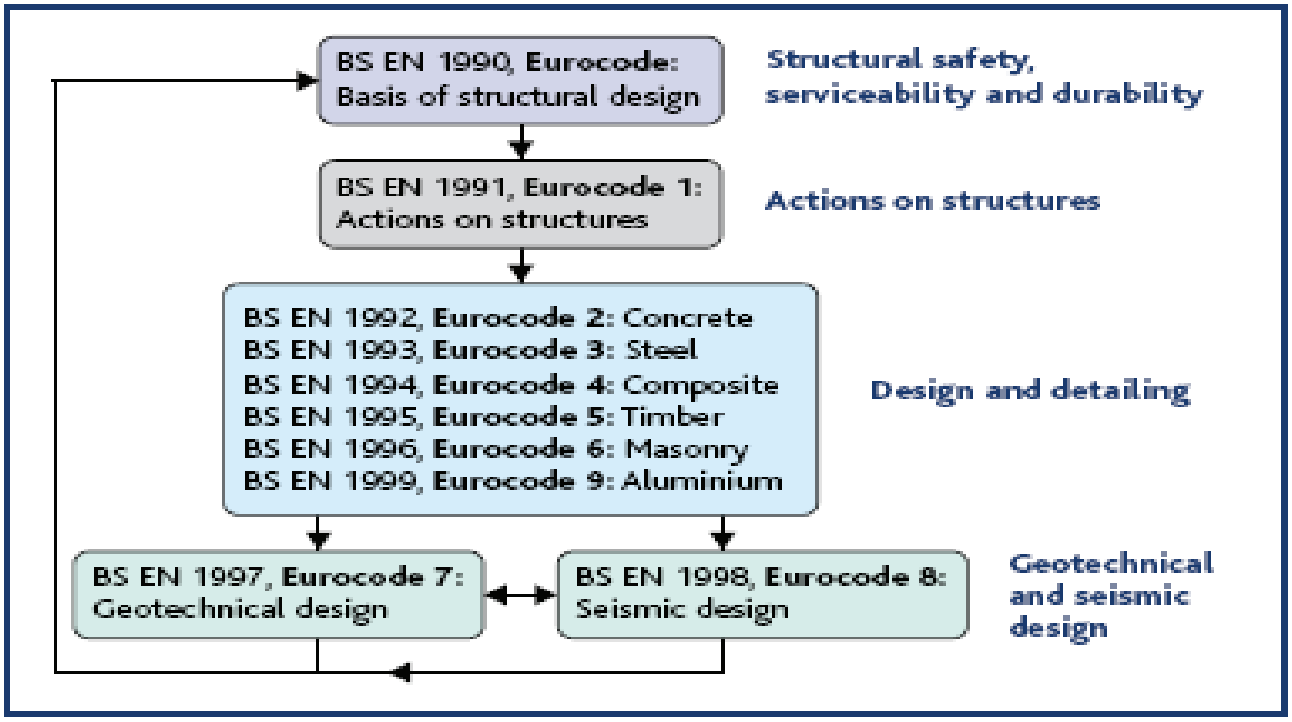
- **Have been developed to improve the competitiveness of the European construction industry both within and outside the European Union.**

- **Eurocode is actually a performance code which has more advantages over British Standard, which is a descriptive code.**

- **Eurocode should result in more economic structures than BS.**

The Eurocodes

The Eurocode Family (58 all together)		
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 of structures for earthquake resistance
EN 1999	Eurocode 9	Design of aluminum alloy structures



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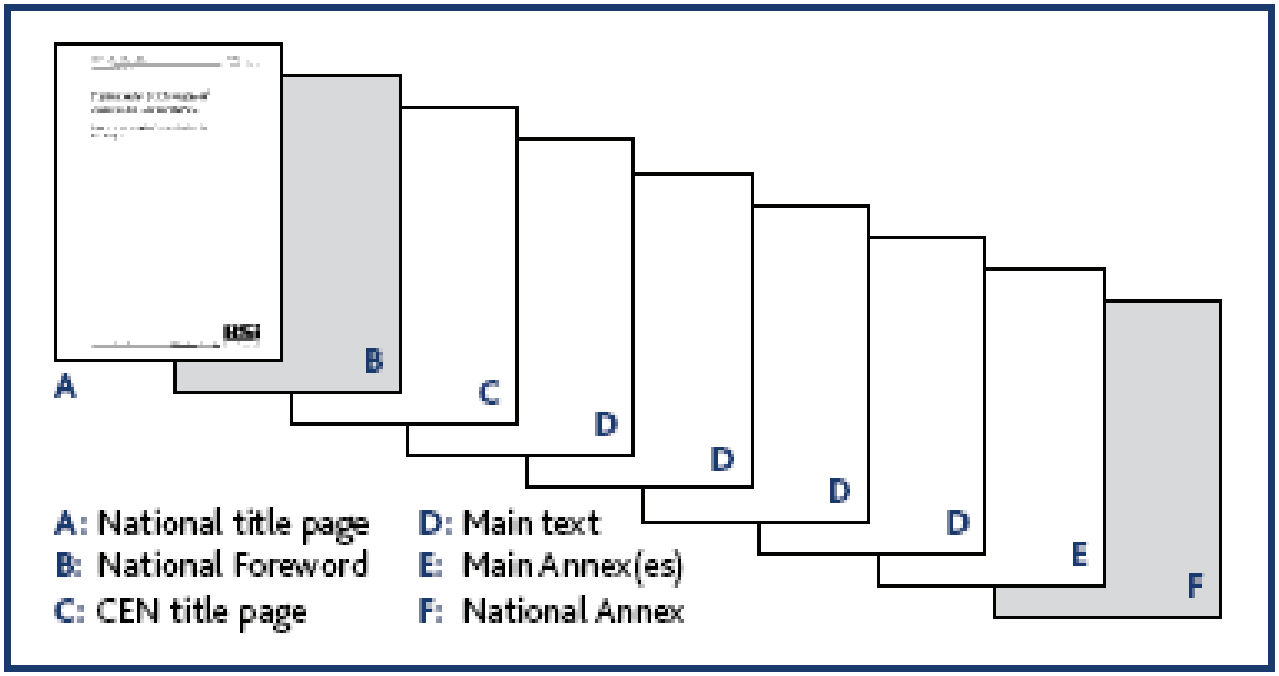
Format of the Eurocodes

- **Each Eurocode contains:-**
  - **National Fowarded**
  - **Main text and Annexes**
  - **National Annex**

- **National annex gives Nationally Determined Parameters (NDPs)**

- **NDPs have been allowed for reason of safety, economy and durability**

Format of the Eurocodes



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- **The family of Eurocodes is based on principles rather than methods**
- **Format of all codes is: principles, materials, ultimate, service, detailing**
- **All materials are subjected to the same limit state regime**

- **Eurocodes used subscripts extensively:**

"Ed" = design internal effect

e.g. N_{ed} = design axial force

"Rd" = design resistance

e.g. N_{Rd} = design resistance of axial force

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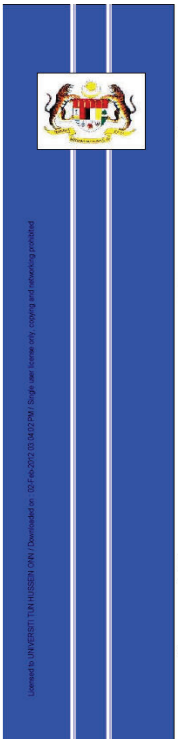
EN 1990 : EUROCODE
Basis of Structural Design

EN 1990



MALAYSIAN STANDARD

MS EN 1990:2010

EUROCODE - BASIS OF STRUCTURAL DESIGN

ICS: 91.010.30

Descriptors: eurocode, basis, structural design

FOR SALE WITHIN MALAYSIA ONLY

DEPARTMENT OF STANDARDS MALAYSIA

Contents	
Section 1	General
Section 2	Requirements
Section 3	Principles of Limit State Design
Section 4	Basic Variables
Section 5	Structural analysis and design assisted by testing
Section 6	Verification by the partial factor method
Annex A1	Application for buildings
Annex A2	Application for bridges
Annex B	Management of structural reliability for construction works
Annex C	Basis for partial factor design and reliability analysis
Annex D	Design assisted by testing

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EN 1991 : EUROCODE 1

Actions on Structures

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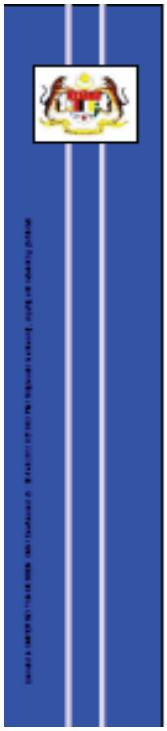
EN 1991



EUROCODE 1: ACTIONS ON STRUCTURES	
EN 1991-1-1	Densities, self weight and imposed loads
EN 1991-1-2	Actions on structures exposed to fire
EN 1991-1-3	Snow loads
EN 1991-1-4	Wind loads
EN 1991-1-5	Thermal loads
EN 1991-1-6	Actions during execution
EN 1991-1-7	Accidental actions
EN 1991-2	Traffic loads on bridges
EN 1991-3	Actions induced by cranes and machinery
EN 1991-4	Silos and tanks

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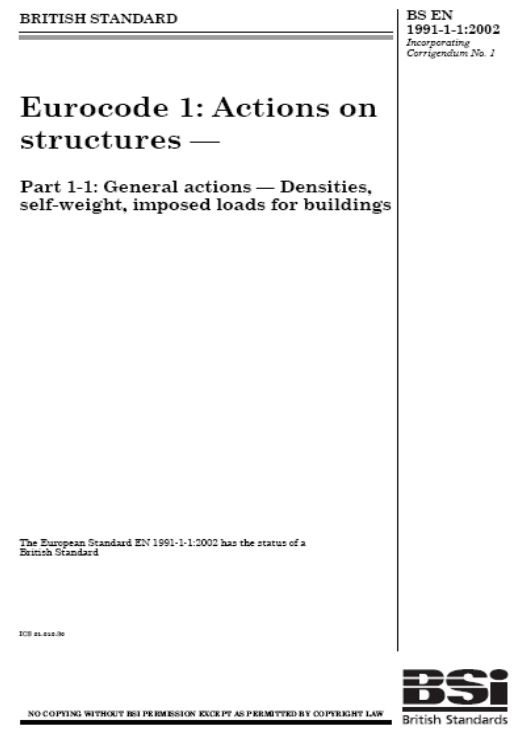
EN 1991-1-1



Contents	
Section 1	General
Section 2	Classification of actions
Section 3	Design situations
Section 4	Densities of construction and stored materials
Section 5	Self-weight of construction works
Section 6	Imposed load on buildings
Annex A	Tables for nominal density of construction materials, and nominal density and angle of repose of stored materials
Annex B	Vehicle barriers and parapets for car parks

EN 1992 : EUROCODE 2
Design of Concrete Structures

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EN 1992

EUROCODE 2: DESIGN OF CONCRETE STRUCTURES	
EN 1992-1	General rules and rules for buildings
EN 1992-1-2	General rules –Structural fire design
EN 1992-2	Concrete bridges –design and detailing rules
EN 1992-3	Liquid retaining and containment structures

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EN 1992-1

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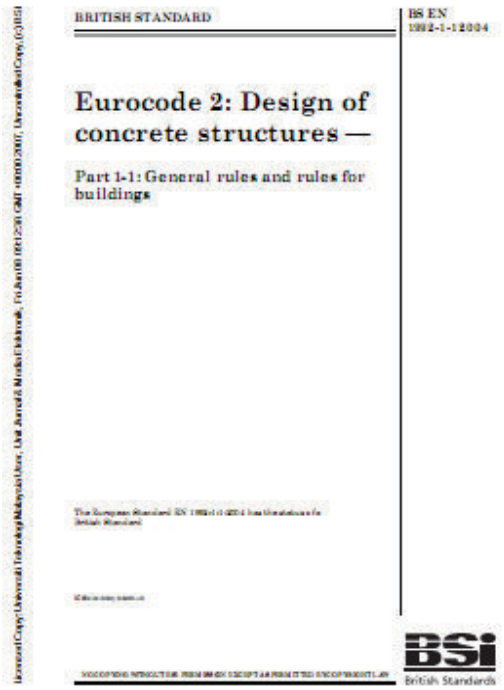
BRITISH STANDARD

BS EN 1992-1-1:2004

Eurocode 2: Design of concrete structures —

Part 1-1: General rules and rules for buildings

BSI British Standards

Contents	
Section 1	General
Section 2	Basis of design
Section 3	Materials
Section 4	Durability and cover to reinforcement
Section 5	Structural analysis
Section 6	Ultimate limit states (ULS)
Section 7	Serviceability limit states (SLS)
Section 8	Detailing of reinforcement & prestressing tendons -General
Section 9	Detailing of members and particular rules
Section 10	Additional rules for precast structures
Section 11	Lightweight aggregated concrete structures
Section 12	Plain and lightly reinforced concrete structures

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EN 1992-1

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Contents	
Annex A	Modification of partial factors for materials
Annex B	Creep and shrinkage strain
Annex C	Reinforcement properties
Annex D	Detailed calculation method for prestressing steel relaxation losses
Annex E	Indicative Strength Classes for durability
Annex F	Reinforcement expressions for in-plane stress conditions
Annex G	Soil structure interaction
Annex H	Global second order effects in structures
Annex I	Analysis of flat slabs and shear walls
Annex J	Examples of regions with discontinuity in geometry or action

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EUROCODE vs BS

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Eurocodes	Title	Superseded standards
EN 1990	Basis of structural design	BS 8110: Part 1- Section 2
EN 1991-1-1	Densities, self weight and imposed loads	BS 6399: Part 1 and BS 648
EN 1991-1-2	Actions on structures exposed to fire	-
EN 1991-1-3	Snow loads	BS 6399: Part 2
EN 1991-1-4	Wind loads	BS 6399: Part 3
EN 1991-1-5	Thermal loads	-
EN 1991-1-6	Actions during execution	-
EN 1991-1-7	Accidental actions	-

EUROCODE vs BS

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Eurocodes	Title	Superseded standards
EN 1991-2	Traffic loads on bridges	BD 37/88
EN 1991-3	Actions induced by cranes and machinery	-
EN 1991-4	Silos and tanks	-
EN 1992-1-1	General rules for buildings	BS 8110: Part 1, 2 and 3
EN 1992-1-2	General rules –Structural fire design	BS 8110: Part 1 Table 3.2
EN 1992-2	Concrete bridges –design and detailing rules	BS 5400: Part 4
EN 1992-3	Liquid retaining and containment structures	BS 8007

EUROCODE vs BS

- **Eurocodes used different terminology:**

Eurocode	British Standard
Action	Force or imposed displacement
Verification	Check
Resistance	Capacity
Execution	Construction
Permanent action	Dead load
Variable action	Live load or imposed load
Isostatic	Primary

Key Differences of EC2

- **EC2 is generally laid out to give advice on the basis of phenomena / behavior (e.g. bending, shear etc) rather than by member type as in BS 8110 (e.g. beams, slabs, columns etc).**

- **Design is based on characteristic cylinder strength (f_{ck}) not cube strength (f_{cu}).**

- **EC2 does not provide derived formulae (e.g. for bending only the details of the stress block are expressed).**

6. Ultimate limit states (ULS)
6.1 Bending with or without axial force
6.2 Shear
- 6.2.1 General verification procedure
- 6.2.2 Members not requiring design shear reinforcement
- 6.2.3 Members requiring design shear reinforcement
- 6.2.4 Shear between web and flanges of T-sections
- 6.2.5 Shear at the interface between concretes cast at different times

6.3 Torsion
- 6.3.1 General
- 6.3.2 Design procedure
- 6.3.3 Warping torsion

6.4 Punching
- 6.4.1 General
- 6.4.2 Load distribution and basic control perimeter
- 6.4.3 Punching shear calculation
- 6.4.4 Punching shear resistance of slabs and column bases without shear reinforcement
- 6.4.5 Punching shear resistance of slabs and column bases with shear reinforcement

6.5 Design with strut and tie models
- 6.5.1 General
- 6.5.2 Struts
- 6.5.3 Ties
- 6.5.4 Nodes

6.6 Anchorages and laps
6.7 Partially loaded areas
6.8 Fatigue

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Key Differences of EC2

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Concrete strength classes and modulus of elasticity

Concrete strength class	Characteristic cylinder strength f_{ck} (N/mm^2)	Characteristic cube strength $f_{ck,cube}$ (N/mm^2)	Modulus of elasticity E_{cm} (kN/mm^2)
C20/25	20	25	30
C25/30	25	30	31
C30/37	30	37	33
C35/45	35	45	34
C40/50	40	50	35
C45/55	45	55	36
C50/55	50	60	37
C55/67	55	67	38
C60/75	60	75	39

Key Differences of EC2

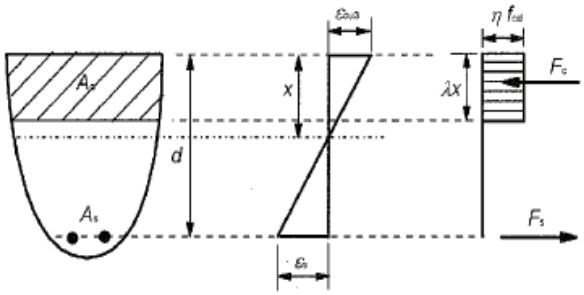

Figure 3.5: Rectangular stress distribution

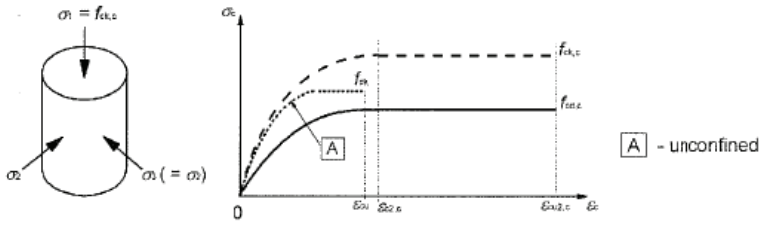

Figure 3.6: Stress-strain relationship for confined concrete

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Key Differences of EC2

- **Units for stress are mega pascals, MPa (1 MPa= 1 N/mm^2)**
- **EC2 uses comma for a decimal point.**
- **One thousandth is represent by %.**
- **The partial safety factor for steel reinforcement is 1.15. The characteristic yield strength is 500 Mpa.**

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Key Differences of EC2

- **Minimum concrete cover is related to bond strength, durability and fire resistance. There is allowance for deviations due to variations in execution.**

- **Higher strengths of concrete are covered by EC 2, up to class C90/105.**

- **The effects of geometric imperfection are considered in addition to lateral loads.**

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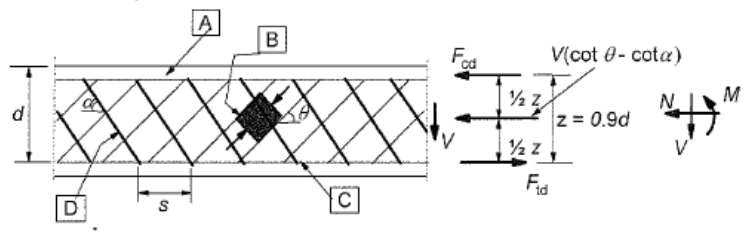
Key Differences of EC2

- **The "variable strut inclination" method is used for the assessment of the shear capacity of a section.**



A - compression chord, B - struts, C - tensile chord, D - shear reinforcement

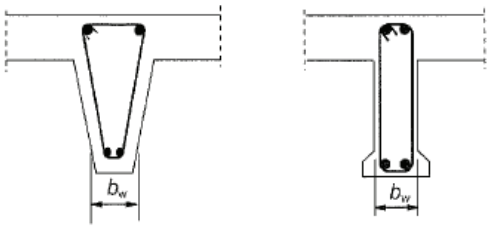


Figure 6.5: Truss model and notation for shear reinforced members

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- **Serviceability checks can still carried out using "deemed to satisfy" span to effective depth (*l*/*d*) rules similar to BS 8110.**

- **The rules for determining the anchorage and lap length are more complex than the simple tables in BS 8110.**

- **The punching shear checks are carried out at 2d from the face of the column and for a rectangular column, the perimeter is rounded at the corners.**