

GENERAL BACKGROUND AND INTRODUCTION TO EUROCODE DESIGN

BY



**ENGR BLDR VICTOR O
OYENUGA**

FNSE PPNIStructE FNIHTE FNICE MNIIOB

MD/CEO: **VASONS CONCEPT CONSULTANTS LTD LAGOS**

1.0 INTRODUCTION

Historical Background.

- The development of the formulation of the Eurocodes started in 1975 when the Member States of the Commission of the European Community decided on an action programme in the field of construction based on the Article 95 of the Treaty.
- In 1989, the Commission, EU and other relevant organizations decided to transfer the preparation and publication of the Eurocodes to CEN (Comite European de Normalization OR European Committee on Standardization) through a series of Mandates, in order to provide them a future status of European Standard (EN).
- The resulting Structural Eurocodes programme comprises the standards now referred as Eurocodes.



TABLE 1: EUROCODES RELEASES

S/N o	Codes & Years	Eurocodes	Descriptions
1.	EN 1990	Eurocode	Basis of Structural Design
1.	EN 1991	Eurocode 1	Actions on Structures
1.	EN 1992	Eurocode 2	Design of Concrete Structures
1.	EN 1993	Eurocode 3	Design of Steel Structures
1.	EN 1994	Eurocode 4	Design of Composite Steel and Concrete Structures
1.	EN 1995	Eurocode 5	Design of Timber Structures
1.	EN 1996	Eurocode 6	Design of Masonry Structures
1.	EN 1997	Eurocode 7	Geotechnical Design
1.	EN 1998	Eurocode 8	Design of Structures for Earthquake Resistance
1.	EN 1999	Eurocode 9	Design of Aluminum Structures

2.0 PURPOSES OF THE EUROCODES

- As a means to prove compliance of building and civil engineering works with the essential requirement of the regulatory council requirements.
- As a basis for specifying contracts for construction works and related engineering services and
- As a framework for drawing up harmonized technical specifications for construction products.

The Eurocode standards provide common structural design rules for member countries and for everyday use. Unusual forms of construction or design conditions are not specifically covered and additional expert considerations will be required.



2.1 ASSUMPTIONS FOR USE OF EUROCODES

- The design of the structure is made by appropriately qualified and experienced personnel.
- The execution by personnel of appropriate skills and experiences.
- Adequate supervision and quality control is provided during the execution ,
- The construction materials and products are of approved standard.
- The Structure will be used in accordance with the design assumptions.

2.2 PRINCIPLES AND APPLICATION RULES

- The Principles comprise:
 - general statements and definitions for which there is no alternative, as well as
 - requirements and analytical models for which no alternative is permitted unless specifically stated.

The principles are identified by the letter P following the clause number.

- On the other hand, Application Rules are generally recognized rules, which comply with the Principles and satisfy their requirements. They are clauses without the letter P.

2.3 NATIONALLY DETERMINED PARAMETERS AND NATIONAL ANNEXES

- The possible differences in construction materials/products; design and construction practices, and regional differences in climatic conditions, etc. some parameters, such as, partial safety factors, allowance in design etc., then a particular application rule may be proposed as determined nationally.
- The recommended values of these parameters and design method/procedures are collectively referred to as Nationally Determined Parameters (NDPs).
- The NDPs determine various aspects of design, but perhaps most importantly, the level of safety of structures during execution and in-service, remains the responsibility of the country.

3.0 THE EUROCODES

This presentation is centred on the following Eurocodes:

- Eurocode: Basis of Structural Design.
- Eurocode 1: Actions on Structures.
- Eurocode 2: Design of Concrete Structures.



3.1 EUROCODE – BASIS OF STRUCTURAL DESIGN.

- Assumptions, Principles and Application Rules Definitions.
- Requirements such as Design Working Life, Durability, Quality and Reliability Management.
- Principles of Limit State Design.
- Actions and Environmental Influence.
- Structural Analysis and Design
- Verifications by the Partial Factor Method (Design Values, Limit States, etc.)

3.2 EUROCODE 1: ACTIONS ON STRUCTURES (EC 1)

This is issued in various parts as stated below:

- BS EN 1991 1 - 1: Dead and Live
- BS EN 1991 1 - 2: Fire
- BS EN 1991 1 - 3: Snow
- BS EN 1991 1 - 4: Wind
- BS EN 1991 1 - 5: Thermal
- BS EN 1991 1 - 6: Execution
- BS EN 1991 1 - 7: Accidental
- BS EN 1991 - 2: Traffic Bridges
- BS EN 1991 - 3: Crane & Machinery
- BS EN 1991 - 4: Silos & Tanks.



3.3 EUROCODE 2: DESIGN OF CONCRETE STRUCTURES (EC 2)

- Part 1 - 1: General Rules and Rules for Buildings.
- Part 1 - 2: General Rules in Structural Fire Design.
- Part 2: Concrete Bridges in Design and Detailing Rules.
- Part 3: Liquid Retaining and Containment Structures.

The Eurocode 2 (EC 2): Part 1-1 gives general basis for the design of structures in plain, reinforced, lightweight, pre-cast and pre-stressed concrete. In addition, it gives some detailing rules, which are mainly applicable to ordinary buildings. It is similar to BS 8110-Parts 1 and 2 (1985, 1997). However, reference has to be made to *Eurocode - Basis of Structural Design* and *Eurocode 1 - Actions on Buildings*, for a complete structural analysis and design in reinforced concrete.

4.0 THE EUROCODE 2

- In general, the design value of an action, F_d , is obtained by multiplying the representative value, F_{rep} , by the appropriate partial safety factor for actions, γ_f . Thus,

- $$F_d = \gamma_f F_{rep}$$

Limit State	Load Type				
	Permanent, G_k		Imposed, Q_k		Wind, W_k
	Unfavorable	Favorable	Unfavorable	Favorable	Unfavorable
Equilibrium	1.10	0.9	1.5	0.0	$1.5\phi_0$

Table 2: Partial safety factors for the ultimate limit state of equilibrium



-Limit State/ -Load Combination	Load Type				
	Permanent, G_k		Imposed, Q_k		Wind, W_k
	Unfavorable	Favorable	Unfavorable	Favorable	Unfavorable
Strength					
1. Permanent and variable		1.0	1.5	0	-
2. Permanent and wind		1.0	-	-	1.5
3. Permanent, imposed, wind					
a	1.35	1.0	$1.5\varphi_{0,1}$	-	$1.5\varphi_{0,2}$
b		1.0	1.5	0	$1.5\varphi_0$
c		1.0	$1.5\varphi_0$	0	1.5

Table 3: Load combinations and partial safety/combination factors for the ultimate limit state of strength.

Note: $\varepsilon = 0.925$ (UK, National Annex).



4.2 PARTIAL FACTORS FOR MATERIALS AND STRENGTH

- The major materials that are referred to are concrete and steel reinforcements. Clause 2.4.2.4 and Table 2.1N of EC2 give the details of the partial factors for materials. The Table 2.1N is represented here as Table 4.
- **Table 4: Partial factors for materials for Ultimate Limit States**

Design Situations	γ_c for Concrete	γ_s for reinforcing steel
Persistent and Transient	1.5	1.15
Accidental	1.2	1.0

5.0 THE NIGERIAN ENVIRONMENT

- The formulation of the Nigerian Annex to Eurocode 2
- Isopleths of basic wind speed in Nigeria
- Local materials
- Concrete strengths
- Locally available reinforcements and steel strength.



**Nigerian Meteorological Agency
Windflow Map for Nigeria (Metres/Sec)**

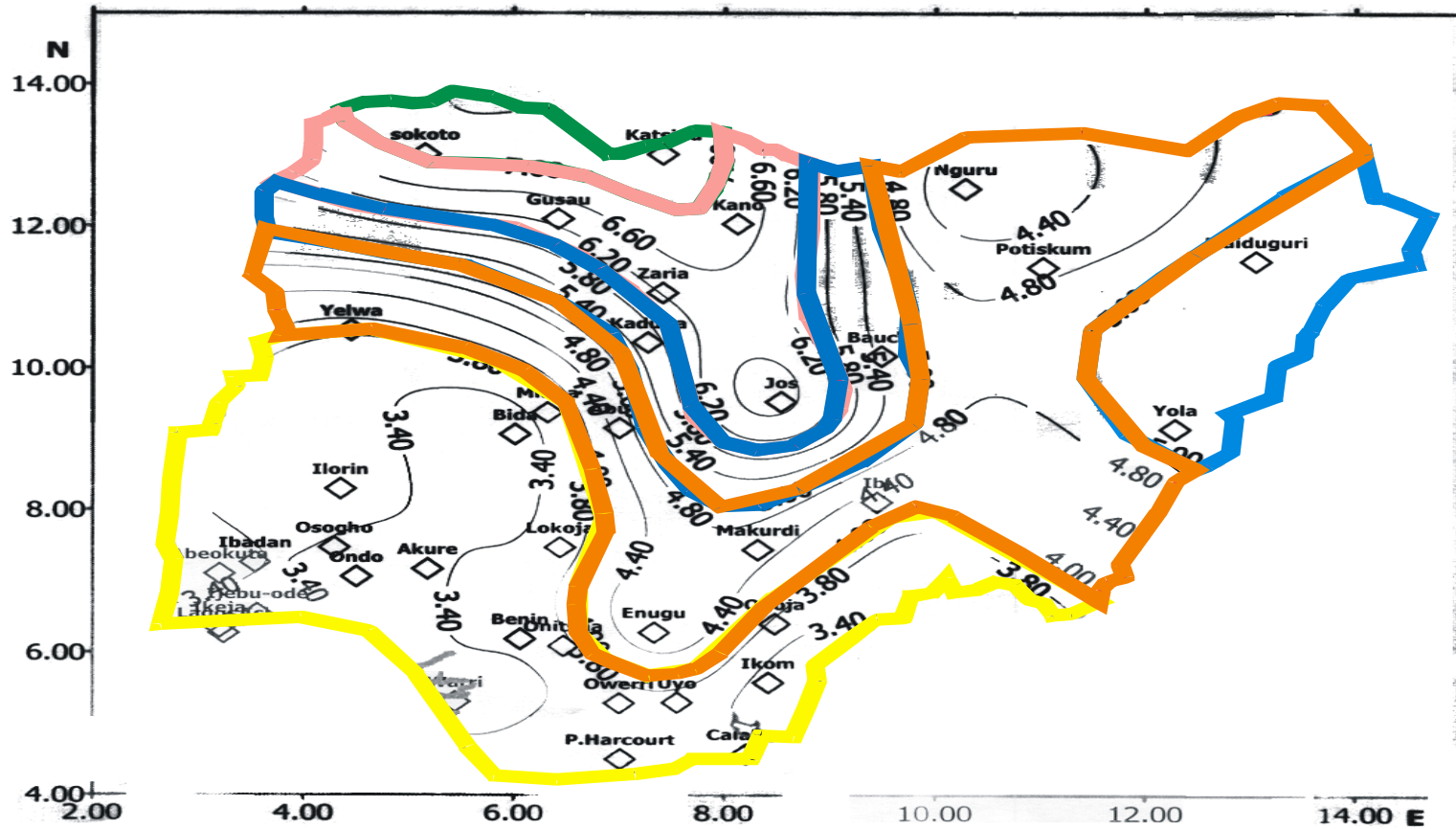



Figure 4 - Categorisation of the Prevailing Wind Isopleths

Figure 1: Basic Wind Isopleths of Nigeria. (NCC, 2009: Onundi, 2009).



6.0 CONCLUSION

The conclusion from this presentation is simple.

- There is the need to move along with the current development in the world around us.
- The publication of the Nigerian Annex to the Eurocodes is an urgent task.
- Our Universities have to buckle up and provide researches into issues that will be of direct benefits to the engineering design and construction practitioners and to Nigeria as a nation in order to mitigate failures and collapses of structures, while modernizing and beautifying the environment. 

FURTHER READING

- Eurocode: Basis of Structural Design
- Eurocode 1: Actions on Structures
- Eurocode 2: Design of Concrete Structures
- Eurocode 3: Design of Steel Structures
- Simplified Reinforced Concrete Design by Victor O. Oyenuka, 3rd Edition, 2019, Vasons Concept Consultants Ltd., Lagos.
- Eurocodes are available at BSI Group Headquarters, 389 Chiswick High Road, London, W4 4AL, UK. Tel: +44 (0) 208996 9001 and +44 (0) 208996 7001.

**THANK YOU FOR
YOUR ATTENTION**

