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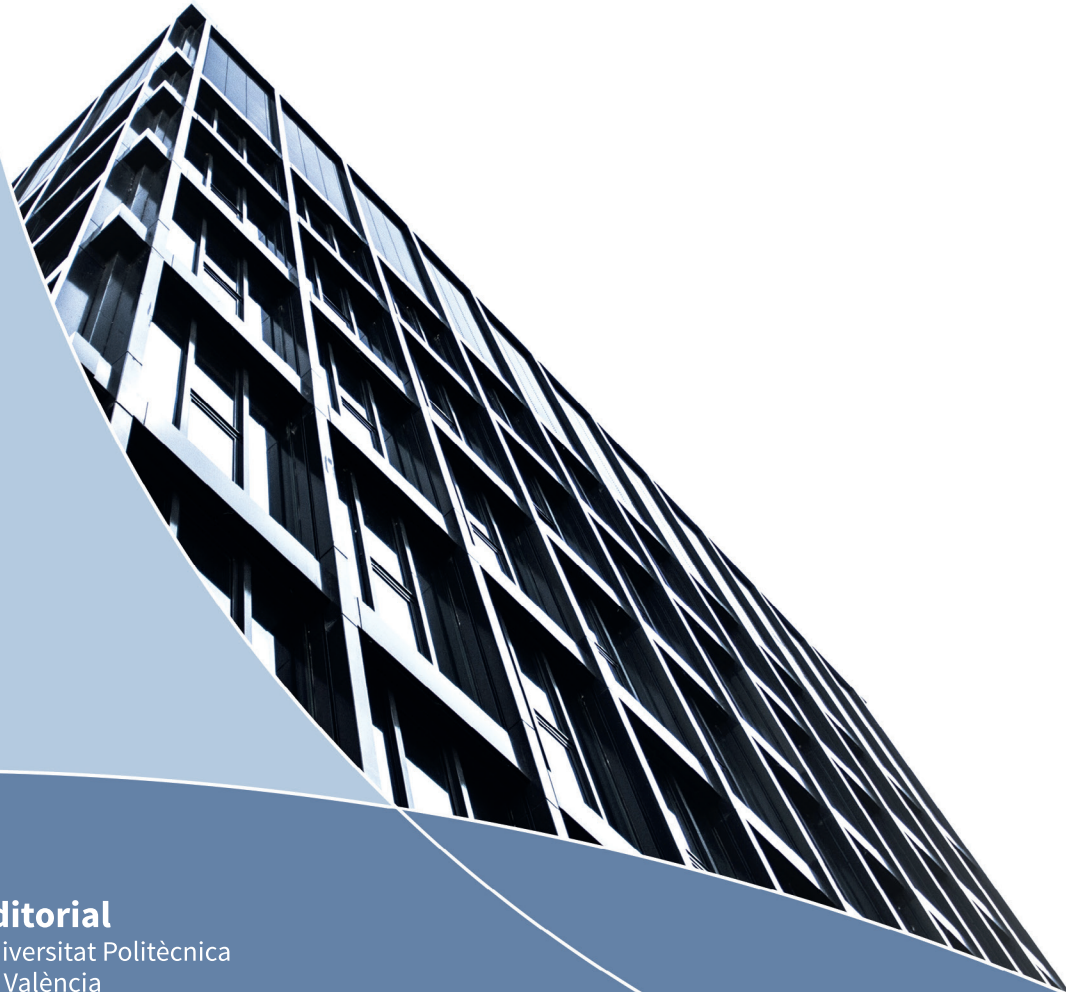
Basis of structural design of buildings

According to CTE DB E, CTE DB SE-AE and NCSE-02

Luisa Basset-Salom
Arianna Guardiola-Víllora



Editorial
Universitat Politècnica
de València

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Arianna Guardiola-Víllora

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Preface

The basic objective in structural design is that the designed and constructed structure is capable, during its intended life, of supporting safely the acting loads, keeping the integrity, without breaking or becoming unserviceable due to excessive deformations, with appropriate degrees of reliability and in an economical way.

The structural design of any structure is a process by which the response of a structure to specified actions is determined. This process involves establishing all relevant design situations; defining the actions (permanent, imposed, snow, wind and seismic actions) to be considered and the appropriate structural models; performing a structural analysis with adequate calculation methods and verifying the accomplishment of the limit states under consideration.

It is necessary for a structural designer to become familiar with basic structural requirements or recommendations regarding correct practice, specified in the national building regulations.

The Basic Document Structural Safety of the Technical Building Code (CTE DB SE) provides comprehensive information and guidance on the principles and requirements for safety and serviceability, giving the partial safety factors for actions and combinations of actions for the verification of both ultimate and serviceability limit states,

The Basic Document Structural Safety Actions on Buildings of the Technical Building Code (CTE DB SE-AE gives the characteristic values of actions (self-weight, imposed loads, snow loads and wind actions) to prove compliance of the structural safety requirements (load bearing capacity and stability) and serviceability requirements established in CTE DB-SE.

Finally, the Code for Seismic Design of buildings (NCSE-02) provides criteria for the design and construction of buildings subjected to earthquake ground motions, establishing the seismic information and the technical conditions to be met by structural and non-structural elements to avoid serious consequences for the safety of

people and economic losses and to improve the capability of essential facilities to function during and after design earthquakes.

This book, intended for students of Architecture or structural engineering, addresses the basis of structural design according to procedures and provisions set in CTE DB-SE, CTE DB SE-AE and NCSE-02. The writing was undertaken with two primary goals in mind:

1. to explain the provisions and requirements specified in these Standards related to structural safety and serviceability, limit state analysis, actions on buildings and earthquake resistant design
2. to provide the student with a collection of practical examples to illustrate key points and to clarify the implementation of these Standards to the structural design of buildings.

The book is organised in different chapters, each of them focusing on one of these three Standards including all tables and mathematical expressions needed to follow every step of the process. These documents can be downloaded, in Spanish, from the website: https://www.codigotecnico.org/ and https://www.fomento.gob.es/MFOM.CP.Web/listapublicaciones.aspx?c=Normativa+t%c3%a9cnica

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Chapter 1
The Spanish Building Codes

1. INTRODUCTION

In November 1999 a new Building Act, named LOE[1] was approved in the Spanish Parliament establishing a new building regulatory system taking into account the performance-based approach[2] adopted by the EU directive 5/5/1985.

The Act sets in terms of objectives the "Basic Building Requirements" on functionality, safety and habitability, which includes requirements on accessibility, structural and fire safety, safety in use, hygiene, health and environment protection, protection against noise and energy and thermal insulation.

These general objectives were developed by the Government in the Spanish Technical Building Code, known as CTE[3].

[1] LOE stands for Ley de Ordenación de la Edificación, Building Act 38/1999 of 5th November

[2] Performance-Based Building Design is an approach to the design of buildings, where constructions are required to meet certain performance requirements, without a specific prescribed method by which to attain these requirements. This contrasts with traditional prescribed building codes, which mandate specific construction practices,

[3] CTE stands for Código Técnico de la Edificación

The design requirements of a structure are the following:

- Structural resistance (strength): A structure shall be designed and executed in such a way that, during its intended life, with appropriate degrees of reliability and in an economical way, it will be safe for people and contents, sustaining all actions and influences likely to occur during its execution and use.
- Serviceability: A structure shall be designed and executed in such a way that, during its intended life, with appropriate degrees of reliability and in an economical way, it will remain fit for the use for which it is required. This requirement implies that deformations, deflections and vibrations shall be admissible
- Durability: The durability of a structure is its ability to remain fit for use after an extended period of time and use. Structures should be designed in such a way that no significant deterioration is likely to occur, resisting environmental influences along its design working life.
- Fire resistance: The effects of fire in structures can be large deformations and reduction of strength and stiffness. In the case of fire, the load-bearing capacity and the structural integrity should be ensured for a defined period of time in order to permit the evacuation of occupants, afford appropriate protection to fire-fighting services and protect the building and the adjoining property from fire spread. The "required period of time" depends on the use and dimensions of the building.
- Robustness: A structure shall be designed and executed in such a way that it will not be damaged by events such explosions, impacts, and the consequences of human errors, to a disproportionate extent to the original cause.

2. THE SPANISH TECHNICAL BUILDING CODE

The performance-based Technical Building Code CTE was published in the Official State Gazette 28/03/2006, being the framework that establishes the safety and habitability requirements of buildings set out in the Building Act (LOE).

This code is arranged in two parts:

The first part includes, according to the Building Act LOE, all the mandatory requirements regarding safety and habitability when constructing a building, whereas the second part consists of a set of different Basic Documents (DB) needed to fulfil the former requirements.

The first part is subdivided into several sections, each one referring to the different areas that must be regulated. In the field of security, provisions related to structural safety, safety in case of fire and safety in use can be found, whereas, the area of habita-

bility includes the requirements related to hygiene, health and environment, protection against noise and energy efficiency.

The Basic Documents of the second part are texts of technical nature, including each of them the methods of verification or compliance and the acceptable solutions: the "official methods of fulfilment" the performance or functional requirements detailed in the first part of the CTE.

However, these documents do not exclude the use of other ways of compliance. In fact, the project designer or architect may, under his/her responsibility, opt for alternative solutions, provided that the building met the basic requirements of the CTE so that its benefits are at least equivalent to those that would be obtained by the application of the procedures specified in the DB.

The Basic Documents are the following:

- DB SE Structural Safety

  This document constitutes the basis. For its correct application the following five documents are also necessary:
  - DB SE-AE Actions on buildings
  - DB SE-C Foundations
  - DB SE-A Steel Structures
  - DB SE-F Masonry Structures
  - DB SE-M Timber Structures

- DB SI Safety in case of fire,
- DB SU Safety in use
- DB HS Habitability Requirements (hygiene, health and environment)
- DB HR Protection against noise
- DB HE Energy efficiency

The pyramid scheme of the CTE is shown in Figure 1.1. At its base, a series of official complementary documents (but not statutory) such as commented DB, support documents, technical specifications or recognised documents, among others, help to understand and put into practice the DB.

The recognised documents are non-statutory technical texts approved by the Ministry of Development (formerly Ministry of Public works and transport), which periodically updates the General Registry of the Technical Building Code in which they are listed.

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