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## THE INSERTION OF THE EUROCODES INTO THE NATIONAL CONTEXTS:

### temporary assessment of the ENVs insertion and perspectives on the ENs insertion

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#### SUMMARY

The aim of this paper is to give an assessment of the insertion of the first ENV Eurocodes into the national contexts and to suggest what their insertion might be in the next stage, once the ENV are converted into ENs. The word *insertion* encompasses all the actions aiming at transposing the Eurocodes into a national standard that is widely *applied* to the verification of structural designs and used as a *reference* in the public or private documents dealing with the design rules.

The problems raised by the insertion show how complex the subject is. What is at stake in a good integration of the European standard is assessed (see 1).

The statutory measures provided for by the CEN in order to insert the European standards and the dispensations from these measures that may be applicable to the Eurocodes, given their special statute within the European normalisation, are recalled (see 2).

The additional measures taken to insert the Eurocodes as ENV are detailed. A provisional assessment of the insertion of the first ENV Eurocodes is given (see 3).

The application of the Eurocodes to the verification of designs is most often prescribed by bodies that are separate from those that apply them (i.e. national authorities, insurance companies, clients). Drawing a lesson from the experimentation of the insertion of the first ENVs, a strategy of insertion, focussing on the satisfaction of the bodies that usually prescribe the application of the structural design rules at the national levels, is recommended. The aim is to introduce *basic adaptations* into the EN so that the documents usually referring to the national rules for structural design may refer to the national standards transposing the Eurocodes. The object of the basic adaptations should be to make the national standard transposing the EN compatible with the safety and/or quality policies adopted at the national level. The basic adaptations should be introduced either into the EN, as *particular national conditions*, unless they are already in the ENV, or in the *National Application Document* (NAD) as *basic transposition measures* (see 4.1).

The basic adaptations are identified and the theoretical elements used to make them are detailed (see 4.2).

An outline is given of a possible way of reaching the major aim of the insertion : to make possible the reference to the Eurocodes both in the national structural design rules and in the construction works contracts (see 5).

Finally, the provisions for the transposition of the EN Eurocodes that are recommended would consist in taking up the adopted measures for the transposition of the ENVs while complementing them :

- the principle of the NAD would be kept
- the numerical values with an unreliable calibration only would be boxed
- guidelines, appended to the CEN Foreword, entitled "Basis of transposition" would make practical recommendations on how to make the basic adaptations that are not already integrated as particular national conditions
- the theoretical elements necessary to implement the basic adaptations should be detailed into Basis of Design (sections 1 and 2) unless they are there already.

## **1. The problems of the insertion and the issues at stake**

### **1.1. The scope of the insertion**

The insertion of the Eurocodes into the national contexts covers all the measures that are supposed to be taken in order to transpose the European standard into a national standard, ensuring a high level of use of the national standard and allowing the withdrawal of the competing rules in the future. The term *use* encompasses the *application* of the national standards to the verification of structural designs together with the *reference* to the national standard within the documents that usually deals with structural design rules.

### **1.2. The problems of the insertion**

The insertion of the Eurocodes raises problems that are at the interface of structural reliability theories, practices of design verification, construction works safety policies, construction works economy, quality policies adopted by the intervening parties.

The multiple aspects to be taken into account makes it a difficult issue. This state of things is accounted for by the fact that the rules are markedly regulatory and that, under the requirements of EU policy national prescriptions and insurance companies, the public clients especially public ones, credit these rules with a contractual nature.

Note : See Directive 93-37/CEE, article II, 10.

For any party intervening in the construction, the insertion of Eurocodes entails issues at stake. This is due to the fact that the insertion process implies the observance of implicit levels of accepted risks. Indeed such levels result from compromises, that have been

reached previously, between the wish for the greatest possible safety and the efforts to be made by the intervening parties to meet needs that undisputedly have priority.

To make the insertion easy and efficient, one must deal with border relations between European and national authorities in a field where states and contracting bodies have strong and infinitely variable prerogatives.

Last, the great variety of the insertion contexts at the institutional, professional and economic levels adds to the difficulties.

### **1.3. What is at stake**

The very quality of the insertion will greatly influence the issue of the Eurocodes and the possibility to withdraw the competing rules. In several Member States, particularly where the rules of structural design have the status of a law, regulation or contractual specification, the level and quality of the insertion should be an essential element of success, at least as important as the scientific and technical values of the EN or its user-friendliness.

## **2. The statutory provisions for the insertion**

The statutory provisions for the insertion of the Eurocodes include general provisions appearing in the "Common rules for standards works" of CEN/CENELEC on the one hand, exceptional or derogatory measures stated into the "Agreement between the Commission and the CEN concerning the works on the Eurocodes" on the other hand.

### **2.1. The provisions of the CEN rules**

They are precisely defined. They deal with the introduction of *particular national conditions* and *national deviations* and with the withdrawal of national standards that are equivalent to the EN.

#### *2.1.1. National particular conditions*

National particular conditions may appear within the course of the standard or in annexes. They must refer to technical realities and not to the concerned country.

#### *2.1.2. National deviations*

In case modifications or exceptions to the EN cannot be taken into account by the means of particular national conditions, national deviations may be introduced into the national standard transposing the EN. A distinction have to be made between national deviations of type A and type B depending on whether they are related to regulatory or technical matters. Although national deviations are not part of the EN, the CEN is careful to control their introduction by the means of authorisation procedures and acceptability criteria.

### *2.1.3. The withdrawal of equivalent national standards*

The date of the withdrawal of national standards that are equivalent to the CEN (DOW) is stated by the Technical Board (CEN/BT). The duration of coexistence of both standards has to be no longer than six months. The CEN/BT may allow the prolongation of the withdrawal date.

## **2.2. The provisions of the "Commission/CEN Agreement"**

The CEN rules have been stated in order to develop product standards. So derogatory measures have been introduced into the Agreement between the Commission and the CEN concerning the works on the Eurocodes to take into account the specificities of the structural design rules. They concern the stages of development of the Eurocodes, the conditions of withdrawal of the equivalent national "rules" (and not only equivalent national "standards").

### *2.2.1. The stages of development of the Eurocodes*

The Eurocodes are to be developed in two stages as European pre-standard (or ENV) then as European standard (EN). The ENV period of two years is used to experiment the Eurocodes or make practical applications of them.

### *2.2.2. The withdrawal of equivalent national rules*

The transformation of an ENV into EN and its adoption by the CEN will not automatically lead to the withdrawal of the national rules already existing in the fields concerned. The time limits for the coexistence of Eurocode-standards or parts of them with the corresponding national standards will be determined in each case in common agreement between the Commission, the Member States and the CEN.

## **3. The insertion of the Eurocodes as ENVs**

### **3.1. The provisions for the insertion of the Eurocodes as ENVs**

The provisions taken for the insertion of the Eurocodes as ENVs include the statutory provisions (see section 2) and particular provisions for the ENV stages : the appending of a National Application Document (NAD) to the ENV, the boxing of numerical values, the distinction between Principles and Application Rules and the possibility to introduce alternate Application Rules.

#### *3.1.1. The alternate Application Rules*

In the clauses of the Eurocodes, the Principles are distinguished from of the Application Rules. There may be an alternative to an Application Rule provided that it is shown that the alternative rule accords with the relevant Principles and has at least the same reliability.

### *3.1.2. The boxed values*

The numerical values that are supposed to be related to safety elements are boxed.

### *3.1.3. The NAD*

The transposition of an ENV into an experimental national standard consists in including a National Application Document to the translation of the ENV. The scope of the NAD is threefold :

- to adapt the boxed values eventually.
- to refer to the accompanying compatible national standards and detail the conditions of application of the temporary reference standards
- to define the national directives for the application of the ENV.

## **3.2. Provisional assessment of the insertion**

### *3.2.1. Transposition*

The provisions described in 3.1 have made possible the transposition of the Eurocodes in the Member States whose legal structures and administrative organisation did not obstruct it or did not take most of its impact away from the experimentation.

It results from the assessment of the transposition of the first set of Eurocodes (i.e. ENV 1991-1 - Basis of Design and parts 1-1 of the ENV 1992 to 8) that these measures have proved pertinent on the whole. Yet they have proved insufficient and hardly convenient on some points :

- one cannot easily adapt the levels of requirement for safety in case the safety policy of the national authorities or the client are a part of a quality policy.

Note : In Norway, the national design rules take into account the levels of design supervision, and the level of execution control.

- the same goes in case safety and economic requirements are competing.

Note : See economic impacts of the detailings for concrete building specified within the ENV 1992-Part 1.1.

- the declared scope of the boxed values is to focus the bodies in charge of the transpositions on the reliability elements ; in fact this provision is ambiguous since numerical values with an uncertain or controversial calibration are boxed.

Note : See properties of particulate material ENV 1991-4 - Table 7.1.

- moreover the provision leads to believe that the adaptation of the levels of requirements for safety can be made in modifying numerical values only (see 4.2.2).

Note : The requirements for the prevention of hazards due to human activities along the construction process or in the course of the working life of the construction works are represented in the Eurocodes as Assumptions.

- besides, the choice of the boxed values may prove arbitrary or insufficiently detailed (e.g. detailings).

However all technical imperfections have been got round ultimately.

### *3.2.2. Experimentation*

The experimentation of the Eurocodes takes various forms :

- general studies (e.g. calibration of safety elements, impact of the application of the European rules on the cost of construction works)
- comparisons (e.g. dimensioning of an existing structure by the means of the Eurocodes alone or associated to the NAD)
- proposals of the application of the Eurocodes for international projects outside the European area
- application of the Eurocodes to the justification of designs of new construction works in the European area
- insertion of an Eurocode or parts of it into the corpus of the national design rules in case gaps have to be filled or outdated rules have to be updated.

The attempts to apply the Eurocodes to the justification of new construction works design have seldom been successful. The obstacles that could not be overcome were invariably due to the reluctance of bodies that refer to the structural design rules (clients fearing an increase in construction costs or insurance companies unable to stand back for lack of experience).

## **4. Perspectives on the insertion of the Eurocodes as ENs**

What is at stake (see 1.3) justifies that provisions should be taken by the CEN to make the insertion of the Eurocodes as EN possible and efficient the insertion. These provisions should aim at explicit objectives and take part in a strategy.

### **4.1. The strategy of insertion**

#### *4.1.1. Objective of the insertion*

The objective should be to maximise the level of effective applications of the national standard transposing the Eurocodes in comparison with the potential applications.

#### *4.1.2. The way and means of the insertion*

The way used to reach the objective should be indirect. One should manage to make it possible to refer to the national standards transposing the Eurocodes in the documents

usually prescribing the application of the national design rules (i.e. regulations on structural safety, insurance policies, technical specifications of contracts).

Three means should be considered :

- the introduction of the concept of *basic adaptation* measures
- the introduction into the EN of particular national conditions implementing basic adaptations
- the development within the EN of the theoretical elements likely to facilitate the implementation of the basic adaptations at the transposition stage.

#### 4.1.3. The basic adaptations

The bodies that prescribe the application of structural design rules are a specific population (regulatory authorities, clients, insurance companies, technical controllers) quite distinct from the bodies that apply them (designers, manufacturers of structural elements, contractors). The concern of these prescribers is to implement the technical aspects of a safety policy of construction works (e.g. regulatory authorities, insurance companies) or a quality policy where reliability is considered as one aspect of quality (clients).

The basic condition set for the acceptance of design structural rules is the compatibility of the rules with the safety and/or quality policies adopted by these bodies.

Note : The scope of the ECs is :

- to translate objectives of an implicit safety policy in terms of requirements for safety
- to specify the formal rules (i.e. Principles and Applications Rules) and the associated conditions to be fulfilled (i.e. Assumptions) to assess the conformity of a structural design to specified requirements for safety.

The scope of construction works safety (resp. quality) policies is :

- to identify the risks of structural failures (resp. of non-quality) and to define the levels of admitted risks (resp. to state the quality of the construction works)
- to translate the admitted risks (resp. stated quality) in terms of requirements for safety (resp. for quality)
- to specify the requirements calling for an attestation of conformity.

It results from the parallel that a national standard transposing the ECs may be made compatible with a safety/quality policy provided that :

- i) - the requirements for safety that are considered in the ECs correspond to the objectives, or the requirements, of the safety (resp. quality) policy,
- ii) - the legal, regulatory, and contractual conditions be taken into account.

Transposing the Eurocodes into a national standard that should meet the compatibility requirements above mentioned implies that the following *basic adaptations* should be made to the EN :

- a) adjusting the level of the requirements for safety that are considered within the EN



- b) differentiating the levels of the requirements for safety
- c) compensating the levels of the requirements related to interchangeable safety measures
- d) detailing the "Assumptions" whose content is vague and adding other legal, regulatory or contractual conditions.

## 4.2. Basis of transposition

### 4.2.1. Implementation of the basic adaptations

The National Application Document (NAD) should be maintained.

The basic adaptations (see 4.1.3 a) to d)) should be implemented into the NAD unless they are already integrated into the NE, as particular national conditions, at the ENV level or during the conversion of the ENV into EN.

Note : See an example of particular national conditions relating to the differentiation of a level of requirement for safety : ENV 1998-1.2 - 3.7 Importance factor.

See an example of particular national conditions relating to a compensation between levels of requirements for interchangeable safety measures : ENV 1996-1.1 - 2.3.3.2 Partial safety factors for materials.

The theoretical elements necessary to implement the basic adaptations would be introduced into the format of the Eurocodes unless they are already there (i.e. 1991-1 Basis of Design - Sections 1 and 2).

Note : In the detailed review of the basic adaptations (see 4.2.2 to 4.2.5) the words in italic correspond to the new theoretical elements that, in our view, should be introduced in Basis of Design.

A guidelines, entitled "Basis of transposition" and appended to the CEN foreword of the Eurocodes should make recommendations on how to implement the basic adaptations into the NAD thanks to theoretical elements.

### 4.2.2. The adaptation of the levels of requirements for safety

The *risk analysis* inherent in the format of the Eurocodes implies the reference to several *categories of requirements for safety*. The *safety elements* that determine the levels of the requirements for safety are specific for every category of requirement. They are represented most often by numerical values. But in case of *requirements for the prevention of hazards* they are Assumptions and in case of *requirements against the effects of hazards* they are variables.

Note : For example :

- the requirements for the prevention of errors or imprecisions of execution are usually represented by an Assumption
- the requirements for the characteristics of the fire protection materials are represented by variables.

To make the adaptation of the levels of requirements for safety possible, one must be able to modify any safety element of any category of requirement for safety.

#### *4.2.3. Differentiation of the levels of requirements for safety*

The differentiation of levels of requirements for safety leads generally to introduce a *level of requirement classification*. Most often, the classification is the result of the application (in the sense of the Sets theory) of a *criteria classification* to a *safety element classification*.

Note : Examples of safety elements classifications :

- design fire time  $t_f$
- importance factor  $\gamma_I$  introduced in ENV 1998-1.1.

The criteria classifications may relate to :

- the risk level
- the level of management measures that are assumed to be taken to prevent hazards due to human activities during the construction stage or the use of the construction.

Note : For example : supervision of design, control of execution, control of use, procedures of maintenance.

The safety elements classifications are normative, whereas criteria classification are given as a rough guide. The definition of the latter is within the competency either national authorities (in case they have a regulatory character) or the clients. They are supposed to be specified either in the transposed national standard, or in the technical specifications of contracts.

#### *4.2.4. Compensation between levels of requirements for interchangeable safety measures*

The safety measures aiming to prevent hazards, protect the structure against the effects of hazards and reinforce the design characteristics are interchangeable. The specified requirements for these categories of measures lend themselves to operations of compensation for a given level of admitted risk.

The mechanism of compensation is used to implement a safety strategy or also to take the quality policies of the intervening parties into account.

The mechanism implies that one may assess and testify the conformity of the design to the various categories of specified requirements for safety, whether those requirements are related to measures that come before or after the design verification.

Note : The  $\gamma_M$  values to be taken into account in the verification of masonry structure give a representative example of compensation between requirements for the execution control, for the materials control and the design dimensioning (see ENV 1996-1.1 - Table 2.3).

#### 4.2.5. The introduction of particular conditions

The Application Rules of the Eurocodes are conditional. As the conditions that are taken into account in the Eurocodes correspond generally to those that are ordinarily fulfilled in Europe, they may remain implicit. Only the conditions to which the verification rules are sensible are explicated in the standard as Assumptions.

A design verified by the means of the Eurocodes shall comply with the specified requirements for safety provided that the Principles are observed, the Application Rules are verified and the Assumptions are fulfilled.

If, for geographical, institutional, economical contractual reasons, a condition differs fairly from the corresponding condition implicitly or explicitly considered in the Eurocodes, the conditions have to be changed explicitly and the rules must be modified. One may sometimes have to consider an alternate rule.

Note : See the alternate rule for snow load shape coefficients for specific climatic regions - ENV 1991 - 2.3 Annex B).

The device consisting in differentiating numerical values of the safety elements may avoid such complications.

Note : The obstacles raised to the access of any part of the structure modify the *conditions of survey* of the structure. In the Eurocodes, this change of conditions is translated in terms of increased *design working life*.

A reinforcement of the traffic regulation on a road (or a river), that modifies the usual *conditions of circulation* on a bridge (or on a river), may lead to reduce *the characteristic value* of the traffic loads (or traffic impacts).

### 5. The reference to the Eurocodes in national rules and contracts

In table 1 the adaptations to be brought in the EN to transpose the Eurocodes into a national standard that specifies the national structural design rules are detailed.

In table 2 are detailed the adaptations to be brought in the national standard transposing the Eurocodes, to specify the structural design rules to be taken into account in a contract.

Figure 1 draws a diagram of the mechanism that makes the reference to the Eurocodes in the contracts possible.

*Table 1 - Specifying the national structural design rules by referring to the Eurocodes: the adaptations to be made to the EN, that the national structural design rules are supposed to refer to*

- a) To adapt or differentiate the levels of requirements for safety and to make possible the compensation of the levels of requirements for interchangeable safety measures (see 4.2.2 to 4.2.4)
- b) To adapt or complete the Assumptions in order to take into account the climatic, institutional, economical, etc... conditions that differ significantly from the corresponding conditions explicitly or implicitly considered in the Eurocodes (see 4.2.5)
- c) To detail the requirements for safety that are held to be "fundamental" (see ENV 1991-1, 2.1) at the national level but nevertheless are not considered in the Eurocodes. To specify the corresponding verification rules to be referred to.

*Table 2 - Specifying the structural design rules, in a contract, thanks to the reference to the Eurocodes : the adaptations to be made in the national structural design rules that are supposed to refer to the Eurocodes*

- a) To detail the alternate Application Rules (see 3.1.2)
- b) To detail the additional conditions to be fulfilled for the design to comply with the project specifications
- c) To detail the requirements for safety that are specified in addition to the "fundamental" requirements (e.g. additional serviceability requirements). To specify the corresponding verification rules to be referred to.

*Fig 1 : The specification of national and contractual structural design rules by reference to the Eurocodes.*

