TAKING ACCOUNT OF RISKS IN EUROPEAN PUBLIC CLIENTS' ROAD-INFRASTRUCTURE CHOICES

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SUMMARY

The logic behind European regulations may be summed up in two words: requirements and performance. Europe showed its determination in this domain as early as 1976, when it released a guide for clients and project managers. The six key requirements introduced encompassed the obligation for clients to take decisions only after giving due consideration to the notions of risk and sustainable development, and after evaluating the socio-economic and legal ramifications of the nature of the order. Standardisation is shifting from description to performance, with choices made on the basis of results rather than means. The opening up of the European market and the application of the principle of identical performance for all Member States have led to the use of a common, representative, coherent technical frame of reference known as "the Eurocodes", which constitutes the most commonly-used, up-to-date set of operational and scientific technical rules in Europe. The Eurocodes form the basis for the presumption that CE marking constitutes proof of a structure's quality. However, the Eurocodes are more than mere rules – they are a rich source of enforceable information for use in approving construction programmes. In this article, we look mainly at Eurocodes components that relate to risks and are of interest to clients.

1. INTRODUCTION

The rather concise first part provides a reminder of the general legal framework and the obligations of clients in France. It sets out the key project-development stages during which the client must make choices. Does the client need to enlist the services of a project manager or an assistant? Over and above legal considerations, should the work of the innovators be highlighted? This part, therefore, provides pointers as to the procedures for taking account of risk-related options and to the related organisational and technical ramifications.

The second part centres on the Eurocodes, which constitute the most recent development in the area of civil-engineering standards, analysing the texts so as to ensure that the six key requirements of the directives are met. How do these texts interrelate? There is clearly no need to explain the content of the Eurocodes, which have been drawn up by Europe's most competent experts – the aim is to outline the spirit of these rules and, in particular, to describe their impact on pre-project choices. This second part is, itself, divided into two sections, which deal, respectively, with:

- risks related to specific actions (fire, impact, explosions, etc.);
- risks related specifically to dynamic ground-structure interaction (due to earthquakes).

Lastly, a non-exhaustive summary table shows some key ideas that make it easier to take account of risks in clients' road-infrastructure choices.

2. "A CERTAIN IDEA OF EUROPE"

2.1. The six key requirements

In concrete terms, it was the European Construction Products directive that launched the single market for civil engineering in 1989. By requiring CE marking on products designed for use in structures, the EU Member States ensured that those structures would comply with the six so-called "basic requirements", which concern the mechanical resistance and stability of structures; safety in the event of fire; hygiene, health and the environment; safety of use; noise protection; and energy savings.

As well as manufacturers and distributors, the civil-engineering players involved include project managers and contractors. Clients may no longer allow the use of non-CE-marked products on their structures, far less demand without justification that such products form part of specifications.

2.2. French adaptation of the directives

In 1992 and 1993, the European services and work directives were transposed into the various successive versions of the French procurement contract code. The 2006 version of this code contains a French adaptation of unified directives nos. 2004/17/CE and 2004/18/CE. In order to avoid unfair competition, the technical specifications imposed by the contracting authorities during consultation must comply with the common rules.

In France, the so-called "MOP" law defines the role of the client in respect of the construction or rehabilitation of structures. It also defines the organisation, the minimum content allowed for each mission component and the conditions for the drafting of the project-management contract. Article 2 of the first section of this law focuses particularly on the client's obligations. The client must define a programme and a provisional budget before commencing the preliminary studies.

2.3. The responsibilities of the client in France

The client is a legal entity whose missions are generally conducted by a group known collectively as "the project owner", whose responsibilities are borne individually by the designated representatives.

As well as its responsibility for quality and communication – which we will not go into here – the client is, in particular, responsible for safety throughout the life of the structure, i.e. from programming to construction and, thereafter, for the duration of the structure's useful life. During the construction phase, the company does, of course, have responsibility, but so does the client. The latter's responsibility may be exercised through an outside project manager within the framework of a specific contract. The client's responsibility is defined on the basis of how its technical and legal expertise compares to that of the other construction players.

In accordance with law no. 93-1418 of 31 December 1993, the client defines the coordinator's contract and monitors its execution as regards health and safety during the design and implementation phases. During the design phase, the results of the coordinator's studies must be available for the preliminary studies, in accordance with point 2 of appendix III of the order of 21 December 1993, which specifies the technical execution procedures for the project-ownership components entrusted to private contractors by public clients (*Journal officiel*, 13 December 1993).

The client must approve a general coordination plan or PGC *(Plan Général de Coordination)* for health and safety during the design phase. This document is attached to the contractor consultation file. It must also ensure that this plan is complied with during implementation. This mission extends to actions performed after the structure goes into use, the aim being to ensure that operations, surveillance and maintenance of the structure can be performed in accordance with safety rules.

When the structure is operational, the client is concerned by risks, both natural and technological (storms, flooding, fire, impact, etc.), which have been taken into account during the design phase on the basis of the programme data. Contrary to what used to be the practice in France, there are no plans for the choice of these parameters to be determined in the new European civil-engineering rules. At national level, regulations are currently limited to seismic and fire risk. The choice of these parameters is therefore a matter for the client, and cannot be delegated to the project manager.

The client must also look after the safety of users, residents and maintenance workers. In the case of bridges, it is, in particular, important to consider the safety of the roads or other infrastructure crossed. SNCF (the French national rail company) has drawn up a framework safety notice for railway lines, which is to be integrated into the implementation programmes of neighbouring structures. This principle could also be useful for roads with heavy traffic.

To sum up, the client's responsibilities therefore concern three areas – safety, quality and communication. The importance already attached to these parameters in France is taken even further in the European context, essentially for two reasons:

- Europe gives contracts preference over fragmentary legal regulation and/or CCTG guides, the concept of project management being a French exception;
- societal change and a strong desire for social democracy, which increase the probability of clients being sued for negligence.

3. TAKING ACCOUNT OF RISKS IN CLIENTS' CHOICES

3.1. A new European technical frame of reference

The creation of the single market would not have been possible without the establishment of a single base of standards and/or rules concerning structural resistance. This is the objective of the Eurocodes, which are European standards governing the calculations used in the design of civil-engineering structures and buildings. The first European directive concerning public work contracts (no. 71/305/CEE dated 26 July 1971) paved the way for the Eurocodes. The stated aim was to allow the European market to be opened up to all contractors and engineering firms in Community Member States. The principle of mutual recognition forbade public clients from refusing a proposal merely because it was based on another member State's regulations. Getting around this problem required a common, representative, coherent frame of reference that would take an unbiased approach to the construction sectors (materials and products) and, if possible, be based on the most recent knowledge.

3.2. Requirements and performance – the basis of the Eurocodes

The two watchwords for European regulations in the area of civil engineering are "requirements" and "performance". Europe showed its determination in this domain as early as 1976, when it released a guide for clients and project managers. The six key requirements already mentioned meant that public clients had to focus in particular on the risks engendered by the planned structures and on the need to protect people and the environment (water, air, fauna, etc.). Interpretative documents were produced by the Commission on the advice of the Standing Committee. These were published in the OJEC on 28 February 1994 under the reference 94/C 62/01.

The Eurocodes encompass a set of 58 European standards describing the calculation methods for use in verifying the stability and design of structures. They enable:

- people to speak the same language when dealing with engineering and work contracts;
- links to be established between the structure and the set of products that comprise it, based on the CE marking of those products;
- verification of project compliance with stability, mechanical-strength and fire-safety requirements.

The Eurocodes concern only new structures, and are not suitable for use with repair studies. In concrete terms, the European texts are accompanied by national appendices allowing minor modifications to the design parameters at the discretion of Member States, so that specific cultural, climatic or geographic characteristics can be taken into account.

The Eurocodes, which were introduced as voluntary standards, will become essential in Europe for three key reasons:

- a public client cannot refuse an offer comprising a solution designed on the basis of the Eurocodes, even if the order is drafted on the basis of local regulations,
- school courses now focus solely on the Eurocodes,
- the old regulations are no longer being updated, and cannot therefore be used for innovative solutions.

3.3. The Eurocodes – *written* for the clients

It should be remembered that the Eurocodes are more scientifically coherent and more homogeneously drafted than certain older regulations. Furthermore, they are open, which means that they allow design to be performed in conjunction with experimentation so that new loads can be defined or innovative materials used. When seeking to prove the quality of a structure's design and the consistency of its components with the CE-marking requirements, it is important to start from the scientific and operational basis of the Eurocodes.

Having said that, the Eurocodes to not do away with the client's decision-making role. They do not, for example, set out risk hypotheses, but simply provide the methods required for risks to be taken into account during the design phase. In other words, the Eurocodes do not allow clients to rely entirely on the experts. This means that, in the

Eurocodes, it is sometimes difficult to distinguish those parts that deal with calculation *per se* (which are extremely technical and aimed essentially at specialists) from those parts that primarily comprise text charged with meaning for the client and are drafted in the spirit of the directives and the essential requirements.

To see this, one need merely “review” the Eurocode articles concerning “Project ownership”. We will limit this exercise by looking at just two types of risk:

- risks relating to a particular action:
  - EN 1990: Basis of structural design;
  - EN 1991-1-2: Structures exposed to fire;
  - EN 1991-1-7: Accidental actions due to impacts or explosions;
- risks relating specifically to dynamic ground-structure interaction:
  - EN 1997: geotechnical structures;
  - EN 1998: Structures in seismic zones.

3.4. Risks relating to a particular action

3.4.1. The bases of structural design

Eurocode EN 1990 entitled “Basis of structural design” could also be called "technical basis for construction programmes”. The text defines very general notions.

<u>The basic requirements</u>: section 2 of Eurocode 0 sets out fairly general requirements according to which the structure must, throughout its lifetime or period of use (including, of course, its construction), remain at a level of reliability that is compatible with its purpose and use. At this stage, therefore, structural resistance, serviceability and durability are already key notions. While they refer to specific technical chapters, these notions involve considerable responsibility on the part of the client, unlike the previous situation, where responsibility was shared between all of the construction players. The fact that a structure must be designed in such a way as to ensure a certain degree of reliability creates obligations, not only as regards the choice of materials and structural components, but also as regards the choice of the teams who are to study and implement the construction phase. This has considerable ramifications for the cost of the operation.

It is important here to highlight the notion of “life”. The client has a structure built, and bears legal responsibility for that structure throughout its life. While this notion is not new, it is the first time that it has been given more concrete expression in the form of quantified specifications and design rules in France. This completely changes the logic of the construction act – it is “building to last”. The structure programme must therefore be coherent and provide for traceability in respect of the construction act.

Another key principle, which will be discussed later, is that which obliges the client (who is responsible for the design) to build a structure that can guarantee proportional resistance to events such as explosions, impacts of all kinds and the consequences of human errors. It is therefore necessary to perform an analysis of potential risks and to make choices accordingly (resistance, structural arrangements and checks), in order to:

- limit dangers;
- minimise the negative consequences of structural damage at a more or less local level;
- avoid unannounced collapse.

Reliability management: the project must be examined in the light of the most recent possible corpus of knowledge and good practice. Reliability levels are defined on the basis of:

- risks for tangible and intangible assets and for people;
- prevention and the economic aspects of prevention;
- the degree of public aversion to structural failure. This important societal parameter varies from country to country, and sometimes from region to region.

These levels generally concern the global or local operation of the structure during implementation or when in use. The requisite reliability may be achieved by using the appropriate protective and preventive measures or “means” (choice of safety barrier, anti-corrosive paint, etc.).

Classes of consequences are provided which take account of the consequences of structural damage or malfunction. The Eurocode classification makes it possible to differentiate reliability in terms of loss of life, of economic, social or environmental consequences and of structure type.

Duration of use of project: for a given project, the structure’s duration of use must be specified by the client, which is a new departure. This duration will be used, among other things, to define time-dependent performance parameters (the case of fatigue in metal bridges, for example). The Eurocodes provide a table showing indicative durations in years.

Durability: The performance of a given structure must remain at the expected level throughout its useful life. A structure’s durability depends on a variety of factors, which must be identified at the design stage. These include:

- the purpose of the structure;
- the qualities of the structure and of the materials;
- the environmental context, including geotechnical parameters;
- the degree of maintenance.
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All of these factors determine the structure’s behaviour over time.

The introduction of durability criteria into the regulations is also completely new. It extends the client’s responsibility beyond the duration of the structure’s construction. Lastly, the project manager must also be reminded of the need to ensure consistency in the event of requests for repair or for modifications aimed at achieving compliancy during construction.

Quality management: All requisite organisational, verification and other measures related to quality management and aimed mainly at eliminating structural failure due to elementary errors and at ensuring that resistance levels are as intended will be taken at the design stage. French standard NF EN ISO 9001 (X 50-131) of December 2000, which relates to quality-management systems, may serve as the basis for the drafting of the relevant documents.

The Eurocode provides for differentiation of project supervision involving different organisational and quality-control measures. There are three levels of supervision relating to the reliability class already mentioned and to the types of control requirements recommended – third-party control, self-supervision, etc.

Section 4 of the Eurocode raises a number of points enabling clients to make informed choices and take decisions aimed at optimising the quality of structure components. Over and above the definition of the actions (accidental or otherwise) and, of course, the level of action – e.g. classes of traffic for a bridge or road – the client must acquire the information required for a knowledge, notably, of:

- the environmental influences likely to limit the performance of the structures or of certain details;
- the properties of the materials and products. The client must, for example, organise boring (ground and rock) and/or tests (concrete) so that the properties of materials and products may be determined using statistical data. In relation to this, appendix D of Eurocode 0 covers the use of experimentation in design. It should be noted that this appendix was added in order to serve as a basis for innovative studies. The often-rigid nature of standards has been raised many times. Here, the client can apply the Eurocodes to innovative materials, provided that compliance can be demonstrated.

3.4.2. Structures exposed to fire risk

These structures are examined in Eurocode EN 1991-1-2. If fire safety is fundamental for buildings, fire resistance is just as important where bridges are concerned. Bridges do not, of course, come under the same heading as buildings open to the public. Nevertheless, many factors can lead to fire either on or under the carriageway (a road tanker getting into difficulty or plunging from the bridge, a crash, an explosion caused by a truck carrying dangerous materials, etc.). This can, in turn, lead to sometimes-irreversible local or global structural damage that is liable to cause collapse. At the design stage, therefore, it is important to anticipate the consequences of a fire, and to be able to determine the failure mechanisms where a structure is subjected to certain types of fire. The client must be aware of the fact that studying the action of fire on a load-bearing structure requires a very high degree of expertise. The financial and technical choices made in this respect are, therefore, of the utmost importance.

Eurocode (EN 1991-1-2) provides technical information on these points, covering the need to conduct a structural analysis of fire resistance using appropriate scenarios so as to obtain the fire values at and beyond which the mechanical behaviour of the structure's components and the formation of mechanisms can be usefully examined and anticipated.

The evaluation of fire risk is essential – even for bridges – since it enables risk situations to be defined, and the repercussions of thermal actions for the mechanical properties of the materials (concrete scaling) to be determined. If the risk is high, it may be deemed necessary to choose a more fire-resistant material. Moreover, certain types of structure prove more sturdy than others when subjected to fire.

The corresponding choices may cast doubt on certain architectural solutions, and these design-related decisions concern the client. In general, these risks should be seen within the context of the overall safety of the structure.

3.4.3. Accidental actions due to impacts and explosions

Eurocode EN 1991-1-7 covers accidental actions due to impacts and explosions. It also introduces the notions of structure sturdiness (mainly for buildings) and of risk analysis. In particular, section 3 of this Eurocode defines the project situations and describes strategies for limiting the spread of failure in the event of accidental actions, identified or otherwise.

These strategies stress direct measures linked to:

- active prevention, such as the protection of an essential pier using a bollard and safety rail, or the reinforcement of a pier following a detailed study of the shaft's stability and bearing capacity in the event of an impact,
- passive prevention, such as the elimination of a pier at the design stage and the reinforcement of the deck, or a change in bridge type; this can involve a choice concerning the structure, the use of less economical materials or the creation of a space between the pier and the carriageway (land-requirement issue).

As in the case of fire-resistance, these strategies can have an indirect incidence on the structural definitions or on the choice of materials (or connections):

- additional redundancy in load distribution (so that the deck does not collapse if a bridge pier is destroyed by a truck);
- protection of bridge piers to avoid impacts with shipping (the shield gabions protecting the northern pier of the *Pont de Normandie* bridge, which have been designed to withstand the impact of a tanker suffering engine or rudder failure);
- particular specifications relating to stability or ductility, such as the choice of a flexible structure that will "bend but not break" or, conversely, the use of three-dimensional tying for additional sturdiness.

In respect of bridges, therefore, initial technical choices – which determine the cost of a structure – can be influenced by safety concerns. These choices can, and must, be reviewed if other solutions offer more appropriate performance.

Design and construction can no longer be envisaged without risk analysis. Risk control is becoming a science, just as structures and materials are approached scientifically, and this is, undoubtedly, a "technological leap". Taking account of the consequences of an accident when designing structures is likely to change both the natures and costs of projects. The focus will shift from the price to be paid to the cost to be avoided – that of an accident.

Let us take a very simple example: a bridge pier can no longer be designed merely to remain in place regardless of what happens. In certain cases, it can be useful to enable the pier to fall (without causing the bridge to collapse) when hit by, for example, a derailed train or a runaway truck. While trains are rarely derailed as they approach bridges, such accidents can have catastrophic results, and the attendant danger must not be overlooked.

In general, the main risk associated with a train crash is that of injury to the train's passengers. The consequences can be grave, and European and international recommendations provide risk-evaluation methodologies designed, notably to limit the numbers of victims. The presence of supports near railway points increases the risk for those travelling on a train. Clearly, therefore, decisions regarding the location of supports are far from simple. The nature of the space available under a bridge can help determine the bridge type and influence the client's choices.

Let us now look at a more sensitive subject – that of public and media perception of accidents, i.e. perceived risk. The railways, for example, are in the lead in this area, since they recommend a wide range of measures designed to prevent trains derailments near structures (buildings, railway platforms and bridges). Such accidents can be very damaging in terms of image. Roads are also concerned, since the closure of sections of motorway or the evacuation of residents following a serious accident can have a similarly negative affect.

The consequences of accidents must, therefore, be evaluated not only from a technical standpoint (structural resistance), but also from a socio-economic or political standpoint (inconvenience for users and danger for nearby residents). Increasing consideration is being given to these risks at the design stage.

Appendix B (informative) of this Eurocode, which was drafted late, provides information concerning risk evaluation. This appendix should feature in the EN 1990 (basis of structural design) at a later date. It examines subjects that will be included in the national appendices and which set out the rules at national level. There are, in particular, an overview of a (qualitative and quantitative) risk analysis, information concerning risk acceptance and limitation measures, and application data by area (road traffic and rail traffic).

3.5. Specific risks relating to dynamic ground-structure interaction

3.5.1. Geotechnical structures

We have seen the importance of geotechnical choices in the development of a construction programme. Eurocode EN 1997 on the “Basis of geotechnical projects” is therefore of considerable use to the client, at least as regards interaction with any professionals providing assistance on this point.

It should be remembered that it is the ground (and/or the subsoil) that determines the specific nature of a structure. Two identical bridges 100 metres apart are not, in fact, identical, since the ground on which they have been built is not the same. The authors of this Eurocode have been careful to take account of this fact and to give extensive coverage to project-ownership notions, including the definition of project situations and notions of durability. There is also a chapter on geometric data (parameters and investigation) and supervision.

3.5.2. Structures in seismic zones

The eurocode EN 1998 part 1 relative to general seismic design rules and building design is more than 220 pages. It deals with design principles of structures in relation with their constitutive materials (concrete, steel, composite concrete-steel, timber, massonry) but it also gives some advices and recommendations on design choices so that to reduce the seismic risk.

In opposition to the preceeding discussed cases, the level of seismic agression can not be defined independently from the structure because it is sharply connected to its intrinsec characteristics (modal vibration frequences, damping coefficient, ductility, etc...). Among the six basic requirements defined in §2.1, the ones related to mechanical resistance, structural stability and users security are mostly under concern...However, one will note that for some particular structures such as dams and nuclear plants, environmental requirements can also be essential. It therefore appears that depending on their destination (or utilization), performance criteria related to a given structure can vary.

Concerning bridges and retaining walls, it is for instance usually usefull to favorize some strategical road axis so that to protect thoses itineries as crisis management and rescue access roads. Part 2 of eurocode 8 relative to seismic design of bridges defines performance requirements and compliance criteria specific to this type of structures at planning and design phases. Moreover, importance categories are defined that enable to take into account the strategical importance of structures within the crisis management and return to a normal socio-economical situation of the stroken region. Those different points are detailed below.

a) Seismic design main principles

- Hazard definition

In Eurocode 8, the vibration seismic hazard is defined using a probabilistic approach by a ground acceleration level associated to a return period. The recommended value of the reference return period is 475 years, what corresponds to a probability of exceedence of 20% over an average expected life of 100 years. This recommended value can be adjusted in accordance to national public authorities and owner choices, as well as the structure destination (or importance category) and its expected service life. To the vibration seismic hazard defined by the ground acceleration must be added all hazards related to induced effects such as tectonic fault opening, soil liquefaction, soil sliding and rock fallings.Those induced effects the consequences of which can be catastrophic are directly related to the choice of the location of the structure and should be investigated since the very beginning phases of plannification and opportunity analysis.

- Importance categories and associated performance objectives

Basis requirements defined by eurocode 8-2 can be expressed as follows : “The design philosophy, regarding the seismic resistance of bridges, is based on the general requirement that emergency communications shall be maintained, with appropriate reliability , after the design seismic event.” This principle leads to non-collapse requirement, emergency traffic loads resistance and repairability exigences under an ultimate seismic event and to a minimisation of damages criteria under a so-called serviceability seismic limit state.

Three importance categories of structures, named I, II and III, are defined, that are represented by three importance factor to ponderate the nominal acceleration, the recommended values of which are 0.85, 1.0 and 1.3. Those importance factors implicitely allows to increase or decrease the return period of the earthquake level to take into account, according to the strategic importance of the structure, such as described by the performance matrix presented by the Figure 1 below.

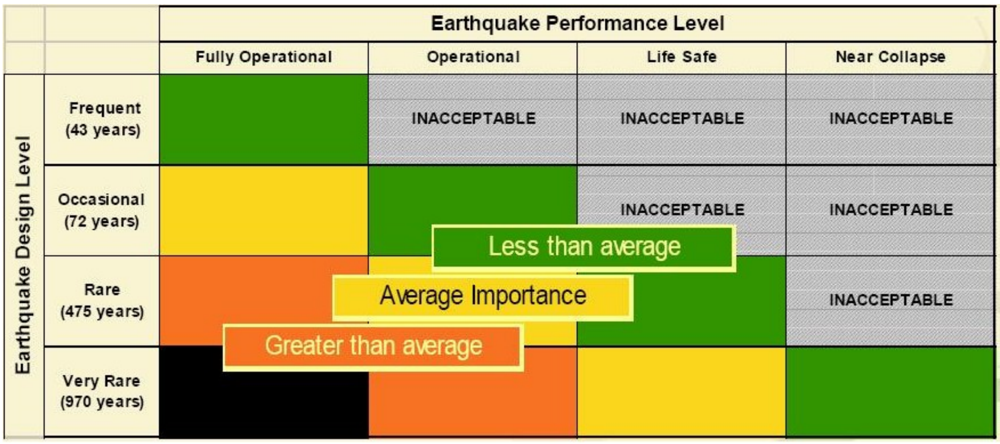

Figure 1 – Performance matrix related to the seismic risk

- Permitted design choices

Compared to more commun hazard loads such as traffic loads, wind, temperature effects, basic requirements preceedingly described and relative to the seismic risk appear to be quite permissive as they refer to non-collapse, emergency circulation and repairability. In order to fullfill those requirement, eurocode 8-2 allows three different design philosophies that implies different analysis methods as well as different seismic performances and damage level. Those design philosophies are respectively refered as “elastic design”, “ductile design” and design based on seismic isolation and damping.

Elastic design consists in designing the structure so that its constitutive materials remain within their elastic domain of behavior. No post-seismic damage nor repair should be expected. Very interesting in low seimic zones, this first type of design however becomes financially not avantageous in regions where the seismic risk is greater.

On the contrary, ductile design consists in allowing incursions in the materials plastic behavior domain in some parts of the structure, so that to dissipate energy and decrease the stress level in the other parts of the structure. These dissipating zones should be chosen by the designer to be easily accessible and repairable. In most cases, it will be the lower part of the bridge columns. Opposingly from the preceeding design strategy, a certain level of damage is here accepted, and even wanted, since it improves the dynamic response of the structure, but can lead to significant repair works after a major earthquake event.

Finally, the third and last design strategy exposed in eurocode 8-2, based on seismic isolation principle and damping devices use, combines advantages from both preceeding design solutions : most of the seismic energy is absorbed and dissipated by external mechanical devices whereas the structural elements do not suffer any damage and constitutive materials remain within their elastic domain. In case of an extreme seismic event, the damping devices can be easily inspected and replaced if necessary. On the counterpart, design analysis can be very complex and sophisticated, and need powerfull analysis tools (nonlinear dynamic analysis). Finally, the high cost of special devices generally reserves their application to regions where the seismic hazard is very high or to special structures.

Different by their cost, those three design strategies also lead to very different seismic behaviors and it is the owner responsability to choose one or the other according to the context in terms of sismicity, structure value, strategical aspects or emergency communications).

De coûts sensiblement différents, ces trois types de conception conduisent aussi à des comportements sous séisme bien distincts et il appartient donc au maître d'ouvrage, en fonction du contexte (sismicité, valeur attribuée à l'ouvrage, aspects stratégiques, organisation des secours) de trancher en faveur de l'une ou l'autre.

b) the national public authorities roles

Natural, environnemental and socio-economical critical issues (for instance seimic context) can vary from on country to another within the European Union. For that reason, eurocodes reserve some part of responsabilities to the corresponding national state authorities for what concerns performance criteria and design. In the case of eurocode 8 relative to seismic aspects, it will correspond in particular and non-exhaustively to :

- Defining the national seismic zoning ;
- Characterising the seismic action by seismic spectra or accelerograms representative of regional sismotectonic and geologic conditions ;
- Defining reference return period for bridges design ;
- Precising the importance categories and associated importnace factors ;
- Precising the recommended security factors (material factors, analysis method...) in order to take into account common national practices and state-of-the-art.

c) The owner responsabilities

As it was seen in the preceeding chapters, the eurocodes publication considerably increases the role and responsabilities of the owners, all along the different stages of the structures life cycle, from the first stages of planning and design to the operation and maintenance stages.

Therefore, during the planning phase, the owner has to define the destination of the structure, which is related to the importance category and consequently the hazard level that has to be considered in terms of return period. He also has to choose the best location for the structure according to risks associated to nduced effects such as liquefaction, fault rupture, rock falling, soil sliding... Concerning this aspect, one has to note that it is the owner responsability to define and characterize hazards at the location of the structure by appropriate sismologic and geotechnical investigation campains.

During the design phase, as stated before, the owner has to choose the design philosophy but also the architecture, which influences the structural regularity and therefore the dynamic behavior and the global seismic response of the structure. It is also his responsability to precise what should be the status of informative appendixes, some of which, specially appendix A relative to the seismic load definition during the construction phase, can have great consequences on the global cost.

Within the operation phase, structure maintenance, control and repair must regularly organized by the owner. This requirement is particularly essential in the case of bridges equiped with specifics devices such as seismic isolators and dampers. Finally, in case of an extreme seismic event, it is again the responsability of the owner to inspect eventual damages and decide or not to re-open the structure to traffic.

4. CONCLUSION

The eurocodes, concerning the construction works, have a direct relationship with design performance. These technical requirements sets in action quality matters. Then, the eurocodes are presented as the reference of the structural quality and are applicable in terms of risk analysis and environment influences. Hereafter, the table give a correspondence between requirements, European essential requirements, decisions of the owner and eurocodes.

Requirements	*Choices of the owner*	*Eurocodes*
Quality management	Design working life Reliability management (Consequences classes) Durability (Environment influences) Robustness	EN1990 EN1990 EN1990 EN1991-1-7
Security	Risk analysis Fire Snow Wind Impacts, explosions Normal and abnormal traffics Earthquake	EN1991-1-7 EN1991-1-2 EN1991-1-3 EN1991-1-4 EN1991-1-7 EN1991-2 EN1998
Résistance	Structural stability Serviceability security	EN1992 à 8

The owners cannot take no part in technical aspects of design. But an inaction concerning these technical aspects might involve the owner responsibility.

These technical aspects, with possible consequences on the decisions of the owner, perhaps also on the basis of design, are found in the eurocodes. These normative documents represent already a real cultural reference in France and in Europe.

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Missions d'assistance à décideur et Maître d'ouvrage (MTETM, Syntec-Ingénierie, AITF), septembre 2005.

Circulaire du 05/07/94 (JORF du 26/08/94) relative à la référence aux normes dans les marché publics et les contrats soumis à certaines procédures communautaires. Les dispositions du nouvel article 6 du projet du nouveau Code des marchés publics 2006 prévoient un arrêté spécifique qui doit annuler cette circulaire pour la rendre compatible avec les modifications du décret 84-74 modifié.

Recommandation T1-99 aux Maîtres d'ouvrage publics, relative à l'utilisation des normes et des certifications dans les spécifications, et à l'appréciation des équivalences. GPEM Travaux / Direction des Affaires Juridiques Ministère de l'Economie, des Finances et de l'Industrie Revue de l'Achat Public n°6/99.