

## QUALITY SITUATION IN THE BUILDING CONSTRUCTION IN SPAIN

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### Abstract

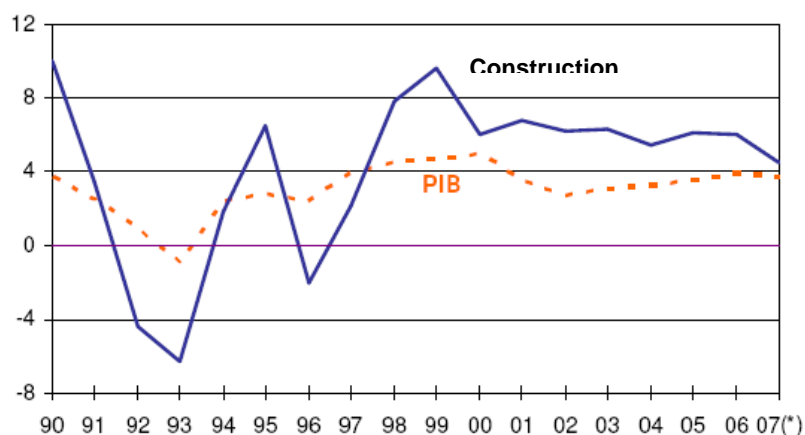
The Construction Industry is one sector of the economy stronger at the international level, however, due to its characteristics, is one that presents a major weakness in the implementation of Quality Control.

This article reviews the state of Quality Control in the implementation phase in the sub-sector of the Residential Building in Spain, analyzed the existing regulations in this regard (in particular the Technical Building Code -CTE- ) as well as the efforts of some institutions to give Designers, Builders and Developers, ease of implementation of these extensive and complex regulations enforceable. All this passed so that an effective increase in the Quality of the User receiving end of these buildings.

**Keywords:** *Project Management, Quality construction, Building control, CTE*

### 1-Introduction

Construction industry and its residential sector are one of the most significant contributors to most countries economy. This importance is greater in Spanish case (Bielsa, 2008), as may be appreciated looking at figure 1, which shows the relationship between construction and global country economical growth.



Source: INE (Spanish National Statistics Institute).

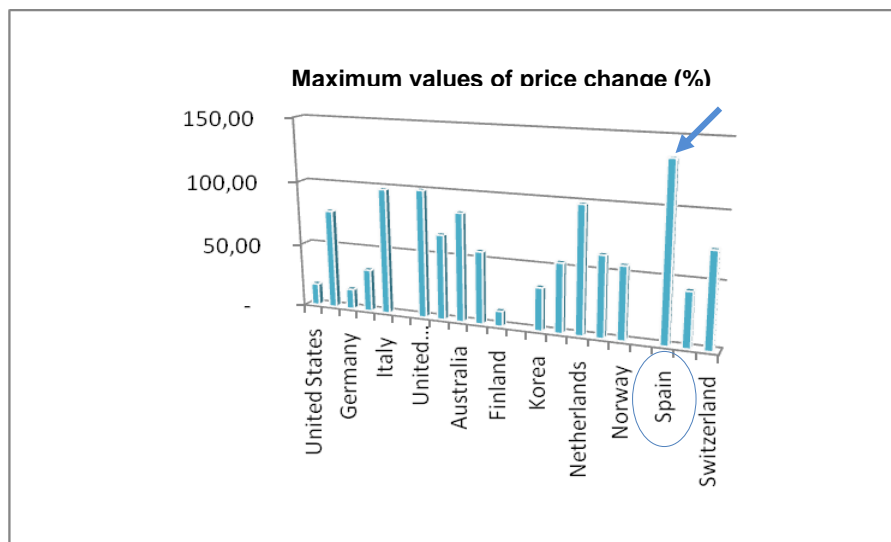
Figure 1. Evolution for annual variation in GDP and construction 1990-2007

Nevertheless, this economical important role has not turned into major improvements in the quality of carrying out constructions. Several features of this industry block or brake quality controls and to name not all but a few we can find the presence of several agents with heterogeneous characteristics (client, developer, constructor, suppliers, administration and others), who use to have opposite interests, the nomad nature of construction which leads to difficulties for getting adequate raw materials and processes comparing to fixed industries, climatic circumstances for works in the open, complex (and sometime contradictories or confusing) specifications for some tasks, unclear responsibilities...

According to one study carried out by the Construction Section in the Spanish Quality Control Association, the following weak points were detected in construction sector (García, 2001):

- Lack of interest for quality in senior management teams.
- Shortage in resources used for quality formation
- Normative are too extensive, unconnected, ambiguous and disperse.
- Short technological innovation in sector.
- Misuses and absence of maintenance.

In developed countries, actual housings prices have been fluctuating with increasing trends (figure 2), what has been attributed to (among other factors) quality improvement exigencies (Girouard, 2006).



Source: Self-elaboration from Girouard, N. et al. 2006

Figure No. 2. Mean of housing prices variations\_1970-2005

Citizens life quality conditions have increased, leading to more quality exigencies for buildings. Responding to this social demand, Spain published the **Ley de Ordenación de la Edificación, LOE**, (Construction General Law), in order to introduce warranting systems to ensure construction quality by establishing basic requisites, and the Código Técnico de la Edificación,

CTE (Construction Technical Code), which includes basic quality exigencies to be fulfilled in constructions.

## 2- Normative Evolution Quality Control Implementation

A new unified frame for construction normative was approved in 1977. It was composed of:

-*Normas Básicas de la Edificación, NBE (Basic Construction Norms*, they increase the Rank of the previous MV (Housing Ministry Norms), which were in force right then.

-*Normas Tecnológicas de la Edificación, NTE (Technological Construction Norms)*, which was not binding, were approved in the same decade and used to develop NBE norms.

-*Soluciones Homologadas de la Edificación, SHE (Standardized Construction Solutions)*. These ones were not developed, although they intended two objectives: Creating Documentos de Idoneidad Técnica, DIT (Technical Adequacy Documents) for traditional solutions and carrying out evaluations of non conventional solutions by means of Eduardo Torroja Institute..

Later on, on May-2000, Law 38/1999 de Ordenación de la Edificación (LOE) comes in force in order to “regulate essential aspects in construction process, establishing obligations and responsibilities of the agents and needed warranties for an adequate development of this process; in order to ensure quality by fulfilling several basic requisites and protecting users interests”.

LOE introduces the obligation of developing a project for new buildings, refurbishments, enlargements, additions or modifications or works of intervention in buildings with official protection due to environmental, artistic or historical reasons. This normative also introduces basic requisites to be fulfilled in order to warranty people safety, society wellness and environmental protection. These requisites are:

- About building function (use, accessibility and services of information, audiovisual and telecommunications).
- About safety (on structures, fire risk and use).
- About habitability (hygiene, health, environmental protection, noise protection, energy saving, thermal insulation and other aspects)

Second Final Disposition authorizes the approval of a future *Código Técnico de la Edificación*, CTE (Construction Technical Code), which will establish the exigencias to be fulfilled by buildings and their projects in terms of safety and habitability. Until the approval of this normative compilation, *Normas Básicas de la Edificación* will be in force, as well as the rest of existing normative.

Royal Decree 314/2006 (March the 17<sup>th</sup>) finally passes *Código Técnico de la Edificación*, CTE (Construction Technical Code), the normative frame for regulating basic quality exigencies to be fulfilled in construction process, including installations, in order to fulfill basic requisites foreseen in LOE.

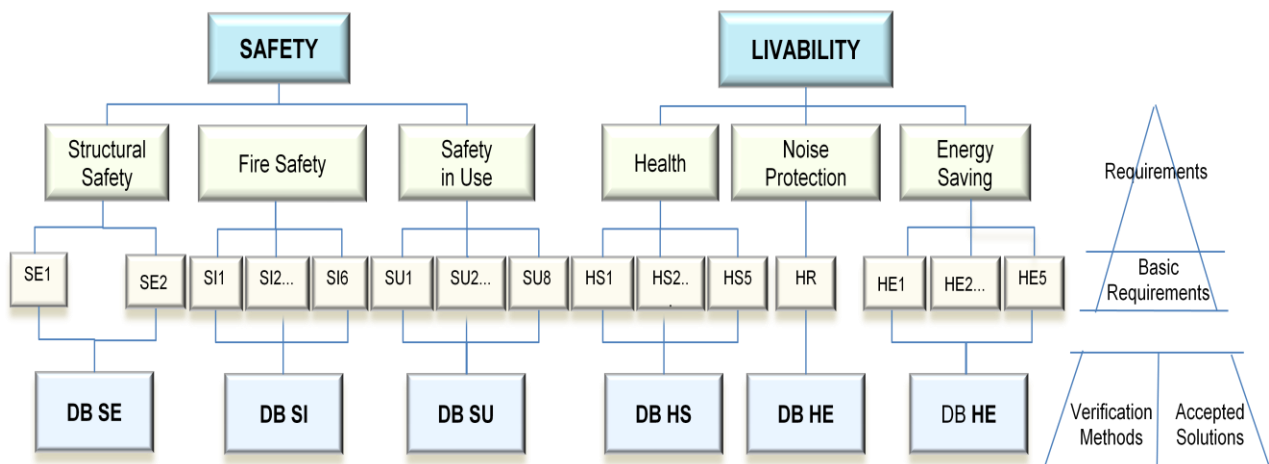
## 3.- Construction Technical Code.

Construction Technical Code follows the “performance based approach”, proposed by the main international organizations related to construction normative, such as International Council for Building or IRCC, the main developers of advanced countries normative. This approach allows

many advantages like opening this industry to more global markets for construction raw materials or professionals.

### 3.1 Normative structure

CTE is Split into two main parts. Part I includes general dispositions and basic quality basic exigencies for buildings, while part II contains basic documents for fulfilling the exigencies by means of fixing levels, values and parameters which will be obliged by basic documents. Exigencies are a group of requisites and performance value with qualitative characteristics to be fulfilled in building projects in order to reach society quality demands (Vega, 2006).



Source: Self-elaboration based upon CTE.

Figure 3. CTE organization.

*Exigencies* establish the conditions to be verified in building design project, constructive systems and the products that compose them in order to fulfill objectives.

*Objectives* express the interests of the community about the building.

*Accepted Solutions and Verification Methods* are offered tools to verify that one system or solutions fulfills the exigencies related to it.

### 3.2 Project Control

The *Quality Control Plan* intends to describe the works that must be carried out for the construction technical quality control, including verifications, materials tests, inspections and any test aimed at ensuring that quality in constructions fits Project specifications, applicable legislation, normative in force and any norm on construction good practices.

According to the CTE, the Quality Control Plan\* takes the form of an Annex in the project. (See table 1).

<b>I</b>	<b>Project report</b>	Descriptive report	
		Construction report	
		CTE fulfillment	Framework safety
			Fire risk safety
			Use safety
			Healthiness
			Noise protection
			Energy saving
		<b>Annexes to the report</b>	Geotechnical information
			Framework calculations
			Fire protection
			Building installations
			Energy efficiency
			Environmental impact study
<b>Quality control plan*</b>			
Safety and Health Study (or Basic Study)			

Source: Self-elaboration based upon CTE

Table 1. Project content

The Quality Control Plan must include the guidelines for building site control process in the following three stages:

**Building site control stages:**

- Materials reception control.
  - Control on supplies documentation (for all materials)
  - Control of reception by means of quality signs and technical adequacy evaluations (materials with DIT, DAU and quality labels).
  - Control of reception by means of tests (materials with Quality Registers regulated control).
- Control of finished work units.
  - Control of every finished work unit, (layout verification, materials used and constructive elements disposition, etc.)
  - Control of each work unit (redesign verification, used materials, constructive elements dispositions, etc.)
  - Verification of compatibility between: products, elements and constructive systems.
- Finished work control.
- Verifications and service tests.

CTE specifies the content of all work monitoring documentation, including that obliged by normative and any control documents contributed by the work site management team. This one includes work process monitoring and quality control process. The whole documents to be kept for the whole work control (materials, products, machinery, systems and work units) mean a quite complex work to be carried out.

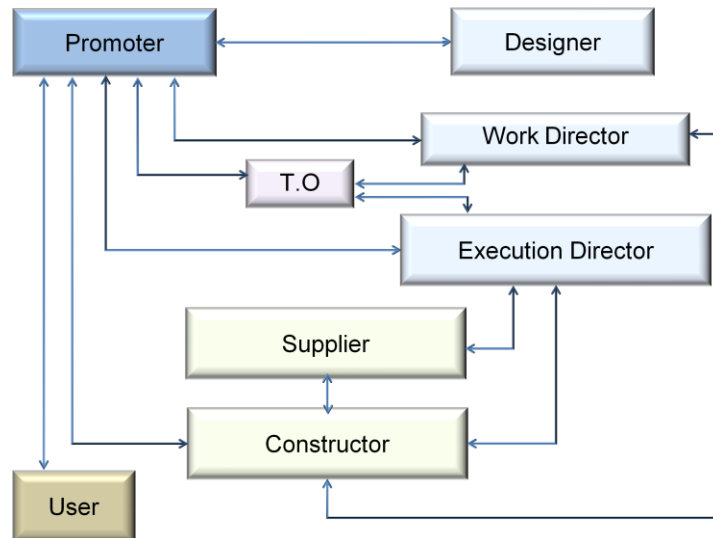
1. Obligated documentation for work site monitoring.	Book of Orders and Assistances
	Book of Incidences on Safety and Health
	<i>Project, Annexes and Modifications</i>
	Works License, work site opening site license and other administrative authorizations
	Partial works certificates
	Final Works certificate
2. Work site control documentation.	Product reception control
	Finished Works controls
	Finished Building controls
3. Works final certificate	Works final certificate will also include as annexes the following documents:
	Description of building modifications that took place along the working period, with developer approval.
	List of controls carried out along the working period and their results.

Source: Self-elaboration based upon CTE

Table 2. Documentaion along works life

### 3.3 Responsibilities in construction quality control.

The agents involved in construction process will be responsible for CTE fulfillment, as read in Chapter III of LOE.



Source: Self-elaboration based upon CTE

Figure 3. Project agents

#### *Developer*

- Must own the right to build in building site
- Must provide all documentation and previous information for carrying out the project and must authorize Construction Management for making later modifications.
- Must manage and get required licenses and administrative authorizations, as well as subscribe the Building reception act.
- Must subscribe foreseen insurances.
- Must give to the purchaser all documentation on works and any other required by administrations.

#### *Project Designer*

- Must write down the Project fulfilling normative in force and anything that was established in the contract, and must give it to the developer with any required endorsements (professional associations visa for instance).
- Must agree (if needed) with the developer about contracting partial collaborations.

#### *Constructor (Construction company)*

- To carry out the Works according to the Project, applicable normative and the instructions of the management team, in order to reach expected quality levels.

- To appoint work site chief who will assume construction company technical representation and who will properly qualified for the works due to education or experience.
- To make sure that proper means and workers are assigned to the works.
- To carry out the sub-contracts of certain parts of the works or installations, under contract limits.
- To sign the redesign, work start and finish minutes.
- To provide to the management team any required data for elaborating works documentation.
- To subscribe any foreseen warranties.

*Construction manager (Management team).*

- To verify redesign and foundations and projected framework suitability to ground geotechnical characteristics.
- To solve any eventuality in the works and write down in the Book of Incidences on Safety and Health the precise instructions to interpret the project.
- To elaborate with developer requirement, adequate project modifications along the works, according to normative and already observed in the project.
- To subscribe the redesign, work start and finish minutes, as well as any partial certifications and the final liquidation of finished works units, with the required endorsements.
- To elaborate and subscribe finished building documentation to be delivered to the developer, as well as required endorsements.
- All the ones listed in article 13, in case construction manager and works manager were named as the same person as foreseen in article 13.2.a.

*Works manager*

- To verify work site reception of construction materials, ordering required tests.
- To manage construction works, verifying redesigns, materials, works and constructive elements disposition, as well as installations, according to the project and the construction manager.
- To fulfill the Book of Orders and Assistances with precise instructions.
- To subscribe the initial layout act, work start and finish minutes, partial certifications and final liquidation of finished work units.
- To collaborate with the other agents in order to carry out all documentation and the results of controls.

*Entities and quality control laboratories.*

- To provide technical assistance and deliver the results of their work to the works manager.
- To justify their capacity (human and material) to carry out their tasks, after receiving competent Regional authorities accreditation.



#### *Materials suppliers*

- To carry out materials deliveries according to requesting specifications, specifying origin, identity and quality, as well as the observance of any applicable normative.
- To provide, if required, any use and maintenance instructions for supplied materials, as well as the corresponding quality warranties, in order to be included into finished building documentation.

#### *Owners*

- To conserve proper building conditions with adequate use and maintenance, as well as to receive, conserve and transfer finished building documentation, insurances and warranties.

#### *Users (owners or not)*

- Adequate use of the buildings or any part of them according to use and maintenance instructions, included in finished building documentation.

### **4- Met difficulties**

After CTE went in force, many complaints were heard due to its length and applicability complexity. Most repeated ones were:

- Length of justifications to be fulfilled.
- Need to permanently stay in working site.
- Increases in costs due to the greater required control.
- Lack of coordination among suppliers, designers and construction companies.
- Low professional qualification of Works managers. For example due to their possible contracting for experience reasons, minimizing professional qualification.
- Traditional construction techniques, hard to be controlled.
- Lack of industrialization or automation in construction industry.
- Lack of uniformity between documentation and control activities.
- Elaboration of Control Plans by Architects (construction managers), although the tasks will be carried out by construction engineers (works managers).

### **5- Initiatives**

As in many other countries, construction industry (especially in residential case) in Spain is still very traditional and reluctant to innovations. Nevertheless, this fact does not mean that changes are not possible.

The most important R+D activity in construction is mainly developed in state-owned research centers, such as CEDEX (Centro de Estudios y Experimentación de Obras Publicas), el IETCC (Instituto Eduardo Torroja de la Construcción y del Cemento), el CIEMAT (Centro de Investigaciones Energéticas, Medioambientales y Tecnológica), Centros Tecnológicos como el ITEC (Instituto Tecnológico de la Construcción de Cataluña), AIDICO (Instituto Tecnológico de la Construcción), CIDEMCO (Centro de Investigación Tecnológica) AITEMIN (Asociación para la Investigación y desarrollo industrial de los recursos naturales) y la Corporación Tecnológica

TECNALIA (Labein, Inasmet...), Universities (UAM, UPC, UPV, Carlos III) and especially the ones focused on construction specialities in roads, architecture, industry, mines, etc.

The recent reform of the building regulatory system plays a key role in regard to scientific and technological progress in the sector. Confronting traditional prescriptive codes, the adoption of a code based on performance, is more open to innovation. This also justified by the consideration that the knowledge and technology of construction are in continuous progress, so rules should promote research and not hinder technological progress.

Another relevant initiative is the one carried out by software companies, generating applications for plans elaboration, CTE adapted project writing and other ones applied to certain conrmatives, like CYPE, "Instalaciones", CDEO Calidad, CTE Solar, etc.

As mentioned in chapter 3.2, the Quality Control Plan required by CTE turns into an Annex in the Project papers, with indicative character but not including content break down. Demilition and construction waste materials management seems to be more relevant, since demilition and construction waste study and planning is required. This situation has led many involved professionals and institutions to undertake some actuaciones to facilitate the application of the new normative system about "*Control de Ejecución*" (Works Management). This task has been carried out by Architects Associations in several Regions and other institutions.

The Murcia Construction Engineers Official Association published in November 2008 one book named "Documentación del control de la obra en cumplimiento con el CTE" (CTE fulfillment works control documentation), which turns to be on practical support tool for professional tasks. It includes "Technical specifications guide", "Control parts" and "Solved practical examples"

Taking for sure that some technical associations initiatives on Works Quality Plans are positive, we consider that it might be possible to advance further by establishing minimum exigencies for the content of such Plan.

Since technicians, Professional Associations and Administrations feel like there is lack of criteria uniformity on required and enough content, there is some risk of generating unfair discriminations, confusions and changing one of the main project documents into just an administrative step, including information that is more useless and bothering than useful and profitable.

Using unified criteria in construction processes control, all along Spanish industry, will no doubt be a positive measure over construction quality and will represent a relevant improvement for construction industry.

## 6.- Conclusions

Quality is one of the most recognized key parameters at European level I order to improve any industry sector (Serra, 2005). Taking into account construction industry relevance on building quality level, there is a great need to properly control it properly in order to take care of its growth.

We understand that, in CTE, Quality Control Plan is underestimated since there is no emphasized room for it in project documents, but just an Annex. Being obliged under this low requirement level turns its importance to a low one in the eyes its responsible teams. Furthermore, its content is not specifically described, so some institutions had to carry out independent and not coordinated initiatives in order to elaborate guidelines to be completed by professionals for fulfilling the Plan.

Since CTE bases upon performance (what is innovation related stress), we consider that some improvements must still be included. They must include terms of elaboration exigency and Quality Control Plan putting into practice by means of minimums establishments in order to reach a collaborating working practice for all constructions at any scope. We also believe that work is an interesting field for professionals involved in the sector.

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