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HYDRAULICS. ENGINEERING HYDROLOGY.
HYDRAULIC ENGINEERING

BINFORMATION SYSTEMS AND LOGISTICS IN CIVIL ENGINEERING

ENGINEERING GEOMETRY AND COMPUTER GRAPHICS

PROBLEMS OF HIGHER EDUCATION IN CIVIL ENGINEERING

УВАЖАЕМЫЕ КОЛЛЕГИ!

Пользуясь случаем, поздравляю вас с наступившими Новым годом и Рождеством!

В 2013 год наш университет вступает с новыми силами, творческими идеями и неиссякаемой энергией. Однако не стоит забывать о достижениях 2012 года.

География работы наших центров и лабораторий была поистине обширной. Это город Певек Чукотского автономного округа, большое количество объектов на Севере страны: в городах Салехард, Ноябрьск, ставший традиционным направлением для МГСУ юг России: город Сочи. А по Подмосковью рабочие объекты расположились более чем в двадцати населенных пунктах.

В первую очередь хочу отметить серьезную и крайне важную работу сотрудников наших материаловедческих лабораторий, которые отличились новыми изобретениями, необычными идеями и разработками новых строительных материалов и технологий. Это и Научно-образовательный центр по направлению «Нанотехнологии» (НОЦ НТ) под руководством Е.В. Королева, и Научно-исследовательский институт строительных материалов и технологий (НИИ СМиТ) под руководством А.П. Пустовгара.

Безусловно, важной является работа сотрудников Института гидротехнического и энергетического строительства (ИГЭС) на двух ГЭС: Саяно-Шушенской и Чиркейской в Дагестане. Научно-технический центр «Взрывоустойчивость» проделал великолепную работу на Белоярской атомной станции.

Я абсолютно уверен, что все изобретения, научные разработки и новые методики, созданные в стенах МГСУ, заслуживают, чтобы о них написали отдельную статью. А может быть, и не одну.

С учетом сказанного мне вдвойне приятно отметить увеличение периодичности выхода университетского журнала «Вестник МГСУ», позволившее более успешно реализовать возможности опубликования результатов научных исследований и разработок сотрудников университета и наших коллег и партнеров из других научно-исследовательских центров.

Отдельно хочется отметить и тот факт, что увеличение количества выпускаемых ежегодно номеров журнала по времени совпало с созданием в МГСУ целого ряда новых лабораторий и центров, а ведь именно там должны рождаться актуальные статьи о результатах научно-изыскательской деятельности и создаваемых объектах интеллектуальной собственности.

Подводя итог всему вышеуказанному, хотелось бы пожелать «Вестнику МГСУ» наряду с увеличением количества публикаций повысить их качественный уровень путем совершенствования механизмов рецензирования и отбора статей, что позволит нашему журналу войти в разряд самых авторитетных и значимых научных периодических изданий.

Проректор
по научно-производственной деятельности М.Е. Лейбман

DEAR COLLEAGUES,

Let me take advantage of this opportunity to extend my greetings on the New Year and Christmas that have arrived.

Our University launches into the new year with renewed vigour, creative ideas and unflagging energy. Nonetheless, our 2012 attainments are worth mentioning.

The geographic coverage of the projects implemented by our research centres and laboratories was truly extensive. It encompassed the town of Pevek located in Chukot Autonomous Area, numerous projects in the North of our country, namely, in Salekhard and Noyabrsk, assignments completed in the town of Sochi in the South of Russia, a traditional locality of multiple MGSU projects. As for the Moscow Region, our projects have been implemented in more than twenty residential areas in close proximity to the capital.

First of all, I'd like to mention a solid and important piece of work performed by the researchers employed with our material science laboratories. They have demonstrated their new inventions, original ideas and advanced building materials and technologies. Our material science labs include our Research and Educational Centre for Nanotechnologies managed by E.V. Korolev and our Scientific and Research Institute of Building Materials and Technologies managed by A.P. Pustovgar.

Undoubtedly important assignments have been successfully performed by the employees of the Institute of Hydraulic Engineering and Power Plant Construction at Sayano-Shushenskaya HPP in Siberia and Chirkeyskaya HPP in Dagestan. Our Scientific and Technical Centre for Explosion Stability has successfully completed its project at Beloyarsk Nuclear Power Plant.

I am doubly sure that all inventions, research advancements and new methodologies developed at MGSU deserve a separate article. Maybe, even several of them.

With reference to the above, I am happy to mention that our university journal Vestnik MGSU has increased its periodicity to raise the chances of MGSU employees, our colleagues and partners employed with other research centres to publish their research findings with us.

I'd also like to emphasize the fact that the increase in the number of issues published by our Journal per year has coincided with the launch of numerous new research laboratories and centres by MGSU, as new labs are the places where relevant articles covering research findings and items of intellectual property come from.

In summary, I wish that, apart from the increase in the number of its publications, Vestnik MGSU improved their quality through the enhancement of the manuscript review and selection procedure for our Journal to be ranked as a most credible and relevant research periodical.

M.E. Leybman,
Vice Rector for Scientific and Production Activities

ОБЩИЕ ПРОБЛЕМЫ СТРОИТЕЛЬНОЙ НАУКИ И ПРОИЗВОДСТВА. УНИФИКАЦИЯ И СТАНДАРТИЗАЦИЯ В СТРОИТЕЛЬСТВЕ

УДК 691

P. Spehl

SECO; Université libre de Bruxelles; Ecole Nationale des Ponts et Chaussées

FROM CONSTRUCTION PRODUCTS TO BUILDING WORKS: THE EUROPEAN INPUT

The paper gives an overview of the evolution of the construction sector within the European unification process and explains the reasons why this evolution happened, how it was organized and lived, and where it is leading. The links between the main stages of this process and the European legislation specific to the construction sector are presented, and the main prescriptions of the Construction Products Directive are reviewed. The need to express the characteristics of products in terms of performance is emphasized and data are given on the CEN program of harmonized product standards, test methods and calculation methods standards. The CEN standards on construction works such as the EUROCODES are also presented, its impact on existing regulatory systems is discussed and some conclusions are drawn on the added value of the European input to the construction sector.

Key words: technical harmonization, directive, European regulations, performance specifications, Eurocodes.

Introduction

The European Union is born from a step by step process designed by Jean MONNET and initiated by the famous declaration of Robert SCHUMAN speaking on behalf of the French Government on 9 May 1950:

"Europe will not be made all at once, or according to a single plan. It will be built through concrete achievements which first create a de facto solidarity. The coming together of the nations of Europe requires the elimination of the age-old opposition of France and Germany. Any action taken must in the first place concern these two countries. With this aim in view, the French Government proposes that action be taken immediately on one limited but decisive point. It proposes that Franco-German production of coal and steel as a whole be placed under a common High Authority, within the framework of an organization open to the participation of the other countries of Europe. The pooling of coal and steel production should immediately provide for the setting up of common foundations for economic development as a first step in the federation of Europe, and will change the destinies of those regions which have long been devoted to the manufacture of munitions of war, of which they have been the most constant victims."

France and Germany, together with Italy, Belgium, the Netherlands and Luxembourg, started in 1951 by creating the European Coal and Steel Community, and later on the *European Economic Community* which is, by far, the most important achievement. Its purpose, defined by the Treaty of Rome of 1957, was to establish a customs union, based on "four freedoms": freedom of movement of goods, services, capital and people.

The economic growth over the years resulting from its implementation became so attractive that the European communities enlarged progressively to many new Member States. But the opening of national borders was not enough to get a "common market" of free trade. On the contrary, a proliferation of national technical standards increased the partitioning of markets, so that, in 1986, the Member States (12 at that time) signed the "Single Act" in order to adopt the measures needed to eliminate all barriers to trade and to create effectively a single unified market.

A "New Approach" to technical harmonization and standards was adopted in 1989, providing a framework to harmonize national regulations for industrial products, and to develop flexible and technology-neutral legislation, by moving from detailed descriptive specifications for individual products, to defining the performance-based "essential requirements" for types of products, thus promoting innovation and competitiveness.

This "New Approach" has been implemented for the construction sector in 1989 by the European Directive 89/106/EEC [1] called the "*Construction Products Directive*" (CPD).

The next major steps in the unification process have been the Maastricht Treaty (1992), which creates a *European Union* (EU) on both economic and monetary fields (from which the EURO is issued), and lastly the Lisbon Treaty (2009) which reinforces democracy in the European Union (now 27 Member States) by improving the co-decision-making process involving the 3 main EU institutions (the Council, the Commission and the Parliament).

Actually, the European legislation includes:

European *regulations*, which are entirely binding and directly applicable,

European *directives*, which are binding on Member States as to the result to be achieved, but leave to the respective national authorities to decide how the objectives set out in the directive are to be incorporated into their domestic legal system before a certain date, and

European *decisions* applying the European legislation, which are binding only on those to whom they are addressed.

It is to be noted that a new "*Construction Products Regulation*" (CPR) has been voted by the EU Parliament on 18 January 2011, and is now published [2], in order to revise and replace the CPD, and to upgrade its legal force.

Construction products

What is a construction product? For the purpose of the CPD, "construction product" means *"any product which is produced for incorporation in a permanent manner in construction works, including both buildings and civil engineering works"*. Shortly, it is what enters into the work site.

The basic principle of the CPD was established in 1979 by a judgment of the European Court of Justice (the so-called "Cassis de Dijon" judgment [3]): a product sold lawfully in one Member State may not be prohibited in another Member State.

This principle of "mutual recognition" effectively reverses the burden of proof, by requiring a Member State, which does not want to accept such a product on its market, to demonstrate why compliance with the requirements of another Member State would not adequately protect its citizens.

Furthermore, the Court ruled that if there were European regulations, directives or decisions prescribing technical requirements for certain products, these exceed the national rules, and because the national rules give rise to trade restrictions, they would no longer be lawful when European technical requirements exist.

The CPD was drafted to prescribe such technical requirements for construction products, so that a product responding to its prescriptions cannot anymore be refused [4]:

Mandatory *essential requirements* are defined to ensure a high level of protection regarding health and safety, they must be worded in terms that can be uniformly enforced by Member States, and they must enable conformity assessment bodies to evaluate conformity of products and standardization bodies to develop standards to ensure, partly or completely, the fulfillment of those essential requirements.

Manufacturers are free to choose any appropriate technical solution that meets the essential requirements.

Products that comply with *harmonized standards*, references to which have been published in the Official Journal of the European Union, are presumed to meet the corresponding essential requirements.

Appropriate conformity assessment procedures are defined, taking into account, among other things, the type of risk related to the products. Where appropriate, these procedures require the intervention of third party conformity assessment bodies, known as *notified bodies* (figure 1).

VERIFICATIONS		SYSTEMS OF ASSESSMENT AND VERIFICATION (CPR - Annex V)				
		1+	1	2	3	4
		Declaration of the performance by the M (Manufacturer)				
		+ certificate of constancy of performance by NB (Notified Body)		+ FPC conformity certificate by NB	+ product type testing by NB	
initial	Type testing or calculation	NB	NB	M	NB	M
	Inspection of FPC	NB	NB	NB	-	-
continuous	FPC (factory production control)	M	M	M	M	M
	FPC surveillance	NB	NB	NB	-	-
	Testing of samples	M	M	M	-	-
	Audit testing of samples before placing on the EU market	NB	-	-	-	-

Fig. 1. Conformity assessment procedures for construction products

For any product that is not covered or not fully covered by a harmonized standard, the manufacturer may request alternatively for a *European Technical Assessment (ETA)*, and a European Assessment Document shall be drawn up and adopted by the organization of Technical Assessment Bodies (TABs).

The *CE Marking* symbolizes the fact that the manufacturer has verified that the product conforms to all the harmonization provisions that apply to it and that the

product has been the subject of the applicable conformity assessment procedures. In a "declaration of conformity", the manufacturer presents the required information on the product and its characteristics, in the language of the Member State in which the product is to be used. Note that this "declaration of conformity", required from the manufacturer by the CPD, will be replaced according to the new CPR by a "declaration of performance of the essential characteristics of the construction product".

The obligation on Member States to take all appropriate enforcement measures, including *market surveillance*, to ensure that non-conforming products are withdrawn from the market.

Performance of construction works and products

When we speak of performance, we mean the properties of a construction work that have to do with the behaviour demanded of it during use so that it correctly fulfils its functions. These behaviours are determined using unified sets of scientific methods (testing, measurement, calculation and observation) regardless of the materials and processes used.

When specifying the performances of a building, rather than describing construction materials and processes in the specifications, we replace an "obligation of means" by an "obligation of results". Various constructive solutions may thus be compared on an equal footing, while freedom as large as possible is left to the design in order to encourage innovation.

A major step in the implementation of the performance concept in buildings has been accomplished at the joint RILEM-ASTM-CIB Symposium organized on 2-5 May 1972 in Philadelphia by the US National Bureau of Standards [5], where many pioneering researchers and developers such as George ATKINSON (UK), Oivind BIRKELAND (Norway), Gérard BLACHÈRE (France), John EBERHARD (USA) or Ingvar KARLEN (Sweden) gathered and shared their experiences.

Short afterwards, the author began his engineer's career within SECO [6] on an ambitious Belgian inter-industrial/construction research program in this field, partly financed by the Belgian State; under Raymond d'HAVÉ, former Director of SECO, he drafted the "Performance Guide for Buildings" published in 1980 [7], which presents the performance specifications, testing methods and calculation methods already available or developed at the time, and the international standard ISO 6241 "Performance standards in building – Principles for their preparation and factors to be considered" [8], in 1982, as technical secretary of a working group within the ISO Technical Committee 59 "Building construction" chaired by Gérard BLACHÈRE.

Both documents did inspire Raymond MOURAREAU of the European Commission, who drafted the CPD which states that the *"harmonized standards"* should be *"expressed as far as possible in terms of product performance"*, and which has been since 1989 the basis of the whole European Commission policy to unify the market in the construction sector.

Annex I of the CPD defines the six essential requirements regarding health and safety, which are applicable to construction works in order to fit for their intended use. This list may be compared to the standard list of user requirements from ISO 6241, where other aspects than health and safety are covered, and to Annex I of the new CPR, where a seventh requirement "Sustainable use of natural resources" has been added (figure 2).

ISO 6241 : 1984 Table 1: User requirements	CPD : 1989 Annex I: Essential requirements	CPR : 2011 Annex I: Basic requirements for construction works
1. Stability requirements 2. Fire safety requirements 3. Safety in use requirements 4. Tightness requirements 5. Hygrothermal requirements 6. Air purity requirements 7. Acoustical requirements 8. Visual requirements 9. Tactile requirements 10. Dynamic requirements 11. Hygiene requirements 12. Requirements for the suitability of spaces for specific uses 13. Durability requirements 14. Economic requirements	1. Mechanical resistance and stability 2. Safety in case of fire 3. Hygiene, health and the environment 4. Safety in use 5. Protection against noise 6. Energy economy and heat retention	1. Mechanical resistance and stability 2. Safety in case of fire 3. Hygiene, health and the environment 4. Safety and accessibility in use 5. Protection against noise 6. Energy economy and heat retention 7. Sustainable use of natural resources

Fig. 2. The essential requirements

In addition to the CPD, for each essential requirement, an "interpretative documents" defines *qualitatively* the performance characteristics to be required from the construction products in order that the construction works made of them will respond to the essential requirement concerned. And these performance characteristics which are needed for the end use of products are then defined *quantitatively* in harmonized product standards referring to performance testing standards, calculation standards and classification standards.

It is to be noted that the jurisdiction of the European Union covers construction products, according to the CPD, but not construction works which remain in the jurisdiction of the Member States and their regulatory authorities (figure 3).

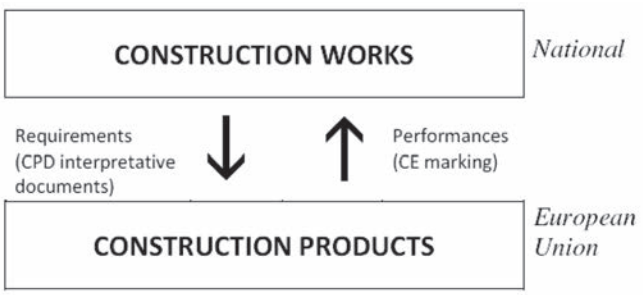

Fig. 3. National and European jurisdictions according to the CPD

CEN standards

The European Committee for Standardization (CEN - Comité Européen de Nor-

malisation) gathers the national standardization organizations from the 27 EU Member States (figure 4), one candidate to EU (Croatia) and the 3 members of EFTA (European Free Trade Association: Iceland, Norway and Switzerland). The standardization organizations of 20 other States are affiliated or partners and may take part to the CEN Technical Committee meetings, but without voting (figure 5).

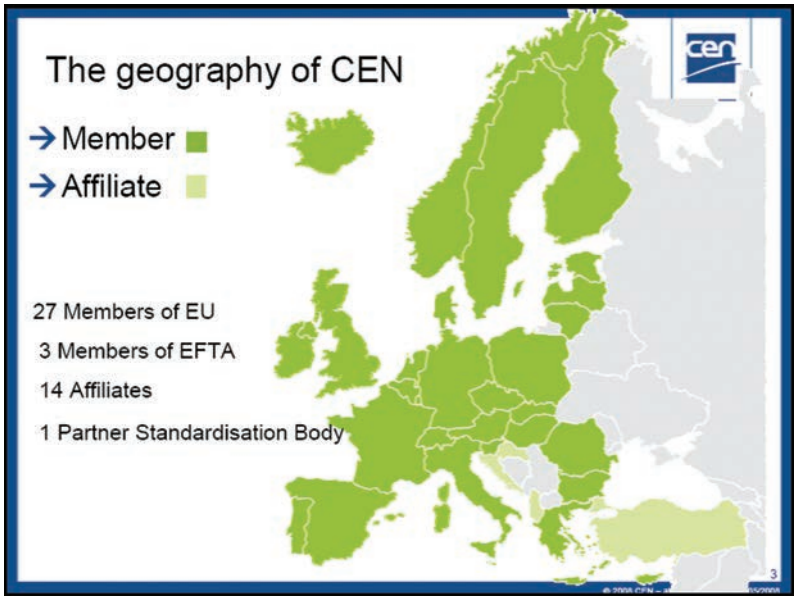

Fig. 4. CEN members, affiliates and partners (2008)

31 CEN members	VOTES	
France, Germany, Italy, United Kingdom	29 (x4)	
Poland, Spain	27 (x2)	
Romania	14 (x1)	
Netherlands	13 (x1)	
Belgium, Czech Republic, Greece, Hungary, Portugal	12 (x5)	
Austria, Bulgaria, Sweden, Switzerland (EFTA)	10 (x4)	
Croatia (EU candidate), Denmark, Finland, Ireland, Lithuania, Norway (EFTA), Slovakia	7 (x7)	
Cyprus, Estonia, Latvia, Luxembourg, Slovenia	4 (x5)	
Iceland (EFTA, EU candidate), Malta	3 (x2)	
CEN TOTAL		372
CEN majority	(71 %)	265
EU TOTAL (without EFTA)		345
EU majority (votes under CE mandate)	(73,9 %)	255

No votes : 19 CEN Affiliates : Albania, Azerbaijan, Armenia, Bosnia/Herzegovina, Libya, Belarus, Egypt, Macedonia, Georgia, Israel, Jordan, Lebanon, Moldova, Montenegro, Morocco, Serbia, Tunisia, Turkey, Ukraine.

1 CEN Partner Standardization Body : Australia.

Fig. 5. Weighted voting on CEN standards (2011)

Although a weighted vote is used to approve standards (figure 5), the aim of the works within working groups and project teams preparing them is to reach a "consensus", which is defined by ISO [9] as *"a general agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments (note: consensus does not necessarily imply unanimity)"*. The good practice of this principle proves to be the best way to obtain standards widely accepted.

CEN has been mandated under the CPD by the EU Commission to draft about 600 harmonized product standards (hEN) and about 1500 standards on performance test methods. This vast standardization program of more than 20 years has been realized through 55 standardization mandates from the European Commission, which have involved more than 80 CEN Technical Committees. This makes from the construction sector, by far, the largest sector in CEN (figure 6).

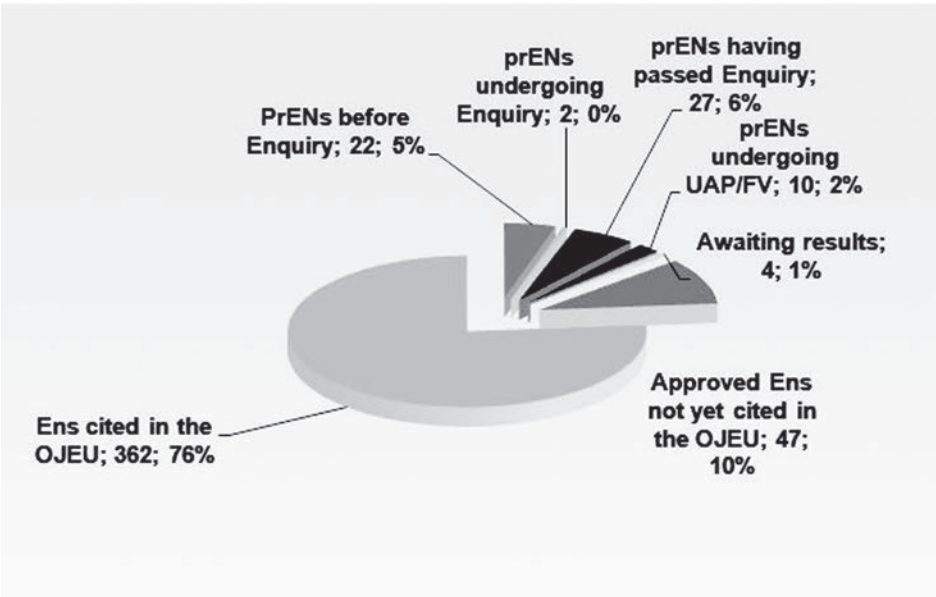

Fig. 6. Present state of the CEN standards for the construction sector (2010)

Figure 7 summarizes how the CPD is managed and how the responsibilities are shared between public authorities – EC (EU Commission), SCC (Standing Committee for Construction), MS (Member States) — and private bodies – Producers, CEN, NB (Notified Bodies) and the market.

In addition to the products standards, CEN has received standardization mandates from the EU Commission regarding construction works and general aspects of safety i.a.:

Sustainability: *"Development of horizontal standardized methods for the assessment of the integrated environmental performance of buildings"* (EC mandate 350).

Energy performance: *"Elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings in accordance with the EPBD (Energy Performance of Buildings Directive* [10])" (EC mandate 343).

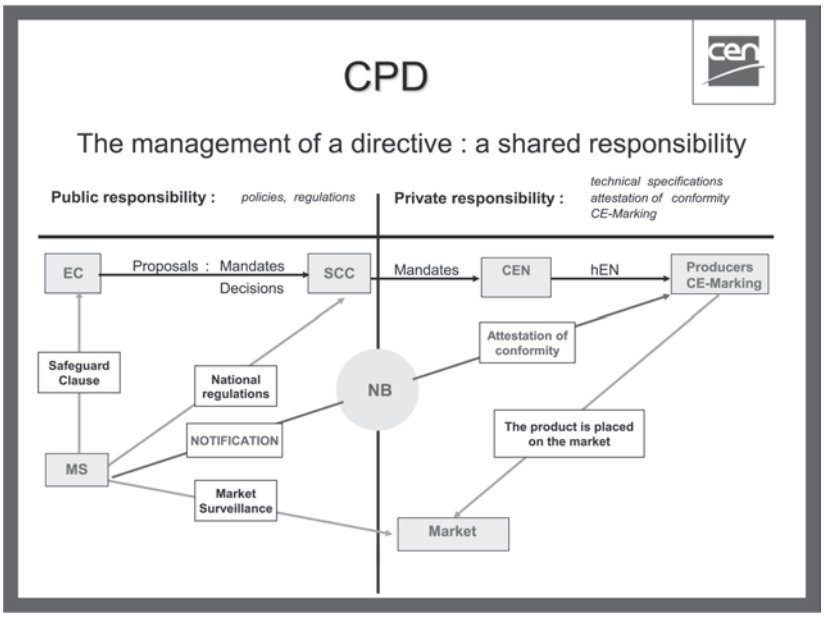

Fig. 7. The CPD management

Dangerous substances: *"Emission to indoor air and release to soil, surface water and ground water"* (EC mandate 366). It is to be noted that, in the new CPR, the "declaration of performance" required for every construction product will have to include the hazardous substance information required by the REACH regulation [11].

Fire safety: *"Evaluation of construction products in respect of their reaction to fire"* (EU mandate 88), *"Evaluation of construction products and elements in respect of their resistance to fire"* (EU mandate 117) and *"Fire alarm/detection, fixed fire-fighting, fire and smoke control and explosion suppression products"* (mandate 109).

EUROCODES: *"Agreement between the EC and CEN concerning the work on Eurocodes for the design of building and civil engineering works*" (BC/CEN/03/89).

EUROCODES

In this last case, the EC took already the initiative herself in 1975 to establish a set of harmonized technical rules with the aim to eliminate technical obstacles to trade, which led to the first generation of European codes in the 1980s. This work was transferred in 1989 to CEN Technical Committee 250 "Structural EUROCODES" in order to provide them with a future status of European Standard (EN).

The second generation of EUROCODES were published in 1999 as 62 pre-standard (ENVs) and after a period of experimental use in the Member States, on basis of the comments received, they have been converted into 58 European Standards (ENs) published in 2010 (figure 8). There are still "Nationally Determined Parameters" (NDPs) for which the ENs are giving recommendations, but it is left to the National Standardization Bodies to publish National Annexes (NA) with national choices for each of them which may differ from the EN recommendations. It is to be noted that, even if separated EUROCODES are devoted to specific structural materials (concrete, steel, timber, masonry, etc.), these have been drafted in order to correspond to the same safety level, and they may therefore be considered as a whole set of performance-based calculation methods.

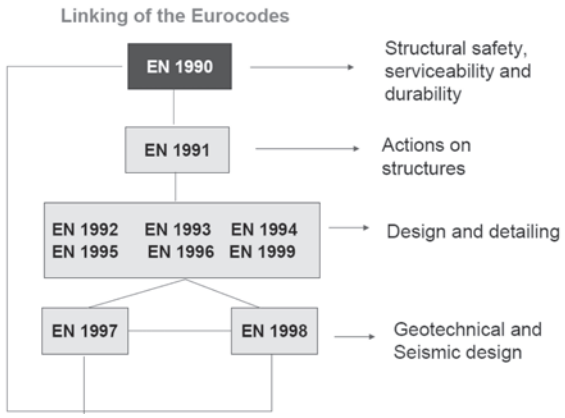

Fig. 8. The EUROCODES

A third generation will be prepared in 2011—2015 (EC mandate 466), extending to other structural materials, such as glass, fibers reinforced polymers or tensile membranes, and with the aim, strongly supported by the EC, to remove all the differences between the NAs, except those which may be justified by natural causes (climatology, seismology, etc.) or those which express overall performances of construction works, such as partial safety factors, which remain within the jurisdiction of the Member States.

Regulations

The first construction regulation in history was the Hammurabi code dating from 1760 BC (figure 9): it covers safety of persons as well as safety of goods, and fixes already performance-based requirements, together with (rather extreme!) penalties in case of failure.

Code of Hammurabi (1760 BC)	Civil Code of Napoleon (1804)
• *"If a builder build a house for some one, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death."* (Art. 229) • *"If it ruin goods, he shall make compensation for all that has been ruined, and in as much as he did not construct properly this house which he built and it fell, he shall re-erect the house from his own means."* (Art. 232)	*"If the edifice, built at a set price, perish in whole or in part by defect in its construction, even by defect in the foundation, the architect and the contractor are responsible therefor for ten years."* (Art. 1792)

Fig. 9. Examples of construction safety regulations

Since 1804, article 1792 of the Civil Code established by Napoleon, which is still the basis of the legal systems of several European countries, fixes the performance requirement as a 10 years liability of architects and contractors, but leaves to the Courts of Justice, not only the fixing of the penalties, but, before that, the evaluation of the responsibilities on basis of the "good practice" at the time of construction. Among the rules of good practice referred to in the Jurisprudence of the Courts, the EUROCODES will become, from now on, the dominating reference (but not the only one possible) for the stability and mechanical resistance of structures (figure 10).