A Story about Standardization for Design of Glass Works

Didier DELINCÉ
Assistant
Ghent University
Ghent, Belgium

Dieter CALLEWAERT
PhD. Researcher
Ghent University
Ghent, Belgium

Jan BELIS
Lecturer
Ghent University
Ghent, Belgium

Rudy VAN IMPE
Senior lecturer
Ghent University
Ghent, Belgium

Summary

This contribution attempts to give an overview of the European standardization framework which is related to the design and calculation of glass works in buildings. The different work levels, institutions, technical committees and workgroups, and the various types of documents and their statute will be introduced, explaining the difference between draft, experimental and final standards, between harmonized, support and design standards, the general and particular meaning of harmonization and implementation. The standardization framework is explained firstly from the point of view of European standardization policy and history, and secondly regarding the standardization framework in Belgium. In particular, an attempt is made to highlight some particularities existing in harmonization efforts of design methods and codes for glass works.

Keywords: glass, structural glass, performances, assessment, design methods, standards, standardization, technical agreement

1. Introduction

Today many engineers, being in charge of design, execution or research in the construction industry, seem to have difficulties to deal with the large number of standards they have to consider. More specifically, it seems to be hard to keep an overview of the status of the various standards documents, of the articulation and inter-operability logic between international, European and national (inside Europe) standards, but also with Technical Agreements and other technical guidelines. Consequently, this can lead to interpretation problems, and in some cases conflicts. It is not that surprising since many changes happened on the European standardization level in the last 30 years, and regarding the many aspects that design standards (among others Eurocodes) in particular aim to cover. Also, the last few years many new documents have been published, introducing a ‘transition period’ towards a more effective “performance based approach” and a “multi-levels” standardization framework. A lot of technical committees and workgroups are thus working in parallel, making it sometimes difficult for ‘outsiders’ to understand what all of these are dealing with precisely. However, it appears to be a challenge also for ‘insiders’ to coordinate and organise the efforts in drafting ‘compatible’ standards and guidelines.

The case of design standards for assessing the mechanical behaviour and performances of glass works is specific in many ways compared to more traditional construction materials, for historical reasons as well as for technical reasons.

This contribution focuses on the first ones, and aims to give a global, but non-exhaustive, overview of the current European standardization framework, and to highlight it regarding its historical background. In the next paragraphs the different work levels, institutions, technical committees and workgroups are firstly introduced, and subsequently, the various types of documents and their statute, explaining the difference between draft, experimental and final standards, between harmonized, support and design standards, the general and particular meaning of harmonization and implementation. These aspects will be considered in a first part from the point of view of the European standardization policy, and in a second part from the particular point of view of the standardization context in Belgium. By this way we intend to explain some practical difficulties for implementing European standards as similar questions may arise in other countries, and the ongoing dynamic in the European standardization, especially concerning the development of guidelines and codes to design glass works.

The present contribution do not pretend to constitute a complete overview of the situation of standardization, not even to be fully exact regarding legal aspects, but aims at giving some comprehensive landmarks for getting familiar with it. For this reason, the list of references at the end of this paper has been kept limited and completed by a (also non-exhaustive) list of links. List of references to published and draft standards has not been included, the exact references may be found in the databases (on-line catalogues) of the involved bodies ([L1], [L3], [L6], [L10], [L11] among others). In particular, references to some Belgian institutions and technical documents are not simple due to the different names or references according to the used language; in such case, we chose to give below their name or abbreviation first in Dutch then in French, in particular because introducing English equivalent terms make it more difficult to find these references.

The recent IABSE publication [9] also includes a large reference list of standards and other technical documents related to glass design from countries inside and outside Europe.

Besides publications and websites of the mentioned institutions and organisms, the free encyclopedia Wikipedia [L16] has also been used as a source of information to compile this paper.

2. European framework for standardization

2.1 Historical context

Many standardization bodies in Europe were founded at the beginning of the twentieth century, together with the growing industrialization, and mainly after the First World War : for example, BSI (United Kingdom) in 1901, DIN (Germany) in 1917, Afnor (France) in 1926, ABS (Belgium) in 1919. At that time most of them were private initiatives from industrial sector, and not acknowledged as a national standardization institute. International associations of these standardization bodies appeared at the same period (e.g. ISA in 1926).

As a general trend, some standardization bodies were recognized as national standardization institutes after the Second World War, or new structures were created : BSI was recognized as (only) national standardization institute in 1942, DIN in 1975, Afnor is decreed a recognized public-benefit utility in 1943, and in Belgium the BIN-IBN was founded in 1945. The International Organization for Standardization (ISO) [L1] was founded at the same period, in 1947, and regrouped, as a rule, one standardization body by member country. In the first years, the ISO was in fact principally led by the European members, and formulated at that time only Recommendations mainly in industrial topics.

The European Committee for Standardization (CEN) [L3], regrouping the European Members of the ISO, was founded in 1961, shortly after the creation by the Treaty of Rome (1957) of the European Economic Community (EEC), which would later lead to the European Union (EU), with the Treaty of Maastricht in 1993. Standardization was in fact perceived as a good tool to create a common, “harmonized” technical background supporting the development of a unified European economic market. But the activities of the CEN only really increased when the European Commission (the “executive authority” of the EU) began to deliver mandates to the CEN for writing technical standards supporting the so-called “New approach” directives (from 1985), like the Construction Products Directive (CPD, 1989) for the construction sector. The later introduced among others the CE-marking for construction products. In parallel of the creation of the CEN, ISO developed further more effectively its international activities and enlarged its field of action, and from 1985 began to release ISO-standards.

In fact, the histories of CEN and ISO are closely related with each other [L1]. While both standardization bodies pursued different objectives, the need of making a “non-aggression agreement” appeared quickly, to avoid a loss of energy in supporting standardization activities. Besides the political motivations, there were simply not enough experts available for supporting complete parallel structures. This led to the conclusion in 1991 of a technical cooperation agreement between ISO and CEN, known as the Vienna Agreement, aiming to develop the

European market inside the international market, and insure a good inter-operability between ISO and CEN standards. In particular this led to the current situation in which among 30% of the European standards (EN) are “inherited” international (ISO) standards. As a consequence, CEN is also now described as a regional standardization operator in a global international standardization framework. It is also worth mentioning that besides the couple ISO-CEN, other acknowledged European and international standardization bodies and international private consortiums are active in specific fields.

The European Organisation for Technical Approvals (EOTA) [L6] was created in 1990 besides CEN specifically to further support the implementation of the CPD, regrouping national approval bodies in charge of issuing different forms of technical agreements aiming to improve the quality in their respective market of construction sector. The aim was clearly to reduce specific technical barriers between members states in the construction sector, among others by the creation of European Technical Agreements (ETA) to be delivered to individual construction products or product families, “kits” or “systems”, and European Technical Agreement Guidelines (ETAG) to harmonize the technical agreement process by member approval bodies. The concepts of “kits” and “systems” are defined in the CPD, and are certainly of importance regarding some applications using glass, like windows and facade components. While CEN only allows one standardization body as member per country, some countries have more than one member at EOTA.

2.2 Overview of current framework

The level of integration and international cooperation varies according to sectors. The standardization processes in the construction sector are presumably among the most complex, due to, among others, 1) the large amount and variety of stakeholders in the construction process (authorities, architects, engineering offices, control bodies, contractors, insurance companies, manufacturers, end-users,…), 2) the wide application scope, and in particular some regional/local particularities (due for instance to climate, resources,...), and 3) the different national legislations and voluntary initiatives in managing the construction quality and the communication between the stakeholders. Another specificity of the European standardization is the multilingual context, which certainly is a point of special relevance in the construction sector.

The apparent complexity of the European framework has historical reasons highlighted in the previous section. It generally grew up from a harmonization effort from individual, national but also sectorial, pre-existing standards or other technical documents, issued by other organizations and standards *de facto*. In some cases, corresponding standards already had at least partly an identical technical or scientific background, but this is not always well documented, and consequently the origin of some rules or choices may appear as unclear.

The standardization framework for construction is also characterized by a multi-layered structure, from general requirements on performances of buildings and general assessment procedures defined in legal texts, to specific technical specifications on individual products, but also by applicable regulations or specifications according to particular building categories.

This leads to some particularities of the general standardization framework for the construction sector, in comparison to other industrial sectors. The Essential Requirements (ER), typical of the European “New approach” directives, do not apply to the characteristics of final products resulting of an industrial process like in other sectors, but to the end performances of buildings, leading to the so-called “Performances based approach”, which is aiming to be more dynamic and more supporting innovation than the prescriptive approach mainly used in standards of previous generation(s).

The hierarchy and inter-connection between standards can lead to an apparently complex framework, in particular for end-users who have to deal with a large application scope in their day-to-day practice (especially designers, contractors, architects, specifications writers,...), and have thus a strong interest in synthetic, clearly structured documents and tools. The implementation can then be supported by regulations (e.g. legal text) that refer to standards, which can suppress part or whole of the voluntary character of a standard. But implementation is also usefully promoted by specific technical document presenting a structured overview of standards applying for specific project categories.

Design standards are in this framework a particular set of standards, which can be seen as the “technical tool” making the link between the Essential Requirements (ER) on building performances and the Product performances or properties. In this perspective, the Structural Eurocodes are a particular set of European standards (58 parts regrouped in 10 Eurocodes, characterized by a standard number beginning with EN 199x), covering the aspects where the structural, mechanical and material behaviour is involved. More precisely, Eurocodes are concerned with all requirements regarding mechanical resistance and stability (ER1), part of the requirements on safety in case of fire (ER2), namely those concerning the stability to be fulfilled during a specified duration, and some of the requirement on safety in use (ER4) related to the safety of people [3]. One particularity about the Eurocodes is that they do not have to be “simply” endorsed by national members – what implies among others the publication, eventually also a translation of the standard, by the national standardization bodies (NSB) – but need to be completed by National Annexes defining the national requirements, in the form of Nationally Determined Parameters (NDP).

While Eurocodes undoubtedly constitute a strategic tool contributing to the objective of harmonization of technical rules according to European policy, they are not considered as “harmonized standards” : the harmonized (products) standards (hEN) are recognizable by including an “Annex ZA”, and their publication is announced in the Official Journal of the European Union (OJ). The other (non-harmonized) European standards (with a standard number EN xxxxx, containing 1 to 5 digits, eventually subdivided in different parts, e.g. EN 1288-1, EN 1288-2,...) are “support standards” to the harmonised ones (e.g. EN 12150-2 is the harmonized standard for the evaluation of conformity of thermally toughened soda lime silicate safety glass products, supported among others by the EN 12150-1, EN 12600, EN 356,...). Standards become harmonized standards if they were established by the CEN on behalf of a mandate from the European Commission. There is no formal distinction between for instance test standard, product standard, execution standard, calculation standard, specification standard,... and some “support standards” are even covering several of those aspects.

As underlined by the title of the last annual report of the CEN [4], the European standardization framework is not only further growing (number of published standards,...) and extending (number of members and affiliates,...), it is also still evolving. Among the different initiatives supporting these evolutions, let’s mention the ongoing revision process of the CPD, with purpose to make this directive evolve into a Construction Products Regulation (CPR). Other initiatives are concerning the promotion of a better integration of standardization in research and innovation efforts, and in education as well, formalized in the STAIR (STAndardization, Innovation and Research) platform. An integrated approach has been proposed in this context [5] and implementation efforts towards researchers and research institutions are expected starting from 2010. Finally, a series of initiatives have been launched the last years to improve the use of standards by Small and Medium Enterprises (SMEs) (among other by mean of specific guidelines addressed to standards writers, specific communication addressed to enterprises, opening of different helpdesks, development of toolkits,...) and facilitate their participation to the standardization process (support to development of specific appropriate platforms), besides parallel (mostly distinct) initiatives to promote and facilitate innovation in SMEs.

2.3 Making of standards

In the previous section, we provided a short overview of the current standardization framework. In the current section, we aim at giving an overview of the fabrication process leading to standards, and thus of the actors and structures standing behind.

Standardization activities are managed and planned by Standardization Bodies on demand of public authorities (e.g. by mandates from the European Commission), generally supported by legislatives acts (European directives, European regulations,...), or on request from demanding parties from the private sector (e.g. industry) or other stakeholders (e.g. end-users). The ISO and the European Standardization Operators like CEN organize their works according to the principles of national delegation from their members, via the National Standardization Bodies (NSB). Some international and European “communities of interest” (industrial and trade federations, sectorial associations, network platforms of research centres, platforms inter-universities, etc.) are also represented directly at different levels, generally mentioned on the website of each operator. In other words, the development and organization of standardization are not resulting from a linear process, but from various interactions at different levels. All those “cross-links” are supposed to increase the chances for finding compromises and solutions which can fit the needs and expectations of the majority of the different stakeholders.

The discussions about the organization of the technical works from the proposal to the formal approval of standards are conducted by Technical Committees (TC) erected as permanent organs within standardization bodies (e.g. CEN/TC250 “Structural Eurocodes”, CEN/TC129 and ISO/TC160 “Glass in buildings”). Some Technical Committees are further organized in sub-committees (SC), like the CEN/TC250, but this is not encouraged by CEN management. The Technical Committees set up temporary workgroups (WG) for the drafting and writing of standards (e.g. the CEN/TC129 count 19 WG, for instance CEN/TC129/WG8 “Mechanical strength”) [L3]. Joint workgroups are depending of more than one TC. In principle each Technical Committee of the ISO and the CEN is followed by a similar structure within each NSB, in the form of a national mirror-committee. In practice, and especially for smaller member states, some Technical Committees are limited to a secretariat and are not really active. At national level, the standardization activities can be decentralized from the NSB to Standardization Developing Organization (SDO), for instance sectorial operators. These general considerations about the organization of standardization activities will be illustrated on a more concrete way by considering the specific situation in Belgium (see §3.1 below).

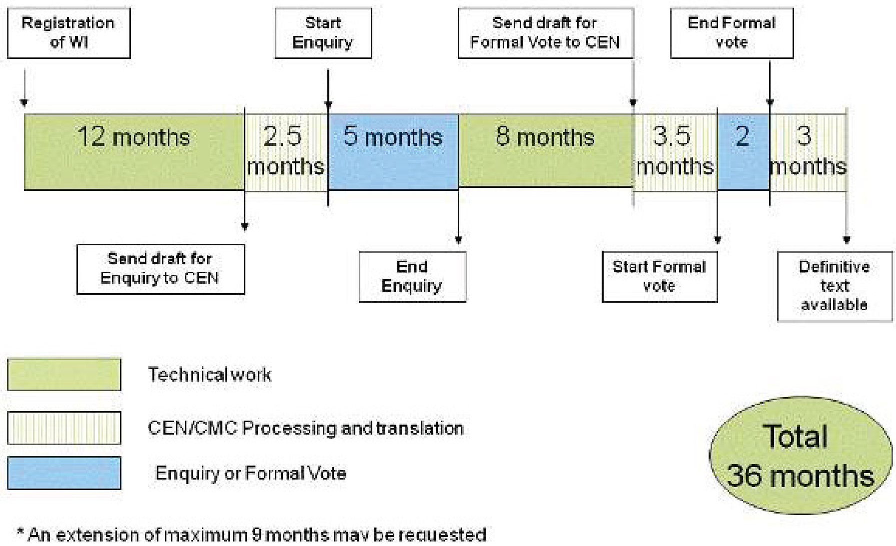

Fig. 1 Reference time schedule for drafting European standards [2]

The reference duration for developing a European standard from the proposal (work item WI) to the formal adoption according to CEN procedures is three years (36 months), but the technical discussions are supposed to be limited to a shorter period according to the reference schedule (see Figure 1). The CEN do not publish standards, but make these available to NSB. At least two ‘official’ draft versions are sent by the CEN to the NSB which organize the ‘CEN Enquiry’ (aimed at collecting technical comments) and later the ‘Formal vote’ (aimed at collecting only last editorial comments). Finally, final versions in three languages (English, French and German) are endorsed by the CEN and made available for publication by the NSB and for eventual further translation. The publication of the standard is followed by a transition period up to the withdrawal of conflicting (national) standards, which have to be defined by the Technical Committee before the final version is made available; a reference period of 6 months is considered between publication date and withdrawal date. Each EN-standard is supposed to go through a review process at least once every five years. These reference durations do not include the preliminary works and consultation efforts previous to a work item. Practically, not all standards are following such a straightforward process, for instance due to funding problems, unfavourable results of enquiries, etc. Consequently, different draft versions “prEN” may be issued or are circulating inside workgroups prior to publication. In some cases, project standards are transferred between TC of different standardization bodies.

It explains why the publication year by a NSB may differ from the DAV by the CEN of EN-standards. It is also worth mentioning that EN-standards can be amended (correction of technical errors) by corrigenda (AC), which are then joined to the corresponding standard part in the catalogue of the NSB, and/or completed by addenda (A1, A2,...), which have the status of a normal EN standard and are prepared according to the same procedure. In particular, almost all parts of the Eurocodes were meanwhile completed by a corrigendum for the last two years. Efforts were announced by the CEN management to reduce the amount of corrigenda in the future.

Procedures for drafting international standards by ISO are similar, with intermediate versions for enquiries recognizable to their codes beginning with “ISO/DIS” (Draft International Standard) and “ISO/FDIS” (Final Draft International Standard), with the difference that ISO standards are also directly sold by ISO (see [L1] for on-line catalogue).

More recently, CEN and ISO developed similar complementary products supporting standards development, like Technical Specifications (TS), a sort of pre-standard that can be released by a TC according to a lighter procedure and that can be endorsed as a national standard, Technical Reports (TR) with an informative status for commenting or explaining some standardization work, and Workshop agreements (CWA for CEN [L3] and IWA for ISO [L1]).

Standardization bodies can also delegate some standardization activities to Standards Developing Organizations (SDO), which are different than the National Standardization Bodies.

This shows that standardization processes are not always simple, and it is thus important to use complete identification codes when making references to standard products. For example, the standard code NBN EN ISO 12543-1 highlights that it has been developed as an international standard (ISO 12543-1) approved by a ISO/TC, then endorsed and released by a CEN/TC (EN ISO 12543-1), and finally endorsed and published as a Belgian standard by a mirror-committee of the NBN. Reference to draft documents certainly requires care according to the target group.

The drafting of the Eurocodes required in fact more time. Preliminary works began during the eighties with “Euronorms”, first attempts of harmonized codes for structural design, which were further developed by the CEN after the publication of the CPD as the Eurocodes program. This led to of a first generation set of Eurocodes released by the CEN between 1994 and 1999 in the form of “experimental standards” (ENV), which could be completed and amended by national provisions to be included in a “National Application Document” (NAD). The effective implementation of these design codes for practical use has been variable according to country and to sector. In a next phase, specific longer procedures were adopted by the CEN to collect the comments on the ENV-Eurocodes, and from there launch the works for writing “final” versions. A period of about three years was foreseen in the adopted reference time-schedule to transpose the ENV Eurocodes into EN versions, up to the date of availability or DAV. According to this schedule, a Eurocode part is supposed to be published by the NSB in at least one of the three official languages within the three months from its DAV, and eventually in other national languages within one year; furthermore, it has to be completed by a National Annex within the two years from the DAV, and finally conflicting national standards should be withdrawn within the three years. Furthermore, Eurocodes parts have been grouped into different coherent packages to define coherent transition periods, which were extended to five years after the DAV of the last part of a package. Considering that the last of the 58 parts of the Eurocodes are available since 2008, full implementation of all Eurocodes should be completed for 2012.

Specifications and design guidelines related to mechanical performances of constructions or parts of it (among others in the form of “kits” and “systems”, mentioned in 2.1 above), including calculation models and assessment methods by testing, can (and should) be based on the Eurocodes, according to Guidance Paper L concerning the CPD (Guidance Papers are non legal interpretations of the CPD dealing with specific matters related to its practical implementation and application; see for instance [L4], [L11] for more detailed information). One difficulty hereby is that the application scope of the Eurocodes is not clearly delimited, and this has to be clarified by the officially competent (national) authorities, but in some cases the interpretation is left to the ‘end-user’ specifications writer, the architect or the contractor. This is partly due to the difference in application scope between the principles and the practical endorsed solutions (calculations and assessment methods). In fact, according to the current framework, Eurocodes are referenced in a wide range of technical documents concerning pre-fabricated construction elements and assemblies, “kits” and “systems”, building parts,... : “support” EN standards, guidelines by approval bodies (ETAG by EOTA,...) and other technical documents which are not always formally bonded to the standardization framework, but can become compulsory if referenced in contractual documents.

2.4 Standards for design of glass constructions

The writing of standards or guidelines concerning design aspects regarding mechanical performances of building parts is more complex than the writing of other kind of “support standards”, because the first need the second ones to be developed previously or in parallel.

For instance, to be able to determine the performances of a structural glazing system, principally specifications are needed on the final performances, on the different constituting parts and on the assembly methods, with corresponding assessment methods (testing methods, measurement methods, dispositions for production control and for control of execution,...). Compared to other structural materials, there are several particularities about the development and harmonization of design rules for glass constructions, of technical and historical nature.

Standardization efforts at European level started in the eighties. Priority was given on standardization of products and of harmonized expression of requirements in specifications, regarding the use of glass as glazing (i.e. as an element of the outer shell). Consequently, the standardization has been essentially done regarding performances of energy (thermal insulation), acoustic comfort, lighting, and safety (resistance to impact,...). Calculation for checking the mechanical resistance of glazing to loads (wind, snow,...) appears at the end of the design process, and apparently also often similarly at the end of the process in works for establishing technical documents (see also §3.2 about the situation in Belgium regarding this comment). One particularity of calculation methods developed in these context is that the considered application scope was essentially limited to basic configurations in framed glazing, and configurations such as plates supported on minimum two edges, in such a way they could be easily and safely applied by non-engineers. Another observed particularity – which might be a consequence of the previous one – is that in many cases the design (calculation) methods for the glazing unit and for the surrounding window frame are covered or handled in different standards or technical documents, established within different technical committees, sometimes from different institutions or sectorial operators.

The windows sector was essentially constituted of small and very small enterprises besides the larger flat glass producers. In parallel of the increasing amount and quality of processed glass products from basic flat (float) glass, as the increase in their application range, companies producing processed finished products and glaziers began to specialize. Similar evolutions happened for companies involved in the other windows and light facades components. Some architect/engineering offices began to specialize in façade engineering, and further developed design methods for the new particular, up to “structural”, use of glass.

A large part of the flat glass products were covered by European harmonized (product) standards during the nineties, some of them meanwhile already received a second reviewed version. First codes of practice or guidelines for designing and assessing the performances of facades elements and structural glazing systems began to be published at the end of the nineties, among other to establish a basis for delivering technical agreements (e.g. ETAG002 by EOTA, and different initiatives in some members states; also general guides for designers are appearing, like [7]). Subsequently, series of support EN-standards introducing performance classes regarding final performance requirements for windows and facade elements followed since 2004. In the same period, parts about design (by calculation) of glass units (prEN 13474 series) progressed less easily. Among the various reasons, a discussion point concerned the question of ensuring a “Eurocodes compatibility”, with all the practical questions lying behind this statement.

This started to be discussed within a joint-workgroup between CEN/TC250 and CEN/TC129 in 2006, which led to a wider consultation resulting in a JRC-report published by the European Commission [10]. More recently, the erection of a specific workgroup “Structural Glass” by the Technical Committee CEN/TC250 has been announced [6].

In parallel, other interesting initiatives have to be mentioned. A five year COST Action, funded by the European Commission and finished in 2006, supported a first European research network round the theme “Glass&Interactive Building Envelopes”; one of the three organised workgroups was dedicated to the “Structural aspects of glass”. A report resulted [8] which stated as major conclusion that the different design aspects of facades are by far not sufficiently integrated. This was followed by an international workgroup “Glass Structures” erected in 2007 by the International Association for Bridge and Structural Engineering (IABSE) [L2], which selected four actions. The two first concerned the identification of achieved and ongoing research, and of the new needs for research; a third one concerned the inventory of existing technical formations in this field; and the fourth one intended to make an overview of development of standardization worldwide. A new four years COST Action “Glass Structures” (TU0905) has been started in 2010 [L8] to propose a new platform enhancing spreading of information and collaboration between research projects across Europe, focusing on the next four themes or priority areas :

1. the prediction of complex loads on glass structures;
2. the characterisation and the improvement of material properties;
3. the development of an integrated design approach incorporating risk analysis and post-fracture performance;
4. novel glass assemblies.

Consequently, closer exchanges between research institutions and standardization bodies through those different platforms are likely to be expected in a close future.

3. Implementation of European standards in national framework

The ways to achieve the implementation of European harmonization policy in the different member states are various according to their national legislation and their traditions in sector organization. We consider the situation in Belgium to tentatively give some insight about some more concrete aspects regarding standardization activities.

3.1 Recent evolutions in organizing standardization activities in Belgium

Some characteristics of Belgium are that it belongs to the smaller European member states, is member from the very beginning, and has more than one official language : three official languages are acknowledged (Dutch, French and German), but practically only the two first are essentially used in national technical standards. Also, French and German belong to the official languages used for CEN works, and Dutch is a common language with another member state, the Netherlands.

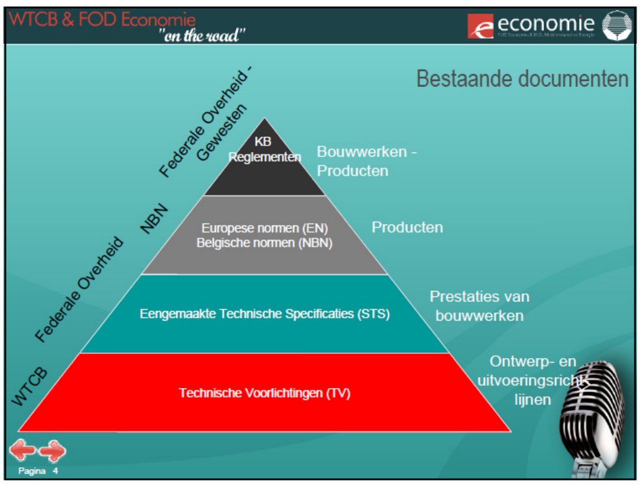

Fig. 2 Hierarchy principle between existing regulations and standards [L9][L11]

In the Belgian construction sector, there is a quite “liberal” tradition for the control of the market compared to other European countries (and in particular to some neighbour countries of Belgium, like Germany and the Netherlands), using relatively few constraining legislative instruments in combination with a relatively large amount of volunteer initiatives to promote quality in construction. Regarding the Essential Requirements of the CPD, only part of the requirements concerning the fire safety were covered by regulations up to recently : regional regulations appeared implementing the Energy Performance of Buildings Directive (EPBD) between 2006 and 2008, which is also related to one of the six ER of the CPD.

This induced that Belgium did not to have to make many modifications to its legislation to endorse European directives. In the construction sector, Technical reference documents besides the Belgian standards (NBN) are among others STS (Unified Technical Specifications) published by the FPS Economy (a Federal Public Service is a department of the national public administration, previously known as Ministry in charge of Economic Affairs) [L9], Technical Information Notes (TV-NIT) and other publications from the Belgian Building Research Institute (BBRI) [L11], and other technical publications from other sectorial organisms. The hierarchy principle between the different documents types has been recently presented by mean of the sketch of Figure 2.

An important change in the organization of standardization activities has been achieved by the reform of the National Standardization Body for CEN and ISO, initiated by a law of 2003. This gave an impulsion to a decentralization of standardization activities with the replacement of the existing Belgian Standardization Institute (BIN-IBN) by a new Belgian Bureau for Standardization (NBN) [L10][1] and a series of sectorial operators (referenced as "Sector Normalisation Operators", SNO), which seem to correspond to the concept of Standard Development Organization (SDO) used in the international standardization terminology. In 2008 the NBN appointed 24 sectorial operators, largely constituted by collective research centres. The NBN delegates so the organization of the mirror-committees of Technical Committees of CEN and ISO. However, some mirror-committees were not affected to an operator, which can then be related to none, one or some experts.

Among the operators acknowledged by the NBN, which were assigned to Technical Committees associated to the construction industry, are (see [L10], [L12] for more complete lists) :

- the BBRI (research centre and notified body), for some committees in association with SECO (control office) – among others for CEN/TC250 and CEN/TC33
- the association Sirris-Agoria (Sirris is a collective research centre associated to the corresponding trade federation, Agoria) [L13]
- the VGI-FIV (trade federation of glass producers) [L14] – for CEN/TC129 and ISO/TC160 only

The collective research centres acknowledged as sectorial operators were generally already actively involved in standardization efforts for many years. The national authorities also already promoted and funded for several years the opening of thematic helpdesks within those organisms, called "Standards Antennas (Normen-Antennes / Antennes-Normes)" ([L15], [L9]), to support the diffusion of information and the formation about standards, and propose assistance services to enterprises, especially to SMEs, for applying and implementing standards in their day-to-day practice. Besides, regional authorities are funding innovation supporting projects, in the form of Technological Advisory Services (TAD-GT) within the same organisms and universities.

3.2 Standardization regarding design of glass constructions in Belgium

As stated in the previous section, there is no global regulation frame for designing and building activities in Belgium. Different sorts of technical documents exist, but they are not always consistent with each other. With the reform of the national standardization institute in NBN, efforts are made to clarify the hierarchy between existing documents and documents in preparation.

The design of constructions containing glass elements (glass panes) are mainly covered by Unified Technical Specifications (STS) and Technical Information Notes (TV-NIT) presented above. Principally, the first are more global specifications documents, developed mainly as support for specifications writers (architects, public administrations, contractors...); the second are more written as practical codes of good practice, directed mainly towards builders, but are also useful for designers and architects.

The Figure 3 gives a schematic representation of the evolution in time of the standardization framework related to design of glass constructions in Belgium. On this drawing are mentioned the principal documents. Some of them are though referring to other technical documents, published by the BBRI or by other organisms, in the form of technical papers, technical fiches, etc.

Following the efforts at European level for the standardization of glass products, which led to first EN-standards round the beginning of the nineties, the TV-NIT 214 has been prepared and has been published in 1999 by the BBRI. This contributed certainly to the practical use of European standards by construction professionals, parallel to the implementation of CE-marking by glass producers. Due to the ongoing state of advancement of the Eurocodes, this Technical Information Note remained referring to older documents regarding design by calculation of glazing units (TV-NIT 176 for sloping glazing and Rapport 2 for vertical glazing, both BBRI publications). Around this period appeared probably the necessity to launch the review works of some STS to bring these in accordance to the European context of that time, especially the STS 38 (= NBN S 23-002) about glass works (essentially glazing applications) and the STS 52, about specifications for facade works (especially the millwork). Many discussions arose, among other regarding two problems : the application of the principles of the Eurocodes for calculations rules, and the specified performance levels and practical assessment methods regarding the conformity of the final impact performances of facade components. Similar problem was stated for the review of STS 54 about guardrails (balustrades). In parallel, another workgroup began to draft design methods for a wide series of particular applications in glass, intended to be published as a Technical Information Document "Particular glassworks" (BGW-OPV). These works were occurring in parallel of the development of prEN 13474 (see above, §2.4).

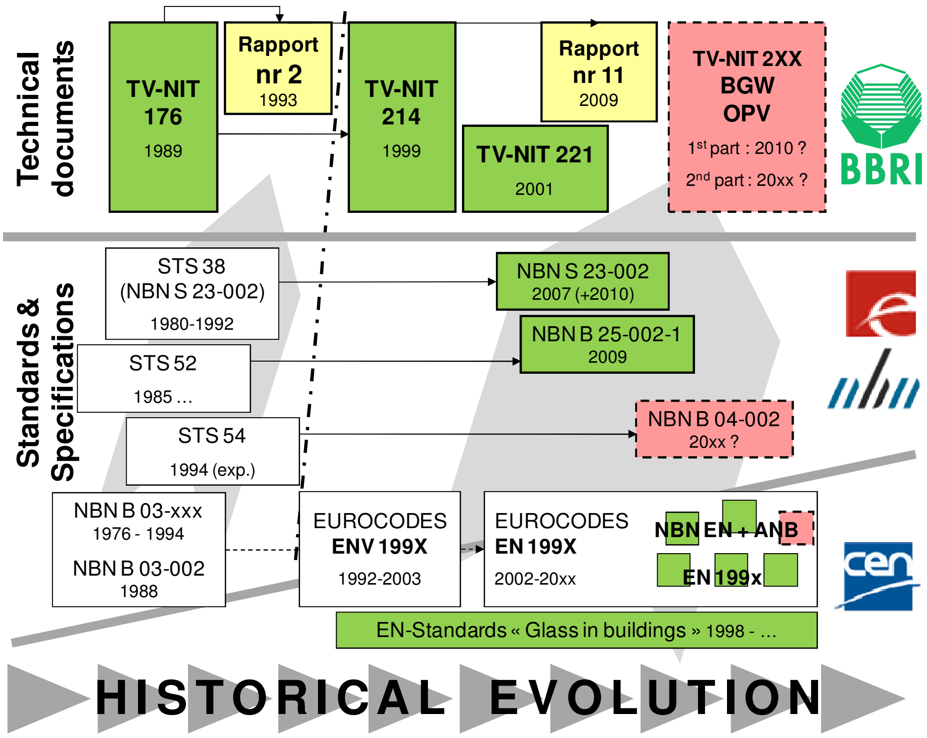

Fig. 3 Schematic standardization framework related to design of glass constructions in Belgium

The new version of the NBN S 23-002 (STS 38) finally has been approved for publication in 2007 (which got an addendum in 2010), and the reviewed version of the STS 52 has been published in 2009 as a new standard with reference NBN B 25-002-1. However, the aspects regarding calculation rules were transferred to a new transversal workgroup, and were not included into the new specifications standards. The draft containing proposals for calculation methods, formalised according to the Eurocodes, has been made available by BBRI in the form of a 'technical report', Rapport 11, in 2009.

In parallel, the project of TV-NIT about particular glass works (BGW-OPV) has been splitted in two parts, the first one covering applications which were identified as "structural" (glass floors and stairs, glazed walls of watertanks – pool, fish tank,... – , etc.) has been approved by the concerned technical committee of BBRI, and is being finalized for publication. Works were started to achieve a second part covering specific "non-structural" applications (among others glass doors, applications with special glass products like channel shaped glass and curved glass, etc.).

The overview given here above allows to highlight some aspects :

- After the TV-NIT 176 which included simple practical calculation methods to determine the thickness of glazing units to resist wind and snow loading, calculation methods to determine the final thickness of glazing units were not included in a standard document (TV-NIT, STS or other standard), but taken over in ‘reports’. The TV-NIT 176 has not been withdrawn essentially because of the calculation methods, all other chapters of the document were replaced by one or other more recent document part.
- The difficulties of achieving European standards or guidelines on short term for design of glass works force some European countries to release new national standards or reference technical documents, because there is a strong demand from the sector, which cannot be delayed for years. There is another reason for this : most of the existing standards or technical documents still refer to or implemented previous national codes for actions on buildings, in particular for wind and snow actions, which are being withdrawn following the publication of Eurocodes and National Annexes (EN 1990 and EN 1991 series in particular), and corresponding defined transition periods. It does not only concern calculation methods of glazing applications, but potentially all the technical documents handling applications which may be considered as targeted by the Guidance Paper L. Efforts in research and towards harmonization should certainly take these aspects into account.
- The practical aspects related to harmonization have to be evaluated and taken into account. Examples of some points which seem to deserve attention : care for unambiguous terminology, concepts and references through the different used languages; coordination strategy of complementary works;...

4. Conclusions

A parallel overview of the evolution of the standardization framework in Europe and Belgium which relates to the design of glass works has been presented and discussed in a larger perspective, especially regarding the more general changes which occurred the last years in the organization of standardization activities.

It is also appearing as a trend that closer interaction between research and standardization activities are expected. It seems in particular important for researchers to have a good comprehension of the standardization context, because in many cases their contribution (included their publications) is expected to be finally valued for practical applications, and thus within the standardization framework. To achieve this, probably efforts have to been done from actors of both sides, in standardization and in research.

5. References

[1] NBN, *Stand van zaken van de normalisatie in België*, Brussels, Belgium, January 2010, http://www.nbn.be/NL/BrochureNBN_NL2009.pdf

[2] SIRRIS-AGORIA, *Wegwijs in technische regelgeving en normalisatie*, publish by FPS Economy, SMEs, self-employed and Energy, Belgium, January 2010, D/2009/2295/86, http://www.sirris.be/uploadedFiles/News/Brochure_normalisatie_NL.pdf

[3] BBRI, *De Eurocodes. Memento 2003*, Brussels, Belgium, 2003 http://www.bbri.be/antenne_norm/eurocodes/pdf/memento_2003_NL_print.pdf

[4] CEN, *Annual report 2009: Change*, 76 p., ftp://ftp.cen.eu/CEN/AboutUs/AR/AR09.pdf

[5] CEN/CENELEC, *STAIR: An Integrated Approach for Standardization, Innovation and Research*, 2009, 11 p., ftp://ftp.cen.eu/PUB/STAIR.pdf

[6] CEN, CEN/TC250 newsletter, Issue 4, May 2010, http://eurocodes.jrc.ec.europa.eu/doc/250news/TC250_Newsletter_4.pdf

[7] INSTITUTION OF STRUCTURAL ENGINEERS, *Structural use of glass in buildings*, 1999, London, ISBN 1-874266-51-4, 168 pp.

[8] CRISINEL M., EEKHOUT M., HALDIMANN L. and VISSER R., ed. *Research in*

Architectural Engineering Series. Volume 1 : Glass & Interactive Building Envelopes (EU COST C13 - Final Report), IOS Press, Delft, The Netherlands, 2007, 308 p.

[9] HALDIMANN M., LUIBLE A., and OVEREND M., *Structural Engineering Document 10: Structural Use of Glass*, IABSE, 2008, ISBN 978-3-85748-119-2, 215 pp.

[10] ZARNIC R., TSIONIS G., GUTIÉRREZ E., PINTO A., GÉRADIN M., and DIMOVA S., *Purpose and justification for new design standards regarding the use of glass products in civil engineering works*, JRC Scientific and Technical Reports EUR 22856 EN, European Commission, 2007, 32 p., http://eurocodes.jrc.ec.europa.eu/doc/EUR22856EN

Links

[L1] http://www.iso.org : International Organization for Standardization (ISO)

[L2] http://www.iabse.org : International Association for Bridge and Structural Engineering (IABSE)

[L3] http://www.cen.eu : European Committee for Standardization (CEN)

[L4] http://ec.europa.eu/enterprise/sectors/construction : “entry point” on the website of DG for Enterprise and Industry of the European Commission

[L5] http://www.jrc.ec.europa.eu : Joint Research Center (JRC) of the European Commission

[L6] http://www.eota.eu : European Organisation for Technical Approvals (EOTA)

[L7] http://www.cost.eu : European Cooperation in Science and Technology (COST)

[L8] http://w3.cost.esf.org/index.php?id=240&action_number=TU0905 : Cost Action TU0905: Structural Glass - Novel design methods and next generation products (Entry into force : 21/01/2010; End of Action : 06/04/2014)

[L9] http://economie.fgov.be : Federal Public Service (FPS) Economy, SMEs, self-employed and Energy (department of the Belgian federal administration)

[L10] http://www.nbn.be : Belgian Standards Bureau (NBN)

[L11] http://www.bbri.be, Belgian Building Research Institute (BBRI / CSTC / WTCB)
(Sector Normalisation Operator (SNO) for NBN, see also http://www.wtcb.be/go/normen)

[L12] http://www.wtcb.be/homepage/index.cfm?cat=services&sub=standards_operator&pag=reglementation_belgium&art=sectoral_operations&niv01=standardization_operator : list of Technical Committees, corresponding Belgian mirror-committees and responsible Sector Normalisation Operator for the construction sector

[L13] http://www.sos-sa.be : Sirris-Agoria (Sector Normalisation Operator (SNO) for NBN)

[L14] http://www.vgi-fiv.be : Verbond van de Glasindustrie (VGI) / Fédération de l’Industrie du Verre (FIV) (Sector Normalisation Operator (SNO) for NBN)

[L15] http://www.normen.be : portal of “Normen-Antennnes” (standards antennas) of BBRI

[L16] http://www.wikipedia.org, http://en.wikipedia.org, http://fr.wikipedia.org : free encyclopedia Wikipedia
(http://en.wikipedia.org/wiki/Standards_organization : one interesting overview of international framework for standardization)