Product Declarations with respect to Durability – A progress report

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ABSTRACT
The scope of ISO/TC59/SC14 "Design Life of Buildings" is to produce standards on the steps to be taken at various stages of the building cycle to ensure that the resulting constructed facility, will last for its intended life without incurring large unexpected expenditures of money or resources. The standards for design life of buildings also identify a guiding concept on durability of building products of help in implementing the European Construction Products Directive, CPD. Four parts of the standard series, ISO 15686 Buildings and Constructed Assets – Service Life Planning, have been published. Another 4 parts of the 15686 series are on the way to be approved, one being the Part 8 "Reference service life and service life estimation". Of particular importance is the concept of Reference Service Life (RSL; the expected service life in a well-defined set of in-use conditions), the procedures for service life prediction (Part 2) and the Factor Method (FM) for estimation of service life in specific projects (Part 1 and 8). The FM is used to modify an RSL to obtain an estimated service life (ESL) of the components of a design object, while considering the difference between the project-specific and the reference in-use conditions. This methodology receives much interest from the international R&D community. A challenge is to establish databases on RSL and factor distributions. This presupposes the involvement of the industry and other stakeholders in the work. RSL is also essential in providing environmental information on whole life cycle of building products. According to ISO/DIS 21930 Buildings and Constructed Assets – Sustainability in Building Construction – Environmental Declarations of Building Products, it is necessary to have RSL data of the product to provide scenarios for environmental impacts of the use stage of the product. The Part 9 "Service life declaration in Product standards" is developed in parallel with work in CEN to establish guidance documents for inclusion of durability declarations in product standards. For innovative products EOTA (European Organisation for Technical Approvals) are issuing European Technical Approvals, where the durability evaluation is performed according to EOTA guidance developed on the basis of the service life prediction concepts as expressed in ISO 15686-2.

With the rapid development of IFC based standards for digital object oriented models of building products there is a huge need for property sets, such as durability and service life data, which can be linked directly to the building elements.

KEYWORDS

Service Life, Product Standards, Durability Declarations

1 INTRODUCTION

In 1993, the standardisation work in the field of service life planning started when ISO/TC59/SC14/WG9, Design Life of Buildings, was launched at a meeting in Atlanta. The purpose of the activity is to document steps to be taken at various stages of the building cycle to ensure that the resulting building, or other constructed facility, will last for its intended life, the design life, without incurring large unexpected expenditures. The group was initiated on a significant European initiative based on the need of supporting standards when implementing the European Construction Products Directive, CPD [CEC 1988]. The establishment was based on the Vienna Agreement on co-operation between CEN and ISO. Some years later the working group was elevated to ISO/TC59/SC14. The background to the standardisation work and specifically its relation to CPD but also its relevance to similar motives and needs internationally have been thoroughly reported by Sjöström et al [2002].

The scope of this article is to report and discuss the further progress of the standardisation, with a specific focus on product standards and the principles for inclusion of durability and service life declarations in these. The significant importance of service life data in all aspects of sustainable construction, e.g. environmental product declarations, is addressed, as is the opportunities offered by the development of digital object oriented models of building products and the IFC based standards.

2 ISO 15686 STATE-OF-WORK

The four parts ISO 15686-1 "General principles" [ISO 2000], ISO 15686-2 "Service life prediction principles" [ISO 2001], ISO 15686-3 "Performance audits and review" [ISO 2002] and ISO "Procedure for considering environmental impacts" [ISO 2004a] have already been approved as full ISO standards.

Further parts in the series are under way.

Table 1: Further parts on ISO 15686.

Parts on ISO 15686 under way
Part 4: Data requirements
Part 5: Whole life costing
Part 7: Performance evaluation for feedback of service life data from practice
Part 8: Reference service life and service life estimation
Part 9: Guide on the inclusion of requirements of service life assessment and service life declarations in product standards
Part 10: Description of the data required in estimating service life
ISO 21933-1 Performance standards in buildings – Levels of functional requirements and levels of serviceability – Part 1: Principles

Part 4 is decided to become a Technical Report. Part 5 is the subject of a current DIS voting, while part 7 and 8 already have been approved as DIS. The development of part 9 and 10 has recently started. The further development of ISO 21933-1 has been transferred to ISO/TC59/SC14 due to the closure of ISO/TC59/SC3. In addition, a revision of part 1 "General principles" has commenced.

In Europe, an approval process by CEN of ISO 15686 as EN standards has started, subsequently making them mandatory within EU. By no doubt, this will generate demands on both further RTD and subsequent standardisation, particularly at the product level. For this purpose, CEN has established CEN/TG Durability, having the task to produce a Short-term Guidance document and a Long-term Guidance document on the inclusion of working life in product standards. The European Organisation for Technical Approvals – EOTA has in principle the readiness to issue CE labelling of products. The significance of this would be that the product meets the requirements of the CPD, which can be demonstrated based either on standards or technical approvals. As a consequence, the Service Life Methodology has also formed the basis of an EOTA document for the assessment of working life of products [EOTA 1999]. This issue of implementation of the CPD via the ISO 15686 standards is also the subject of a recent paper by Sjöström et al. [2002].

3 THE FACTOR METHOD AND THE REFERENCE SERVICE LIFE CONCEPT

Service life planning of a design object involves the estimation of service life of its components. However, even if there are certain service life data of a component available from various sources, in general such reference service life data cannot be used satisfactorily as found. This is because it is very unlikely that the in-use conditions specific to the design object will be the same as the reference in-use conditions, i.e., the in-use conditions under which the reference service life data are valid.

Accordingly, in order to achieve an appropriate estimated service life, there is a need of modifying a reference service life available by taking the differences between the object-specific in-use conditions and the reference in-use conditions into account. The Factor method [ISO 2000 and ISO 2004b] provides a systematic way of carrying out such a modification.

The Factor method can be applied at different levels of sophistication, from working as a simple check-list to complex calculations. The level should be selected in dependence on conditions such as the actual purpose of the estimation, type and quality of available data and models, skill level and type of expertise of the user(s) making the estimation, and resources and time available for the calculation.

One straightforward way of applying the Factor method is to multiply a reference service life *RSL* by a number of modifying factors *A* to *G*, each of which reflecting a difference between the object-specific and reference in-use conditions within a particular factor class, see Table 1, thus obtaining an estimated service life *ESL*:

$$ESL = RSL \times A \times B \times C \times D \times E \times F \times G. \quad \textbf{(1)}$$

Table 2: Factor classes.

Factor class	Designation
A	inherent performance level
B	design level
C	work execution level
D	indoor environment
E	outdoor environment
F	usage conditions
G	maintenance level

For the application of the Factor method, except from knowledge of *RSL* itself, of course also information of the reference in-use conditions as well as the object-specific in-use conditions must be available in order to allow estimation of the modification. Thus, the reference in-use conditions should be provided together with the *RSL*, while the object-specific in-use conditions are determined from the knowledge of the design object and site.

In ISO [2004b], it is described how an *RSL* and appurtenant reference in-use conditions together with additional required or useful information concerning the *RSL* should be formatted into an RSL data record.

4 SERVICE LIFE DECLARARTIONS IN PRODUCT STANDARDS

There is a need of standard guidance on the inclusion of requirements in product standards of how service life assessment and service life data should be derived and declared to enable compliance with the existing ISO 15686 standards, specifically parts 1, 2 and 8 [ISO 2000, ISO 2001, ISO 2004b].

Hence, a new work item in the ISO 15686 series is part 9: " Service life declarations in product standards". This standard is intended to give guidance to standard writers how to take into account and include requirements of declarations of service life assessment and service life data in product standards. This ISO work item is closely interrelated to the scope and objectives of a CEN Task Force on Durability, which are to give guidance to CEN technical committees in their work to establish harmonised European product standards. The CEN TF has produced a short term guide aimed at supporting those CEN TC´s still working on the first generation harmonised product standards. This guide give directions on how to meet the durability requirements of CPD, and is included in an ongoing revision of the CPD Guidance Paper F "Durability and the CPD" [CEC 2001]. The second task of the CEN TF is to produce a long term guide for second generation of harmonised product standards considering the concepts established in ISO 15686, and subsequently this task goes hand in hand with the work by ISO.

It is of crucial importance to form a document that the manufacturers will consider as a useful tool when marketing their products and not as an obstacle. That is, within a standardised frame and without compromising with the credibility, as large a number of freedoms as possible to evaluate and declare service life data should be allowed. Of course, subsequently the manufactures themselves may impose stricter requirements at the product level via their participation in respective product standardisation committees. In other words, this standard should provide a minimum level for the evaluation and declaration of service life data.

It can be foreseen that it would not be feasible to require that service life declarations have to be given for every bolt or nail. What products that could be excepted from declaration provisions are up to the standardisation organisation issuing the product standards to decide. However, it is important to offer every producer the possibility to declare service lives, if so on a voluntary ground, to improve his/her competitiveness.

A declared estimated service life is not to be interpreted as a guarantee given by the manufacturer, but are regarded only as a means for choosing the right products in service life planning according to ISO 15686-1 [ISO 2000].

Preferably, service life data should be obtained in accordance with the provisions of 15686-2 [ISO 2001], that is, by long-term exposure and/or short-term exposure, and subsequent evaluation, or feedback from practice [ISO 2000c].

Nonetheless, other test methods should be allowed. Such tests, however, have eventually to result in explicit statements of the estimated service life. The minimum requirement on a statement could be just a lower limit of the estimated service life. This type of minimum statement could be particularly suitable when a test result or a property just is evaluated against a simple pass/fail requirement, which in some respect has to be based on experience of the service life becoming long enough upon passing, say at least 100 years. Finally, if the concept of "normal" service life is used as the lower limit, "normal" has to be quantified in years!

In every instant, all in-use conditions or measures required to reach the estimated service life should be provided. Particularly, as for outdoor environment an appropriate range of conditions should be assumed, resulting in a range of service lives. A definition of environment classes or use categories may be done.

Provision of data should be made according to ISO 15686-8 [ISO 2004b].

5 REFERENCE SERVICE LIFE IN SUSTAINABLE CONSTRUCTION

Predominantly a client sets the performance requirements for the building in terms of building performance and functionality. The key elements that need to be developed for the successful linkage of performance-based building with service life planning are thoroughly discussed in Trinius, Sjöström [2004]. The basis for the requirements is usually about technical performance. But during its life cycle, from raw material supply of building products to the final disposal of building components, the building has environmental and economic impacts as well as impacts on the health & comfort of the users. These impacts can be analysed in the assessment of environmental performance, economic performance and health & comfort performance of building.

According to the scope of the becoming European framework standard for the assessment of integrated building performance there are three dimensions for sustainability of the building: environmental, economic and health & comfort. Assessment of overall sustainability of buildings can be done, but it is necessary to assess those three dimensions of sustainability at the same time, but separately. It is impossible to evaluate and integrate indicators of environmental, economic and health & comfort performance into one indicator and one value. Nevertheless, it is clear that the assessment of sustainability of buildings must be done with life cycle approach.

5.1 Environmental performance of buildings

There is a very important bond between durability of building products, service life planning and assessment of integrated building performance. Life Cycle Assessment (LCA) is used as a tool for assessing environmental impacts of a building during its whole life cycle, from cradle to grave. It is impossible to assess environmental performance of a building without having scenarios on the use and durability of building products, i.e. information on the service life of building products in the intended conditions of use.

The International draft standard, ISO/DIS 21930 Buildings and Constructed Assets – Sustainability in Building Construction – Environmental Declarations of Building Products, requires that in order to declare environmental information on the whole life cycle or on the use stage and on the required maintenance of the building product, it is mandatory to declare the reference service life of a building product together with the reference in-use conditions. Of course, it is not necessary to declare all the detailed service life information in the Environmental Product Declaration (EPD), because in the EPD it is logical to have a reference to the service life declaration of the building product. The becoming CEN standard on the EPD of the building products is going to be totally in line with the ISO/DIS 21930.

The main purpose of the EPD is to communicate the environmental information and related additional information to the building level for assessment of environmental performance or health & comfort performance. The related additional information can be on the technical properties or e.g. the release of hazardous substances into the indoor air during the use stage. The essential fact is that the manufacturer of the building product is a sole owner of the environmental and technical information of the product. It means that the information in a generic database is not always updated.

5.2 Economic performance of buildings

In order to be consistent in the assessment of the economic dimension of sustainability of buildings, the term “life cycle” must refer to the whole life cycle of the building, from cradle to grave. Again, as is the case with environmental assessment, it is impossible to assess life cycle costs of a building without having information on the service life of building products in the intended conditions of use.

6 IFC BASED STANDARDS AND DURABILITY DATA

With the rapid development of IFC based standards for digital object oriented models of building products there is a huge need for property sets, such as durability and service life data, which can be linked directly to the building elements. On the other hand the IFC development opens up and facilitates for a much quicker than anticipated implementation of ISO 15686.

The ISO standard ISO16739, known mostly as Industrial Foundation Classes (IFC) has been developed by the IAI (International Alliance for Interoperability) for the building sector based on the generic Standard for Exhange of Product model data (STEP), ISO 10303. IAI is an alliance of organizations within the construction and facilities management industries dedicated to improving processes within the industry through defining the use and sharing of information. Organizations within the alliance include architects, engineers, contractors, building owners, facility managers, manufacturers, software vendors, information providers, government agencies, research laboratories, universities and more.

EXPRESS is the data modelling language allowing for implementation of the IFC and STEP standard. International Framework for Dictionaries (IFD), or the ISO 1200-3/PAS, extends IFC to include unique and specific definitions of concepts used in the building industry. A simplified analogy would be to describe IFC as a communication method, just as speaking is a communication method commonly chosen in certain situations, as opposed to sign language used at other times. IFD is then the language used while speaking. IFD provides the dictionary, the definitions of concepts, the common understanding, necessary for the communication to flow smoothly. Work is going on in many countries to develop national dictionaries to ease the trans - national communication flow (Bell et al, 2004).

The IFC standard has already reached an implementation level where it now provides real value for users in projects. The US General Services Administration requires drawings and plans to be delivered on IFC format from 2006 on. IFC allows, among other things, two or more unrelated applications in the building process to exchange information about the underlying model the project wishes to realize. It thus supports the move away from drawings and onto real 3D models, allowing for a continously enrichment of the model with relevant information throughout the building process.

The IAI developers has already defined and included concepts and properties related to a whole range of facility management aspects, such as life cycle costing, environmental impacts and service life, relying and referring to international standards, such as ISO 15686.

Within the IAI framework several pilot and –development projects are paving the way for implementation of IFC/IFD based models within the sector. One such project is the development of IFC based links to geographical information (IFG) [Wix et al, 2005]. This will be essential for example for facilitating a seamless zoning and building plan permit. It will also be essential in linking the appropriate exposure data to the building and the algoritms of the service life. In Norway Bjørkhaug et al [2005] has developed a pilot that describes the implementation of the ISO 15686 SLP process on an IFC/IFD/IFG platform by link to existing knowledge bases at Byggforsk and elsewhere [Bjørkhaug et al, 2005].

6 DISCUSSION AND CONCLUDING REMARKS

The ISO 15686 series of standards on design life of buildings and constructed assets are today implemented as national standards in a number countries. The concepts for service life planning presented in the standards are being met with interest, but there is still far from a situation where the standards are commonly used in practice. Education and information campaignes are being organised in certain countries, e.g., Sweden, and the standards with design concepts are also in focus by European network projects.

This article has a prime focus on the implementation of the ISO 15686 concepts in product standards, as a means to meet the requirement on, e.g., harmonised European product standards, to declare durability of the product in its intended use situation. The concept of Reference Service Life of products is described in ISO 15686 Part 8. The relevance of the RSL concept also in planning for sustainability and in, e.g., EPD is discussed. It is anticipated the RSLs predominantly will be offered by the materials and products producers. The reasons for this being at least twofold: firstly, the industry knows their products and the RSLs are – even if as far as possible objective data in accordance with the standard requirements – also their arguments on the market, and secondly, only in a few cases there will be resources available for authorities or R&D-organisations to provide RSL-data.

The rapid development of IFC based standards for digital object oriented models of building products fuels the need for property sets, such as durability and service life data, which can be linked directly to the building elements, and on the other hand the development opens up and facilitates for a much quicker than anticipated implementation of ISO 15686.

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