INTERNATIONAL STANDARDS FOR SERVICE LIFE PLANNING OF BUILDINGS

International standards for building planning

G. J. FROHNSDORFF
Building and Fire Research Laboratory, National Institute of Standards and Technology, Gaithersburg, Maryland, USA
CH. SJÖSTRÖM
Centre for Built Environment, Royal Institute of Technology, Gävle, Sweden
G. SORONIS
Swedish Building Standards Institution, Stockholm, Sweden

Durability of Building Materials and Components 8. (1999) *Edited by M.A. Lacasse and D.J. Vanier*. Institute for Research in Construction, Ottawa ON, K1A 0R6, Canada, pp. 1537-1542.

Abstract

ISO Technical Committee TC 59, Building Construction, is an international standards committee dealing with general rules for performance requirements for buildings. SC14, Design Life, is the subcommittee of TC59 that deals with standardisation of the principles and processes that apply when planning the design life of construction works. The standard being drafted by SC14 will serve designers, owners, potential buyers/investors, educators, students, and others. It points out that, while it is difficult to make precise estimates of service lives, the discipline of making estimates based on the principles presented can help avoid unexpected failures. This paper reviews the current work within SC14 and draws attention to issues and research needs yet to be addressed by the working groups drafting the parts of the design life standard.

Keywords: Buildings, building materials, constructed facilities, durability, service life, standardisation, standards, sustainable building, life cycle cost, performance concept.

1 Introduction

Durability and service life of building materials and products is an area of research and development (R&D) that has gained increasing attention over the last decade. There are several reasons for this including the continuing concern for quality and safety in buildings and a growth in concern for resource conservation in the building and construction sector with attention to the issues of life-cycle costing (LCC), life-cycle analysis (LCA), and optimisation of maintenance programmes. From a research point of view, service life prediction is now a recognised scientific activity with fairly uniform methodologies available to help guide the R&D work. Service life prediction is also recognised as being important for engineering applications.

2 International collaboration in service life research in CIB and RILEM

Durability and service life prediction of building materials and products is a multi-disciplinary research field. Based on materials science, it involves building technologies and building physics, and also meteorology and environmental research. Modern information technologies such as geographical information systems (GIS) are essential to the modelling of performance of building materials and components over time, characterisation of degradation environments, and user-friendly presentation of service life data.

At the suggestion of two of us (CS and GJF), a joint CIB/RILEM research co-operation on service life prediction was started in 1982; (CIB is the International Council for Building Research Studies and Documentation, and RILEM is the International Union for Research and Testing Laboratories for Materials and Structures). It was aimed at establishing generic methodologies for assessing the service life of building products and buildings, thereby unifying the field from a methodological point of view and creating a basis for quality assurance as it relates to service life in constructed facilities.

From the beginning, the intention was to establish a basis for standardisation in the area. In the first period, 1982 – 86, the work focused on describing the state-of-the-art and establishing a generic methodology for service life prediction. In 1989, the generic methodology was accepted as a RILEM Technical Recommendation (Masters and Brandt 1989) and it is now under standardisation by ISO (ISO /TC59/SC14, Part 2, 1998). In the next period, 1987 – 89, the CIB/RILEM joint work focused on methodologies for the feedback of durability data from practice by inspection of buildings (Sjöström 1990), (Brandt 1990). In the 1990 - 96 period, the work concentrated on further development of the methodologies (Sjöström 1994). The results have been reported in a number of reports and papers and it is intended to compile these publications into a handbook (Jernberg et al. 1993). The present work programme, 1997 – 99, continues the detailing of the methodologies with a focus on information technologies (Jernberg et al. 1993).

3 History of ISO TC59/SC14, design life

The standardisation activity started in 1993 when, at a meeting of ISO TC59 in Atlanta, the working group, ISO TC59/SC3/WG9, Design Life of Buildings, was established. There was a significant European initiative behind this action as a result of the setting up of the Eurocare umbrella project under the European research programme, EUREKA. The strategic goal of Eurocare is to increase the service life of the built environment and decrease yearly life-cycle costs for conservation, restoration and maintenance. Eurocare was among the first to adopt the service life prediction methodology established by CIB and RILEM. In 1991, the three organisations – Eurocare, CIB and RILEM -- took the initiative of discussing the methodology and its standardisation with the Commission of the European Communities and the European Standards Organization (CEN). The methodology was accepted as a guiding concept regarding durability of building products that should be of help in implementing the European Community's Construction Products Directive (CPD). ISO TC59/SC3/WG9 was the result of a CEN/BTS-1 request to ISO and a subsequent proposal from ASTM (the American Society for Testing and Materials) through ANSI (the American National Standards Institute); it benefitted from the Vienna Agreement on co-operation between CEN and ISO. Recently, in 1997, in recognition of its high level of productive activity, SC3/WG9 was elevated to subcommittee status as ISO TC59/SC14, Design Life. Apart from the service life prediction methodology document (i.e., the RILEM Technical Recommendation), the basic documents available to assist the early standardization work were some national standards and codes of practice -- specifically, the British Guide to Durability of Buildings and Building Elements, Products and Components (1992); the Japanese Principal Guide for Service Life Planning of Buildings (1993); and the Canadian Guideline on Durability in Buildings (1994).

4 Status of the work of ISO TC59/SC14, design life

The first part of the proposed ISO standard (ISO/TC59/SC14 Part 1, 1998) has been described by Browne and Soronis (1996). It gives guidance for building designers on the service life planning of buildings. It is expected to be approved as a DIS (Draft International Standard) early in 1999. The voting on the document's DIS status will be completed in December 1998. Part 2 of the standard: Service Life Prediction Principles (ISO/TC59/SC14 Part 2, 1998) is also expected to become an ISO/DIS early in 1999. Subsequent parts of the standard will focus on Auditing, Maintenance, Life Cycle Costing, and Data Formats. In addition, a work item for guidelines for the inclusion in the standard of matters relating to LCA has been initiated. A vision of the standards that need to be developed over the long term has been provided by Frohnsdorff and Martin (1996).

The standardisation activities in ISO TC59/SC14 are strongly supported by the work of the joint CIB W80/RILEM 175-SLM Committee on Service Life Prediction, with SC14 being seen as the primary customer for the products of the committee.

5 Prenormative research needs

The following R&D areas are crucial for the future implementation of the ISO standard:

- *Performance analysis.* A systematic, internationally-accepted methodology for preparing lists of performance requirements for important types of construction products is urgently needed.
- *Characterisation, mapping, classification, and development of databases of environmental degradation factors.* Reliable and comprehensive environmental data suitable for use in service life predictions are needed for all regions of the world. The

environmental degradation factors should be classified, mapped and presented by GIS in a user-friendly form; (ISO 9223:1992 provides a standard classification system for corrosivity of environments for some metals that might be used as a model). To meet the need for data, a network of standardised, well-instrumented field test sites in various climatic and environmental zones should be established. The sites in such a network should be linked together to provide reliable and comprehensive environmental data. A basis for a network exists through the United Nations ECE International Co-operative Programme for Materials; the Programme has operated a well-monitored network of approximately 40 test sites throughout Europe and North America for the last ten years. The present monitoring programme is only scheduled to run until 2001. A number of co-operative initiatives are based on, and connect to, the UN/ECE Programme and focus on areas such as corrosion mapping, air quality, and cost-benefit analysis.

- *Identification and modelling of degradation mechanisms and dose/response functions.* The lack of knowledge of exposure/degradation environments and of dose/response functions relating the response of materials and components to the environment are major barriers to reliable service life predictions. In the environmental research area, knowledge and data that have been generated over the years have been used in cost-benefit analyses of the degradation of the built environment and as input to policy decisions on abatement strategies. However, much more data will be needed before service life predictions can become a routine aid to designers and others. The considerable body of data on exposure conditions that now exists includes European data on the macro and meso levels, and dose/response functions have been established for a number of important building materials (Haagenrud and Henriksen 1996). A major task will be the transition from knowledge based on dose/response functions to predictions of service life and performance over time for real buildings and other constructions. Building inventories and testing under in-use conditions are needed in this process to refine and further develop the knowledge base. Dose/response functions should be validated in the micro environment of buildings.
- *Development of long-term and short-term test facilities and programmes.* Special laboratory facilities are needed for studies of factors affecting the mechanisms and rates of degradation of materials and components, and development of relevant test methods where needed. These include environmental chambers of various types in which materials can be exposed to various combinations of closely-controlled conditions in applying the service life prediction methodology. It should be noted that, contrary to the widely-accepted notion, appropriately-selected reproducible laboratory conditions, not irreproducible outdoor exposures, must ultimately become the standard of reference for service life predictions. Dose-response functions based on laboratory data may then be combined with knowledge of typical environmental conditions at a site to make service life predictions for materials that are to be used at that site. Protocols for relating the results of artificial aging to those of natural weathering must be developed.
- *Life-Cycle Cost and Life-Cycle Assessment models.* Research is needed on life-cycle cost models to connect service life of materials and components to the economic performance of the building during its whole working life. It is internationally accepted that the rapidly growing interest in life-cycle assessment of building products will require reliable service life data if LCA is to be most useful (Soronis and Makenya 1998).

- *Information Technologies (IT)*. It is essential that IT systems be developed to facilitate incorporation of the service life prediction methodology into the building design process. The systems must be user-friendly computer-integrated knowledge systems consisting of databases, simulation models, and knowledge-based expert systems established according to standard guidelines; GIS-based information systems would be included (Haagenrud and Henriksen 1996). It is to be expected that most of the laboratory data for materials and components in the knowledge systems, and much of the material degradation data from test sites and actual buildings, will eventually be provided by the manufacturers of the materials and components.

6 Some concluding remarks concerning implementation of service life planning standards

The development and implementation of service life planning standards are complex tasks that should be considered together. The following remarks relate to implementation and further development of the ISO service life planning standard:

- There is sufficient knowledge and data to show that standardisation regarding prediction of service life in the built environment is a realistic, though challenging, goal; however, much more data will be needed to obtain the full benefits from the standard.
- In some cases, modelling and mapping of environments and the response of materials (in a building assembly) to exposure in an exterior environment are possible using available tools and data.
- International efforts are needed to provide the data and knowledge that will benefit all regions of the world by increasing the service life of the built environment and decreasing life-cycle costs.
- Service life research is interdisciplinary and some of the necessary knowledge and tools, such as materials science, environmental characterization, and information technologies, lie outside the traditional building sciences; R&D programmes must be organised accordingly.
- Most of the research needs relaying to service life prediction and planning are of a prenormative character; encouragement of prenaormative research is vital.
- It is necessary to ensure that the ISO standard on design life and service life prediction is consistent with the life-cycle analysis standards in the ISO 1440 series.

7 References

Masters, L.W. and Brandt, E. (editors) (1989) Systematic methodology for service life prediction of building materials and components, *Materials and Structures*, 1989, 22, 385 – 392

ISO TC59/SC14 (1998), Buildings - Service Life Planning - Part 2: Service Life Prediction Principles, *Second Committee draft*, 1998-08-31

Sjöström, Ch. (editor) (1990) Feedback from practice of durability data: Inspections of buildings. *CIB report, publication 127*.

Brandt, E. (editor) (1990) Feedback from practice of durability data: Appendix. Examples of field investigations. *CIB report, publication 128*

Sjöström, Ch. (1994) CIB W80/RILEM 140-TSL on Service life prediction. – Methodologies and research needs. Proceedings of Vision EUREKA Conference *New technology for Management and Maintenance of Old and New Built Environment*, Lillehammer, Norway, June 1994.

Jernberg, P., Sjöström, Ch. And Lacasse, M. A. (1997), TC 140-TSL: Prediction of Service Life of Building Materials and Components (Joint with CIB W80). State-of the-art-report, *Materials and Structures*, supplement March 1997, pp 22 - 25

ISO TC59/SC14 (1998), Buildings - Service Life Planning - Part 1: General Principles, ISO/DIS 15686-1

Browne, R. and Soronis, G. (1996) A proposed ISO-standard for service life of buildings: Part 1 General Principles. *Durability of Building Materials and Components 7*, (ed. Ch. Sjöström), E & FN Spon, London

Soronis, G., Makenya, A. (1998) Towards a new integrated ISO-standard for sustainable building, *Proceedings of CIB World Building Congress 1998*, Vol. 1, Gävle Sweden

Frohnsdorff, G. and Martin, J. (1996) Towards prediction of building service life - The standards imperative. *Durability of Building Materials and Components 7*, (ed. Ch. Sjöström), E & FN Spon, London.

Haagenrud, S.E. and Henriksen, J.F. (1996). Degradation of built environment – Review of cost assessment and dose response functions, *Durability of Building Materials and Components 7*, (ed. Ch. Sjöström), E & FN Spon, London.

International Organisation for Standardisation (1992) Corrosion of metals and alloys – Corrosivity of atmospheres - Classification. ISO 9223:1992.

Haagenrud, S.E., Henriksen, J.F. and Skancke, T. (1996) Modelling and mapping of degradation of built environment from available data and GIS based information tools. *Durability of Building Materials and Components 7*, (ed. Ch. Sjöström), E & FN Spon, London.

British Standards Institution BS 7543:1992. Guide to Durability of Building Elements, *Products and Components*.

Architectural Institute of Japan (1993). The English Edition of Principal Guide for Service Life Planning of Buildings.

Canadian Standards Association (1994). Guidelines on Durability in Buildings, S-478-1994.