Joint CIB W80 / RILEM TC 140 – TSL Committee on
Service Life of Building Materials and Components

Guide and Bibliography
to
Service Life and Durability Research for
Building Materials and Components

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March 2004
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Acknowledgements

This Guide and bibliography has been compiled over the course of the 1997-2002 work programme of the CIB W080 /RILEM 175-SLM Commission and the editors are particularly indebted to the authors for their significant contributions. Thanks is also extended to those who offered contributions, assisted in the review of the documents, and as well to those who provided advice regarding publication or helped prepare the final version of this document.

The CIB W080 /RILEM 175-SLM Commission is likewise particularly grateful to the many academic or research organizations that have supported the contributors, authors and editors in this endeavour and sponsored their efforts over the years.
Preface

This publication covers work undertaken within the CIB Working Commission W080/RILEM Technical Committee 140-TSL on the prediction of service life of building materials and components during the period between 1991 and 1996 and as well, additional information subsequently provided in the period between 1997 and 2002. It was intended that this publication offer researchers and knowledgeable practitioners a useful guide to service life prediction – a primer –providing fundamental information related to methods of service life prediction, information on environmental characterisation, and relevant information on the performance and durability of construction materials. Each part is self-contained - pagination is unique to the part and Tables or Figures in the text have been enumerated using a prefix that relates to the section in which they are presented. References are exclusive to the Part in which they are used – these have not been cross-referenced to the other parts nor the bibliography.

The introduction offers background to the work, a general overview of the document and the terminology used in the text. Following which, the document is divided into four parts, the first of which provides an overview of service life and durability issues – it is an introduction to the topic. The second part represents a significant contribution on environmental characterisation, previously published by the Norwegian Institute for Air Research in 1996. The third part encompasses various contributions specifically related to materials. Originally, it was thought that this part would provide basic information on material properties and the performance and durability of a broad range of construction materials including, cement-based materials and concrete, different metals including, steel, iron, aluminum, and polymer-based materials and so on. Although this part does provide some extremely useful information on copper, natural stone, brick masonry, clay and wood construction materials the broad list of materials originally intended is yet to be completed. Given the significance of the task this work must be considered ongoing. The format for reporting has been set and it is hoped that future editions of this work will help fill in the missing pieces of information.

The final part of the document provides an annotated bibliography that includes abstracts or summaries of works related to service life and durability, case studies as well as experimental work on materials, components and systems, based on the original document prepared at the National Research Council Canada in 1993.

Information on the service life and long-term performance of materials, components and system is a vital link in attaining sustainable and economically viable construction. It is hoped that this initial contribution will spur others in this domain, in particular in the construction material manufacturing industry, to provide additional information on the durability of components, insights into their comportment in an assembly or system and related information on their performance and long-term performance. The task to compile the information is considerable and continued support of these activities is essential if these worthwhile objectives are to be fulfilled.

P. Jernberg, M.A. Lacasse, S.E. Haagenrud, and C. Sjöström
March 2004
Introduction
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1 Background

The most recent decades have seen rapid development in the area of durability and service life prediction of buildings materials and components. What earlier were ideas, ambitions or visions among a fairly few number of researchers, are today realities or within the reach for engineering applications. There are several reasons to this positive development: improvements in testing procedures, better analytical tools and methods, and a common computerisation that significantly has facilitated the ability to handle and process data, may be singled out as examples of factors that greatly have contributed. Another important influence and certainly a driving force to continued research in this area has been the demand for reliable service life data from building asset/property managers, management firms and management consultants as well as building owners.

In 1982 a joint CIB and RILEM activity was established on the Prediction of Service Life of Building Materials and Components, denoted W080 and 71-PSL (Prediction of Service Life) within CIB and RILEM, respectively. Mr. Larry Masters, National Bureau of Standards, USA chaired this Committee. The Committee focused on describing the state of the art of the research area, and proposed a generic methodology for the prediction of service life; work was concluded in 1986.

During the period 1987-1990 the RILEM co-operation with CIB W080 continued with the formation of TC 100-TSL. The work during this period centred on developing methodologies for generating data from long-term ageing studies of materials and components in actual, ‘in-use’, conditions. Within this area, special consideration was given to obtaining durability data from the inspection of existing buildings. The combined work resulted in the publication of a number of reports and papers.

The work of both these earlier technical committees was in general concerned with generic methodologies for service life prediction. It was a common opinion among those engaged in the earlier work, and also among many interested parties outside the Committee, that there was a great need for additional work on the development of a generic methodology. Hence, activities in the area of service life prediction continued in the same vein as the previous joint CIB/RILEM committees following the termination of RILEM TC 100-TSL in 1990.

This publication covers work undertaken within the CIB Working Commission W080/RILEM Technical Committee 140-TSL on the prediction of service life of building materials and components during the third period between 1991 and 1996 and as well, additional information subsequently provided in the period between 1997 and 2002.

2 Objectives

Described in a simplified way, service life analysis aims at establishing the performance of a given material, component or element over time, i.e. how measured values of some chosen

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performance indicator varies with time. Loss in performance over time is clearly indicative of
degradation taking place. Hence, service life prediction requires knowledge of the degradation
environment and the resistance of materials to factors causing degradation. This simplistic
view of the research area may be regarded as self evident, but it nevertheless describes the
domain in which the development of both generic methodologies and material specific
methodologies are needed. Further insights in regard to service life and long-term
performance are provided in Part 1 section A.3.

3 Scope

3.1 Purpose

The work programme of W080/140-TSL was set up in 1990 and aimed at further detailing
of the generic methodology established by W080/71-PSL. Prof. Christer Sjöström, KTH,
Sweden, was elected as chairman of the joint committees. The programme covered five
subject areas and was likewise organised into five sub-groups each having their respective
sub-group chair to co-ordinate activities within the group. The five groups included:

1. Data from field exposure testing, in-use testing and experimental buildings in service
life prediction

The chairman of this sub-group has been Mr. Erik Brandt, SBI, Denmark. The group
aimed at completing efforts made within committee W080/100-TSL in which further
descriptions of methodologies and development of approaches required to generate long-term
ageing data were developed. The primary focus was on in-use testing, experimental buildings
and field exposure testing.

2. Environmental characterisation including equipment for monitoring

Dr. Svein Haagenrud, NILU, NORWAY, and Dr. Jonathan Martin, NIST, USA chaired
this subgroup. The work planned within this sub-group is to result in a contribution presenting
the state of the art and research needs regarding characterisation of the degradation
environment, including methods and equipment for microclimate monitoring.

3. Materials characterisation including monitoring of degradation processed

The chair in this sub-group has been Dr. Per Jernberg, KTH, Sweden. The sub-group task
was to produce a report on modern experimental analytical methods for materials
characterisation and the monitoring of degradation processes. The report is problem
orientated, i.e. focusing on degradation processes, and is structured according to material
classes (i.e., polymers, metals, brick, etc.).

4. Mathematical modelling

Mr Ton Siemes, TNO, The Netherlands, and Dr Jonathan Martin, NIST, USA chaired the
subgroup. The group was to produce a report on the modelling of degradation processes and
on prediction models.

5. Design of short-term test methods

Ms. Lesley Jacques from South Florida Test Service, USA has been the chair for this sub-
group. The aim of the group was to prepare a state of the art report on the design of short-term
test methods.
3.2 **Significance — the liaison with standardisation**

Twenty years ago, predicting the service life of building materials and components was only a distant vision. Today, the possibility of standardising methodologies and incorporating predictions of the service lives of materials and components into the design process for whole buildings is being given serious attention. The change in perspective is due to the sustained efforts of a small group of researchers to advance in building material science and to developments in computerised knowledge systems.

The generic methodology established by W080/71-PSL for the prediction of service life became a RILEM technical recommendation in 1990. Hence, practitioners have increasingly accepted the methodology and service life concepts embodied within this recommendation. Indeed, this document is being promoted as the guide to use in dealing with service life problems. The need for standardisation in this area has been mentioned by several practitioners in the domain and consequently, this has been one of the key arguments for the work performed by W080/TC 140-TSL. In 1990 Eurocare, an umbrella project within the European research programme EUREKA, in collaboration with W080/TC 140-TSL approached CEN to help support standardisation of the methodology. The discussion that followed, involving ISO, CEN, W080/TC 140-TSL and a number of other interested parties, helped resolve the issues and resulted in the establishment, in 1993, of an ISO working group on the design life of buildings (ISO TC 59/SC 3/WG9 Design Life of Buildings). The ISO working group decided from the outset, to utilise the contributions provided by the W80/TC 140-TSL. In fact, the committee was asked to undertake the role of producing pre-normative work in the area ‘design life of buildings’ for the consideration of the ISO working group in the standardisation process.

The set of standards to be developed will be structured in a hierarchical way with, at the highest level, a generic standard presenting a methodology to be followed in predicting the service life of a material or component. An obvious candidate to this standard is the RILEM Technical Recommendation on Prediction of Service Life (the generic methodology). Other important documents to be mentioned are:

- British Standard BS 7543 “A Guide to Durability of Building Elements, Products and Components”;
- Architectural Institute of Japan, “A Principal Guide for Service Life Planning of Buildings”, (1993); and
- Canadian Standards Association CSA S-478, “Guideline on Durability in Buildings”.

On the second and lower level, a set of standards will be produced giving guidance on how the principles of the generic methodology should be incorporated into material specific service life prediction. As an example, the set of standards might be:

- Establishment of performance requirements and criteria;
- Characterisation of service environment;
- Characterisation of a material or component;
- Identification or degradation mechanisms of a material or component;
- Data from ageing under service conditions;
- Short term test methods;
- Predictive models and modelling of degradative processes; and
- Form of report on results of the service life prediction.
INTRODUCTION

In view of this brief outline of the planned standardisation work it is evident that the current publication will establish an important input to this standardisation.

4 Future work

The work of the present committee will be continued in a new RILEM TC joint with CIB W80. The new work programme will be undertaken over a three-year period. The direction of work in the proposed committee is similar to the present one and will continue to refine existing prediction and service life techniques, tools and methods. However, the new committee will make efforts towards further development of service life prediction methods in the context of emerging information technologies (IT). Hence, the focus of a joint committee will then be to integrate existing prediction and service life techniques, using information technologies being developed for the construction industry. Furthermore, stochastic and reliability methods, typically used in the aerospace and automotive industries, will be reviewed as potential means of addressing particular aspects of service life prediction.

The proposed work is based on the elaboration of key areas of knowledge in the service life domain, which together provide practitioners with the necessary tools to guide their decisions. The five areas under the title, "Service Life Methodology” includes:

I. Information technologies in construction: an integration tool in SLP

II. Service life and durability
   • Service life and long-term performance; performance concept in buildings; integrated approach
   • Establishing requirements for service life prediction, including factors causing degradation and performance over time functions: review of work undertaken by previous TCs with additional input from other committees contributing, based on proposed workshop.
   • Data formatting

III. Selection of service life prediction methods
   • Long-term studies, e.g. inspection of buildings (surveys) and controlled studies, e.g. in experimental buildings, field exposure studies and in-use testing
   • Short term tests (accelerated test methods)
   • Modelling of prediction methods: guide to the use of deterministic and stochastic methods

IV. Understanding factors causing degradation
   • Characterisation of factors: e.g. weathering, biological, stress, compatibility
   • Modelling of degradation factors: e.g. climatic modelling (macroclimate, meso-climate, and microclimate), weathering maps, climatic indices (e.g. solar radiation, time-of-wetness, driving rain, pollution).

V. Characterisation of degradation of building materials and components

Expected achievements are:
• Harmonisation of test methods;
• Internet access to various databases;
• Development of database of environmental test sites;
• Environmental modelling (micro and meso climate);
• Recommendations of accelerated and short term test methods using expert systems;
• Organisation of the 8th International Conference on the Durability of Building Materials and Components (8DBMC) and workshops on issues common to other committees within CIB and RILEM; and
• Support the development of ISO draft standard.
## Terminology

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<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Accelerated short term exposure</td>
<td>Short term ageing exposure in which the intensity of the agents is raised above the levels expected in service</td>
</tr>
<tr>
<td>Adapt</td>
<td>Intervention required to make an item suitable for a new use</td>
</tr>
<tr>
<td>Ageing</td>
<td>Degradation due to long term influence of agents related to use</td>
</tr>
<tr>
<td>Ageing exposure</td>
<td>Procedure in which building products are exposed to agents believed or known to cause degradation for the purpose of service life prediction (or comparison of relative performance)</td>
</tr>
<tr>
<td>Ageing test</td>
<td>Combination of ageing exposure and performance evaluation used to assess changes in critical properties for the purpose of service life prediction</td>
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<tr>
<td>Agent (degradation agent)</td>
<td>Whatever acts on a building or its parts (to reduce its performance), e.g. Person, water, load, heat</td>
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<td>Agent intensity</td>
<td>The momentary magnitude of an agent, for instance the relative humidity or the SO₂ concentration at a certain moment (the term &quot;agent intensity&quot; refers either to intensity in the strict sense, or to concentration level, frequency or, maximum or minimum values. Momentary values of the agent in question)</td>
</tr>
<tr>
<td>Assembly (building assembly)</td>
<td>Set of components used together (draft amendment to ISO 6707/1)</td>
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<tr>
<td>Biological degradation factor</td>
<td>Degradation factor that is directly associated to living organisms, including micro-organisms fungi and bacteria</td>
</tr>
<tr>
<td>Biological growth</td>
<td>Growth of organisms on the surface or in the body of a material. These are generally fungi (moulds) or algae but other life forms are not excluded.</td>
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<tr>
<td>Bleeding</td>
<td>Diffusion of a soluble coloured substance into or through a coat from beneath that produces an undesirable staining or discoloration</td>
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<tr>
<td>Blister</td>
<td>Dome-shaped defect in a coat that arises from loss of adhesion</td>
</tr>
<tr>
<td>Bloom</td>
<td>Deposit on a coat of paint or varnish that causes loss of gloss and dulling of colour that can be removed by wiping with a damp cloth</td>
</tr>
<tr>
<td>Blooming</td>
<td>A visible exudation or efflorescence on the surface of a sample</td>
</tr>
<tr>
<td>Brief</td>
<td>Statement of the requirements for a building project</td>
</tr>
<tr>
<td>Building</td>
<td>Construction works that has the provision of shelter for its occupants or contents as one of its main purposes and is usually enclosed and designed to stand permanently in one place (draft amendment to ISO 6707/1)</td>
</tr>
<tr>
<td>Building context</td>
<td>A description of a building and its parts in terms of influences from design, service environment and usage</td>
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<tr>
<td>Chalking</td>
<td>Loose, removable powder resulting from breakdown of the surface of a material</td>
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<tr>
<td>Client</td>
<td>Person or organisation that requires a building to be provided, altered or extended and is responsible for initiating and approving the brief</td>
</tr>
<tr>
<td>Colour change</td>
<td>Change in colour other than that due to chalking, dirt collection or biological growth</td>
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<tr>
<td>Commissioned specialist</td>
<td>Person or organisation capable of conducting a service life prediction study</td>
</tr>
<tr>
<td>Commissioning client</td>
<td>Person or organisation that orders the service life prediction study</td>
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<td>Component (building component)</td>
<td>Product manufactured as a distinct unit to serve a specific function or functions or, specifically in this International Standard for editorial convenience, an item such as an assembly, a sub-component, a product or a material (based on ISO 6707/1)</td>
</tr>
<tr>
<td>Condition</td>
<td>All levels of critical properties of a building or a building part, determining its ability to perform</td>
</tr>
<tr>
<td>Conservation</td>
<td>Maintenance to preserve the appearance and performance of buildings and other structures, particularly historic buildings and structures</td>
</tr>
<tr>
<td>Constructor</td>
<td>Person or organisation that undertakes construction work</td>
</tr>
<tr>
<td>Control samples</td>
<td>Samples retained in an environment that is believed or known not to induce degradation for the purpose of comparison between exposed and non-exposed samples</td>
</tr>
<tr>
<td>Cost in use</td>
<td>Total cost including purchase, installation, running costs, removal, disposal and reinstatement</td>
</tr>
<tr>
<td>Cracking</td>
<td>Pronounced breaks that may extend well below the surface. The breaks may be &quot;irregular&quot; forming no definite pattern; &quot;line&quot; if running in parallel lines; or &quot;sigmoid&quot; if running in relatively large curves that meet or intersect.</td>
</tr>
<tr>
<td>Critical property</td>
<td>Property that must be maintained above a certain level if the building or the building part is to retain its ability to perform its intended functions</td>
</tr>
<tr>
<td>Damage</td>
<td>All the consequences of failure of a building component. This concerns the direct and the indirect effects.</td>
</tr>
<tr>
<td>Defect</td>
<td>Fault or deviation in aimed condition of a building or a building part</td>
</tr>
<tr>
<td>Degradation</td>
<td>Reduction over time in performance of a building or a building part</td>
</tr>
<tr>
<td>Degradation indicator</td>
<td>The complement of a performance characteristic, for instance when gloss is a performance characteristic, then gloss loss is the corresponding degradation indicator; when mass (or thickness) is a performance characteristic, then mass loss is the corresponding degradation indicator.</td>
</tr>
<tr>
<td>Degradation mechanism</td>
<td>Chemical, mechanical, physical or biological changes that lead to changes in a critical property(ies) of a building or a building part when exposed to degradation agent(s)</td>
</tr>
<tr>
<td>Delamination</td>
<td>Separation of layers of material</td>
</tr>
<tr>
<td>Design life</td>
<td>Service life intended for a building or a building part as stated by the designer, being in accordance with specifications set by the client</td>
</tr>
<tr>
<td>Designer</td>
<td>Person or organisation responsible for stating the form and specification of a building or a building part</td>
</tr>
<tr>
<td>Dimensioning critical property</td>
<td>The critical property of a building or a building part on which, for a certain set of performance requirements and a certain service environment, is imposed the performance requirement that first in time will fall short</td>
</tr>
<tr>
<td>Discoloration</td>
<td>Change in colour, including the effects of chalking, dirt collection and biological growth</td>
</tr>
<tr>
<td>Dose (agent dose)</td>
<td>The value of a definite time integral of the agent intensity function</td>
</tr>
<tr>
<td>Dose-response function</td>
<td>Function that relates the dose(s) of a degradation agent to a degradation indicator</td>
</tr>
</tbody>
</table>
**INTRODUCTION**

**Terminology**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durability</td>
<td>Capability of a building or a building part to perform its required function over a specified period of time under the influence of the agents anticipated in service</td>
</tr>
<tr>
<td>Effect</td>
<td>Result of an action of an agent, e.g. Wear, dampness, deformation, expansion</td>
</tr>
<tr>
<td>Environment</td>
<td>Aggregate of all external and internal conditions either natural, man made or self induced that can influence performance and use of a building and its parts (based on MIL-STD-721 C and draft ISO 6707/1)</td>
</tr>
<tr>
<td>Environmental condition</td>
<td>State of a characteristic of the environment</td>
</tr>
<tr>
<td>Estimated service life</td>
<td>Reference service life multiplied by factors related to specific circumstances, e.g. Materials, design, environment, use and maintenance (factor approach)</td>
</tr>
<tr>
<td>Exposure in experimental buildings</td>
<td>Long term ageing exposure in special buildings where the conditions may be monitored and in some cases controlled</td>
</tr>
<tr>
<td>Exudation</td>
<td>Emergence on the surface of a coat of one or more of its liquid constituents or of liquids from a substrate</td>
</tr>
<tr>
<td>Factor method</td>
<td>Modification of reference service life by factors related to the specific in use conditions</td>
</tr>
<tr>
<td>Failure</td>
<td>Termination of the ability of a building or a building part to perform a specified function</td>
</tr>
<tr>
<td>Failure probability</td>
<td>Probability that a given building component will fail during a given period</td>
</tr>
<tr>
<td>Feed back from practice (inspection of buildings)</td>
<td>Performance evaluation or assessment of residual service life of building parts used in actual buildings</td>
</tr>
<tr>
<td>Field exposure</td>
<td>Long term ageing exposure at special locations with known environmental conditions (agents)</td>
</tr>
<tr>
<td>Flaking</td>
<td>Lifting of coating from underlying surface in form of flakes or scales</td>
</tr>
<tr>
<td>Gloss</td>
<td>The shine or lustre of the surface of a material</td>
</tr>
<tr>
<td>Hair crack</td>
<td>Crack that is just visible to the naked eye</td>
</tr>
<tr>
<td>Incompatibility</td>
<td>Detrimental chemical and/or physical interactions between components which lead to degradation</td>
</tr>
<tr>
<td>Inspection</td>
<td>Activities that are necessary to register the present situation and performances</td>
</tr>
<tr>
<td>In-use condition</td>
<td>Environmental conditions under normal use</td>
</tr>
<tr>
<td>Life cycle</td>
<td>Successive periods of a building component, starting with the design, the construction, the use, the maintenance, the demolition and reuse</td>
</tr>
<tr>
<td>Limit state</td>
<td>Situation in which the product (materiel, component etc.) Is exactly equal to resist the influence of a degradation factor</td>
</tr>
<tr>
<td>Long term exposure</td>
<td>Ageing exposure with a duration of the same order as the service life</td>
</tr>
<tr>
<td>Long term in-situ exposure</td>
<td>Long term ageing exposure of building parts deliberately incorporated in actual buildings</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Combination of all technical and associated administrative activities during the service period that are meant to retain an item in a state in which it can perform its required function</td>
</tr>
<tr>
<td><strong>Terminology</strong></td>
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<td>--------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Maintenance strategy</td>
<td>Maintenance policy</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Person or organisation that manufactures</td>
</tr>
<tr>
<td>Material (building material)</td>
<td>Substance that can be used to form products or construction works (draft for ISO 6707/1, pren 1745)</td>
</tr>
<tr>
<td>Obsolescence</td>
<td>Inability of a building or a building part to satisfy changing performance requirements</td>
</tr>
<tr>
<td>Peeling</td>
<td>The lifting of pieces from the surface without their becoming completely detached</td>
</tr>
<tr>
<td>Performance (performance in use)</td>
<td>Ability of a building or a building part to fulfil its functions under the intended use conditions (adapted from CIB W60 but “a building or a building part” used rather than “material, component, assembly or building”)</td>
</tr>
<tr>
<td>Performance characteristic</td>
<td>A quantity being a measure of a critical property, or an actual value of said quantity, i.e. A performance characteristic can be the same as the critical property, for instance gloss, or if the critical property is for example strength, thickness or mass may be utilised in certain cases as a performance characteristic</td>
</tr>
<tr>
<td>Performance criterion</td>
<td>A level of a performance characteristic, below which the corresponding critical property or properties of a component no longer are maintained</td>
</tr>
<tr>
<td>Performance evaluation</td>
<td>Evaluation of critical properties on basis of measurement or inspection</td>
</tr>
<tr>
<td>Performance over time</td>
<td>Description of how a critical property varies with time under the influence of degradation agents</td>
</tr>
<tr>
<td>Performance requirement</td>
<td>Range of acceptable performance within which a critical property is maintained (use set of requirements to denote the set of performance ranges within which the corresponding critical properties are maintained)</td>
</tr>
<tr>
<td>Predicted service life</td>
<td>Service life predicted from recorded performance over time as obtained, for instance, in ageing tests</td>
</tr>
<tr>
<td>Predicted service life distribution</td>
<td>The probability distribution function of the predicted service life</td>
</tr>
<tr>
<td>Preservation</td>
<td>Activities that are meant to maintain the present capacity of a building component (conservation, protection)</td>
</tr>
<tr>
<td>Preventive maintenance</td>
<td>Maintenance activities performed to avoid failure</td>
</tr>
<tr>
<td>Product (building product)</td>
<td>Item manufactured or processed for incorporation in construction works (draft ISO 6707/1, pren 1745)</td>
</tr>
<tr>
<td>Propagation time</td>
<td>Time in which the performance is degrading</td>
</tr>
<tr>
<td>Property measurement test</td>
<td>Test to determine a (performance) property</td>
</tr>
<tr>
<td>Reference sample</td>
<td>Samples of known performance which are exposed simultaneously and under identical conditions as the samples under study to provide comparative data</td>
</tr>
<tr>
<td>Reference service life</td>
<td>Service life for a building or a building part for use as a basis for estimating service life</td>
</tr>
<tr>
<td>Refurbishment</td>
<td>Modification and improvements to an existing plant, a building or a civil engineering construction to bring it up to an acceptable condition</td>
</tr>
</tbody>
</table>
**Introduction**

**Terminology**

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<tr>
<td>Rehabilitation</td>
<td>Extensive work to bring a plant, a building or a civil engineering construction back to an acceptable functional condition, often involving improvements</td>
</tr>
<tr>
<td>Reinstatement</td>
<td>Restoring and making good the surface structure of roads and land, replacement of fences, clearing of ditches and watercourses, and all similar operations following work of repair or construction work</td>
</tr>
<tr>
<td>Repair</td>
<td>To replace or correct damaged or faulty components or subsystems of a building to maintain operating capability</td>
</tr>
<tr>
<td>Restoration</td>
<td>Actions to bring back an item to its original appearance or state</td>
</tr>
<tr>
<td>Retrofit</td>
<td>To add new materials or equipment not provided at the time of the original construction</td>
</tr>
<tr>
<td>Risk</td>
<td>The product of the probability of failure and the amount of damage</td>
</tr>
<tr>
<td>Service life</td>
<td>Period of time after installation during which all conditions of a building or a building part meet or exceed the performance requirements</td>
</tr>
<tr>
<td>Service life planning</td>
<td>Preparation of the brief and design for a building or a building part to achieve the desired design life in order to, for instance, reduce the costs of building ownership and facilitate maintenance and refurbishment</td>
</tr>
<tr>
<td>Service life prediction</td>
<td>A generic methodology which, for a certain or any reasonable performance requirement, facilitates a prediction on the service life distribution of a building or its parts for the use in a certain or in any reasonable environment</td>
</tr>
<tr>
<td>Short term exposure</td>
<td>Ageing exposure with a duration considerably shorter than the service life anticipated (a term sometimes used and related to this type of exposure programme is &quot;predictive service life test&quot;, which is a specifically designed short term exposure and performance evaluation procedure in conjunction)</td>
</tr>
<tr>
<td>Short term in-use exposure</td>
<td>Short term ageing exposure in which the intensity of agents are at levels expected in service</td>
</tr>
<tr>
<td>Specimen</td>
<td>Representative single item or quantity of material</td>
</tr>
<tr>
<td>Staining</td>
<td>Formation of discoloured areas</td>
</tr>
<tr>
<td>Sub-component (building sub-component)</td>
<td>Manufactured product forming part of a component</td>
</tr>
<tr>
<td>Supplier</td>
<td>Person or organisation that supplies buildings or building parts (the supplier can also be the manufacturer)</td>
</tr>
</tbody>
</table>