French National Service Life Information Platform

Julien Hans [1]
Julien Chorier [1]
Jean-Luc Chevalier [1]
Sonia Lupica [2]

T 41

ABSTRACT

At the beginning of the 20th century, about 90% of the cost of a building was attributable to the structure and the enveloppe. According to the good durability of the component contributing to the structure, it is understandable that we were designing building for 70 or 100 years without the same need of knowing the service life of the components as knowing its mechanical resistance.
New performances are today measured and taken into account during the design to fullfill among others, acoustic, fire safety or thermal insulation requirement.
But new requirements have to be thinked ahead. Today, up to 75% of the cost of a building is allocated to equipments and indoor fittings. Most of the time these components have to be replaced during the service life of the building, and the economical impact on the life cycle cost are significant: for 1 euros spent in the construction phase of an office building, 5 can be spend to maintain and manage it during 30 years! [Tupamaki, 2005]
The Environmental assessment of a building using Environmental Product Declaration is also required to estimate the service life of the components.
Thus, service life is on the point to become a very usefull data for building design and facility management according to the sustainable development principles [ISO SC17, 2007]. The aim of this paper is to present a platform for service life planning. www.durée-de-vie-batiement.fr . It's a french tool for the moment, but we intend to propose it at an international level to optimize its interest.
A collaboration between contracting authorities, architects, research offices, manufacturers and entrepreneurs has been established to develop this collaborative tool, a plateform to collect Reference Service Life (compatible with the ISO series of standard 15686). It proposes an organization of knowledge in grids in which are stored and indexed the essential informations, to estimate the service life of construction components and to evaluate the factors impacting building durability (quality of materials, quality of the implementation, environment, users, maintenance…).

KEYWORDS

Reference Service life, Service life planning, database, Factor method, ISO 15686

[1] CSTB / Scientific and Technical Centre for the Building Industry, Energy Health Environment Department, Grenoble, France, Phone +334.76.76.25.89, Fax +334.76.76.25.60, julien.hans@cstb.fr
[2] Politecnico di Milano, BEST Department, Milan, Italy, 20133, piazza Leonardo Da Vinci, 32, Phone +39 0223996002, sonia.lupica@polimi.it

1 INTRODUCTION

Buildings have always been built to last "for a long time". Houses have a patrimonial value, while office buildingsmay acquire, sometimes, an historic value. Since actors have diversified, the building action has become the result of a relatively prompt transaction: an owner orders a work to a contractor in order to obtain function more or less precisely defined. The building’s owner is interested in its exploitation and therefore in the future stages of its history. The need addresses the perenity of the performances, materialized through the setting up of legal guarantees (decennial in France). A way to match the requirements related to these guarantees, can be to produce results of accelerated ageing tests applied to building materials and components. Moreover, the European Construction Product Directive underlines that the essential requirements which products must confer to the work must be satisfied "for an economically reasonable Working Life".

In the last few years, the need to respect the principles of this development, as well as the new economic models (life cycle cost, **Private Finance Initiative** (PFI) "Public-Private Partnerships" (PPP)) have changed the expectation related to the "durability" of construction works, and introduces the "service life planning" process. The whole life cycle of the building becomes a trading object, while protocols and consensual assessment ans decision aid tools (references, methodologies, databases, technical and economic guarantees) become essential.

Some more focused demands for service life data appear in different practical procedures.: typical service life are required in the environmental product declarations (EPD). The service life data of the components can be asked for in the contract in the frame of a private public partnership (PPP), which generally goes beyond legal decennial guarantee. Service life data should be attached to a performance in the energy diagnosis that will soon become compulsory for real estate transactions. In the energy saving certificates as well such data are needed These certificates allow validation of energy savings due to additional actions, such as reinforcement of insulation, change of energy supply product, …The energy unit used in the certificates is the kWh of final energy needed summed up and updated on the entire product’s service life.

2 PRESENTATION

This plateform allows to organize and to share in a dynamic manner the knowledge concerning building components’ Service Life.

The web address is: http://www.duree-de-vie.batiment.fr

First of all, the aim of the platform is to established a bridge between durability specialist and final users of service life data. For this reason, it first gives the possibility to create specific grids for each family of building components:

The specific grids for every family of building components will be established in accordance with the ISO 15686-8 [ISO SC14, 2007], to associate a "script" of ageing to every defined service life data for each component.. The following factors will be taken into consideration :

- A- Quality of materials and components
- B- Design level
- C- Work execution level
- D- Indoor environment
- E- Outdoor environment
- F- in-user conditions
- G- Maintenance level

For every grid created, reference service life data can be stored, by using the range of parameters which is provided by the corresponding grid.
Of course all the gathered data can the be read by all the user of the platform.

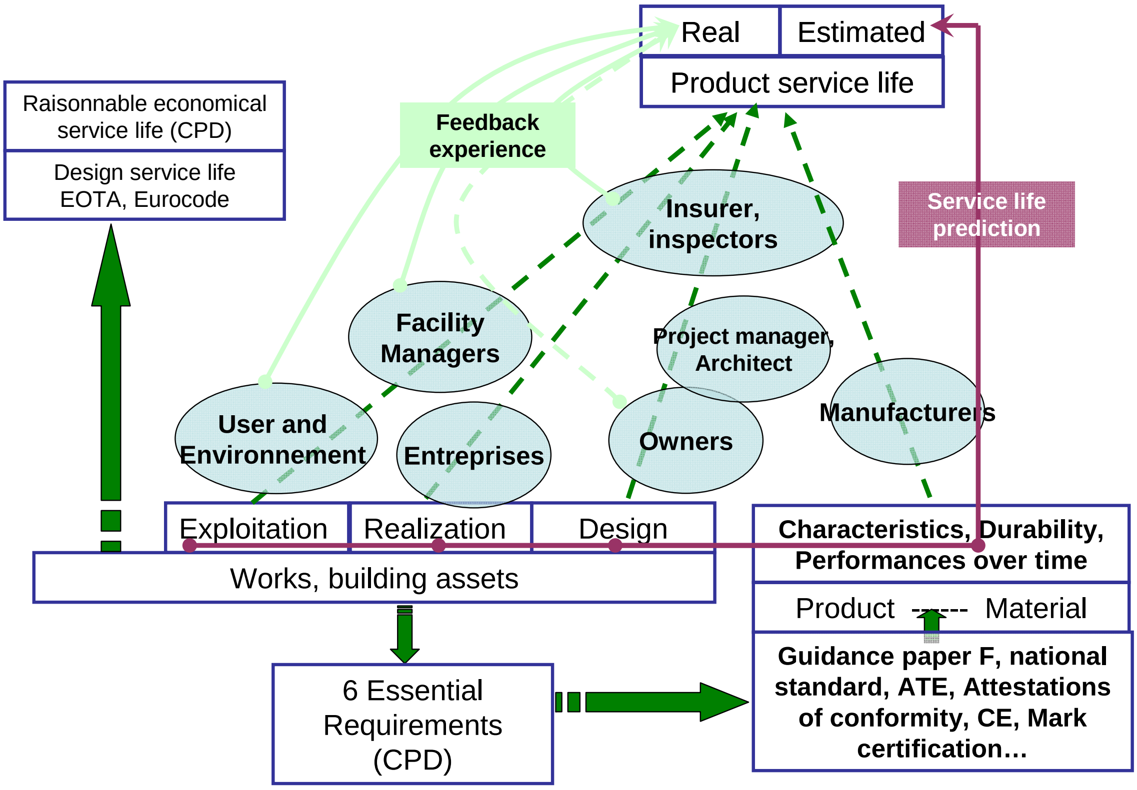


Figure 1. Impact of stakeholders on service life of building products, ability of each stakeholders to capitalize Reference service life. [HANS, 2006]

2.1 Creation of grids for factors conditioning Service Life

The first database's function is to allow the creation of grid for any building components, In these grids it is possible to take into consideration all factors impacting on building components' Service Life (materials, design level, inside and outside environment, in use condition, mechanical, thermal loading, etc.). The ISO 15686 part 8 standard developped within the ISO TC 59-SC14"Building and constructed assets – Service life planning" [ISO SC17, 2007] suggests to use seven factors (from A to G), as listed in [Table 1].

The creation of grids takes place in the following way:

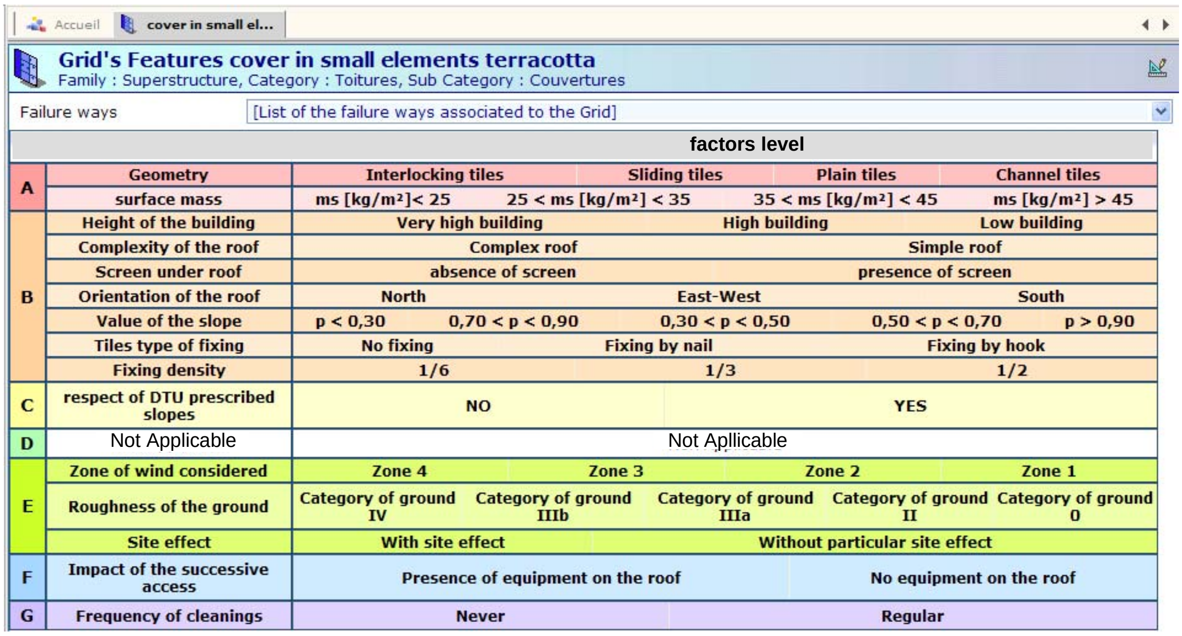
- The first step consists in defining the component to study and the materials it is made of (generic window, or more specifically window wood, PVC window, window Aluminium);

- The second stage consists in identifying the possible damaging scenarios for this kind of component which the grid must permit to characterize. That's why it is necessary to lead a functional analysis and/or an analysis of the failure scenario of the component;

- The third stage has for object to define the grid of building component's service life and to create the different influencing factors and the level of this influence.

Table 1. Conditions to take into consideration for evaluating Service Life.

AGENTS	REMARKABLE FACTORS		
Agent related to the inherent quality characteristics	A	Quality of components	Manufacture, storage, transport, materials, protective coatings (factory-applied)
	B	Design level	Incorporation, sheltering by rest of structure
	C	Work execution level	Site management, level of workmanship, climatic conditions during execution of the work
Environment	D	Indoor environment	Aggressiveness of environment, ventilation, condensation
	E	Outdoor environment	Elevation of the building, microenvironment conditions, traffic emissions, weathering factors
Operation conditions	F	In-use conditions	Mechanical impact, category of users, wear and tear
	G	Maintenance level	Quality and frequency of maintenance, accessibility for maintenance



	Factor	factors level				
A	Geometry	Interlocking tiles	Sliding tiles	Plain tiles	Channel tiles	
A	surface mass	ms [kg/m²]< 25	25 < ms [kg/m²] < 35	35 < ms [kg/m²] < 45	ms [kg/m²] > 45	
B	Height of the building	Very high building	High building	Low building		
B	Complexity of the roof	Complex roof	Simple roof			
B	Screen under roof	absence of screen	presence of screen			
B	Orientation of the roof	North	East-West	South		
B	Value of the slope	p < 0,30	0,70 < p < 0,90	0,30 < p < 0,50	0,50 < p < 0,70	p > 0,90
B	Tiles type of fixing	No fixing	Fixing by nail	Fixing by hook		
B	Fixing density	1/6	1/3	1/2		
C	respect of DTU prescribed slopes	NO	YES			
D	Not Applicable	Not Apllicable				
E	Zone of wind considered	Zone 4	Zone 3	Zone 2	Zone 1	
E	Roughness of the ground	Category of ground IV	Category of ground IIIb	Category of ground IIIa	Category of ground II	Category of ground 0
E	Site effect	With site effect	Without particular site effect			
F	Impact of the successive access	Presence of equipment on the roof	No equipment on the roof			
G	Frequency of cleanings	Never	Regular			

Figure 2. Illustration of possible grid for building components' Service Life (ex: roof covered with small clay tiles)

2.2 Collection of building components' Service Life data

Every Service Life data stored for a building component can be referenced while assigning it a range of values for determining each factors in the corresponding grid and for characterizing its specificities 'Fig. 3'.

Other information are associated to Service Life data:

- The format of Service Life value distribution (deterministic, range, asymmetric range, Gaussian distribution, etc.), see'Fig. 4'.

- The quality of the data: this information allow to determine data's reliability, important especially for merging all data. The quality of the data is related to the data source. If it acts of a test it is related to the type of test on which it is based, see 'Tab.2'

- Further information, such as :

- Year
- Place
- Bibliographic references
- Reason of the damaging
- Further observations

A	Geometry	Interlocking tiles	Sliding tiles	Plain tiles	Channel tiles	
	surface mass	ms [kg/m²]< 25	25 < ms [kg/m²] < 35	35 < ms [kg/m²] < 45	ms [kg/m²] > 45	
B	Height of the building	Very high building	High building	Low building		
	Complexity of the roof	Complex roof	Simple roof			
	Screen under roof	absence of screen	presence of screen			
	Orientation of the roof	North	East-West	South		
	Value of the slope	p < 0,30	0,70 < p < 0,90	0,30 < p < 0,50	0,50 < p < 0,70	p > 0,90
	Tiles type of fixing	No fixing	Fixing by nail	Fixing by hook		
	Fixing density	1/6	1/3	1/2		
C	respect of DTU prescribed slopes	NO	YES			
D	Not Applicable	Not Apllicable				
E	Zone of wind considered	Zone 4	Zone 3	Zone 2	Zone 1	
	Roughness of the ground	Category of ground IV	Category of ground IIIb	Category of ground IIIa	Category of ground II	Category of ground 0
	Site effect	With site effect	Without particular site effect			
F	Impact of the successive access	Presence of equipment on the roof	No equipment on the roof			
G	Frequency of cleanings	Never	Regular			

Figure 3. Selection of factors level characterizing the ageing scenario of one reference service life

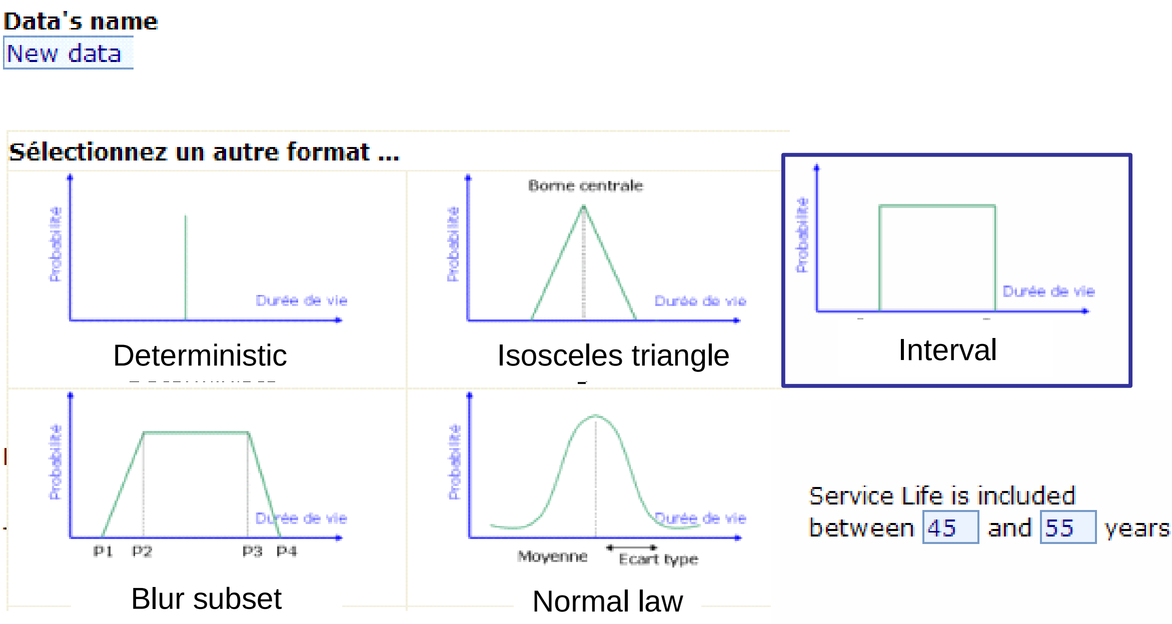


Figure 4. Formats of Service Life data value

It is important to define the data benchmark.

The capitalized data will have to enable us to limit the component Service Life. It is indeed necessary to born Service Life boundary and to know that it lies between 20 years (the most unfavourable case) and 50 years (the most favorable case) for a failure mode. Intermediate data we will allow us to approximate our case of study. For example to reduce the interval at 25-35 years.

Table 2. A life tests comparison of the constructive entities. [Talon, 2006]

Tests	Scale	Interests	Limits
Exposure on the ground (long duration)	Material Products	real climatic Conditions	**(1)** Uncertainties on the climatic conditions (nature, intensity, frequency). **(2)** Extrapolation with other products or other sites difficult.
Inspection of the buildings (long duration)	Materials products buildings	**(1)** Material /Produces /real Building **(2)** Weaker experimentation cost	**(1)** climatic conditions and of use not measured . **(2)** Problems of censure. **(3)** Extrapolation with other constructive entities or other sites difficult. **(4)** Conditions of maintenance sometimes badly known.
Exposition in experimental buildings (long duration)	Materials products buildings	**(1)** real climatic conditions. **(2)** Knowledge of the total behavior.	**(1)** Uncertainties on the climatic conditions. **(2)** Extrapolation with other constructive entities or other sites difficult.
Exposure in service (long duration)	products buildings	**(1)** Produced / real Building. **(2)** climatic conditions and of use real **(3)** Knowledge of the total behavior. **(4)** weaker experimentation cost.	**(1)** Many uncertainties on the climatic conditions and of use. **(2)** Extrapolation with other constructive entities or other sites difficult.
Exposure of short accelerated duration	Materials products	**(1)** Control of the climatic conditions. **(2)** Time and reduced cost of experimentation.	Possible inaccuracy at the time of the passage to the real time.
Exposure in service of short duration	Products	**(1)** climatic Conditions and of use real. **(2)** Time and reduced cost of experimentation.	**(1)** Many uncertainties on the climatic conditions and of use. **(2)** Extrapolation with other constructive entities or other sites difficult.

For that it is necessary to determine :

- a number of relevant data per failure mode,

The number of data capitalized by failure mode will be related two parameters:

  - homogeneity of the Service Life to reach the failure. More they will be near, less there will need data to obtain our kit of reference;
  - More the failure mode is frequent more we will retain data.

It is necessary to study the impact of the various factors over the Service Life per failure mode. Indeed, if the impact of the factor is weak it will not be essential to vary the factor in the benchark data. On the contrary if the impact of the factor is important over the Service Life it will be necessary to vary the factor.

- a relevant choice of factors level selection to identify the representative extreme cases, see ‘Fig. 5’.

The representative extreme cases are not case where all the factors are at the maximum or the least. Indeed, these extreme cases do not represent reality (red line on the ‘Fig. 5’). It is necessary to make a small preliminary study to determine which case would be most unfavourable while remaining possible. This case is represented in green on the ‘Fig. 5’.

- an identification of available data sources.

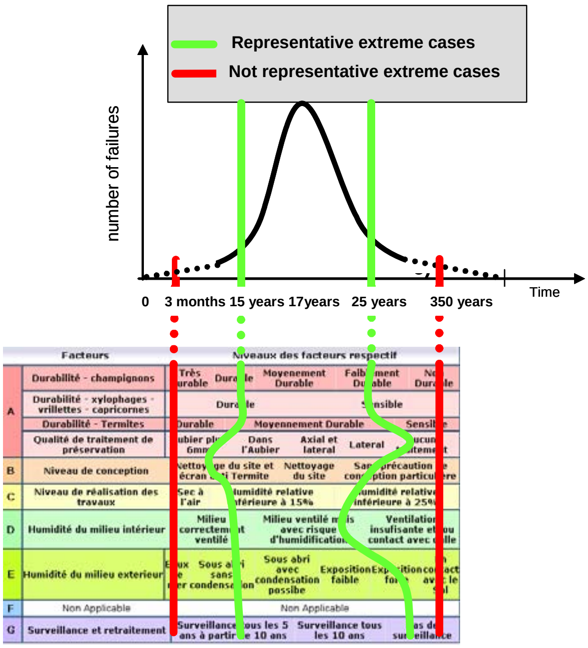


Figure 5. Identification of the representative extreme cases

To help us to make this study it can be interesting to set up an experimental plan.

2.3 Consultation of reference Service Life

Once these data capitalized in the platform, the originators will find there the Service Life which the investors could ask them. The managers of works will be able to draw information relating to maintenance there. The platform will be able for example to make it possible to check that the foreseeable Service Life of a constructive solution is adapted to the destination of the work, with its economic model.
The database allows the consultation of Service Life stored, in order to estimate Service Life of a component in similar conditions.
Three types of possible studies:

- Systems of prediction starting from the play of factors of the study;
- Decision-making aid starting from the play of some factors and the DDV concerned;
- Information starting from the play of factors of the study.

CONCLUSION

Components Service Life is an essential data to conceive and manage buildings. Creating a tool to capitalize and share information is needed for the knowledge of construction products Service Life. It

is required by the "French national service life information platform", financed by the French ministry for housing and carried out by the CSTB.
To go further in the capitalization of the data, an international extension of the platform is in project. It is carried out by Politecnico di Milano which works on Service Life Estimation using Reference Service Life Databases and Enhanced Factor Method [DANIOTTI, 2008].

REFERENCES

ISO/TC 59/SC 17 , 2007, *Sustainability in Building Construction — General Principles*

ISO TC 59/SC 14 N 315, 2007, *Buildings and constructed assets — Service life planning — Part 8: Reference service life and service life estimation*

Foliente G., Wang X., Wang C.H., 2005 'Reliability-based asset management of timber utility poles', CSIRO, 10 DBMC conference LYON.

Hans J., 2006, *French Guide for taking into account of service life in building industry*, FFB report

Bell, D. 1973, *The Coming of Post-Industrial Society*, Basic Books, New York.

Tupamaki O. , 2005, '*Total LCC and Probabilistics*', 11th Joint CIB International Symposium 13-16 June, Helsinki FI.

Talon A., 2006, *Évaluation des scénarii de dégradation des produits de construction*, UNIVERSITE BLAISE PASCAL – CLERMONT II - CSTB

Daniotti, B. & Lupica, S. 2008, *Service Life Estimation using Reference Service Life Databases and Enhanced Factor Method*, in papers of the conference "11 DBMC International Conference on Durability of Building Materials and Components", Istanbul, Turkey.