Service Life Performance and Planning – European Developments

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Aus PeBBU domains

1. **Life Performance of Construction Materials and Products**
2. **Indoor environment**
3. **Building Design and Engineering**
4. **Environmentally Sustainable Built Environment**
5. **Innovation**
6. **Legal and Procurement Practices**
7. **Building Regulations and Standards**

Domain 1: Life Performance of Construction Materials and Products

- **Objectives of Eu-PeBBu**
  - Further development of the Factorial Approach to Design Life of Buildings and Components
  - Develop of methods and standards to define Reference Service Life

Design life concepts underpinning series of International Standards

- **ISO 15686**
  - Part 1 – General Principles
  - Part 2 – Service Life Prediction Principles
  - Part 3 – Performance Audits and reviews
- **Provides Guidance to**
  - Sellers/Purchasers – to determine whole of life costs
  - Designers – to match performance requirements
  - Component/Material Suppliers – to assist in material specification and testing requirements
  - Maintenance and Facility Managers – to determine remaining life and guide condition assessment

Domain 1 Activities

- Responding to the PeBBu task to address the requirements of the EU Construction Products Directive (CPD) in relation to harmonised product standards
- National State of the Art Reports on service life research and practice
- Support for Sweden and France in publishing national guidelines for service life planning
- Surveys to find out to what extent material producers
  - are familiar with the ISO standards on service life planning
  - know about life performance of their products
  - can generate and provide such information to practitioners

The Factor Method

$$PSLDC = RSLC \cdot f_A \cdot f_B \cdot f_C \cdot f_D \cdot f_E \cdot f_F \cdot f_G$$

- PSLDC is the Predicted Service Life Distribution of the Component based on the Reference Service Life RSLC. The factor indices are for
  - A quality of component
  - B design
  - C work execution
  - D indoor environment
  - E outdoor environment
  - F in-use condition
  - G maintenance

Factor Method Issues

- **Method Itself**
  - **Basic – Deterministic approach – Unique values associated with each factor – too simplistic**
  - **Probabilistic – Assign Probability Distribution to each factor**
- **Data**
  - **Obtaining valid values for Reference Service Life and Components and factors**

Probabilistic Approach - Windows

Factor		Face	Relevant conditions	Factors for the fractiles 5% / 50% / 95%
f_A	Quality of component	all	general variations of components	1.2 / 1.5 / 1.8
f_B	Design level	all	good, identical value	1.2
f_C	Work execution level	all	general variation, but insufficient quality repaired	1.0 / 1.2 / 1.5
f_D	Indoor environment	S	occasional risk of condensation	0.9 / 1.0 / 1.2
		W	medium risk of condensation	0.8 / 0.9 / 1.1
		N	high risk of condensation	0.7 / 0.8 / 0.95
		E	medium risk of condensation	0.8 / 0.9 / 1.1
f_E	Outdoor environment	S	occasional cycling dry / damp	0.8 / 1.0 / 1.3
		W	regular cycling dry / damp	0.6 / 0.8 / 1.0
		N	sheltered from rain	1.0 / 1.2 / 1.5
		E	occasional cycling dry / damp	0.8 / 1.0 / 1.3
f_F	In use conditions	S	occasional access by children [1])	0.8 / 1.0 / 1.2
		W	regular access by children [1])	0.6 / 0.8 / 1.0
		N	occ. / reg. access by children [1])	0.7 / 0.9 / 1.1
		E	occasional access by children [1])	0.8 / 1.0 / 1.2
f_G	Maintenance level	all	painted on judgement of caretaker	0.9 / 1.0 / 1.1

Variation in each factor defined and the type of distribution – Monte-Carlo method used to form PSLDC

Defining Reference Service Life

- field testing
- laboratory testing
- service experience
- analysis
- combination of the above

There is a strong need to establish protocols and examples

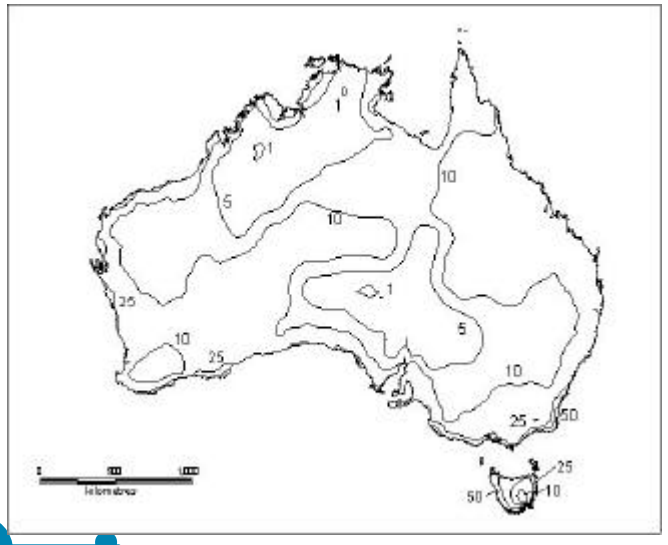
AusPeBBu

- **Documentation** of Existing Tools for Life Cycle Performance
- **Assessment** of relevance of International methods to Australia
- **Dissemination** of Information on Tools

Australian Perspective

- **Focused primarily on prediction reference service life**
  - **In Australia approach environmental factors tend to be already factored into service life**
- **Methods used**
  - **Laboratory Testing (embedded in many Australian Standard but connection between tests and life uncertain)**
  - **Maps derived from understanding the Degradation Process**
    - **CSIRO – Corrosion Map**

Corrosion Map of Australia for Zinc



Corrosion Map of Australia for Zinc (g/m^2.year)

New approaches to Reference Service Life

- Delphi Survey
  - Expert Opinion
- Case Based Reasoning
  - Combining
    - Models
    - Experimental data
    - Expert Opinion
    - Maintenance data
- CRC CI projects and Aus-PeBBu

Microclimates

- Fully exposed – external
- Partially exposed – facades
- Roof space
- Wall cavity
- Subfloor
- Internal

Typical metal components

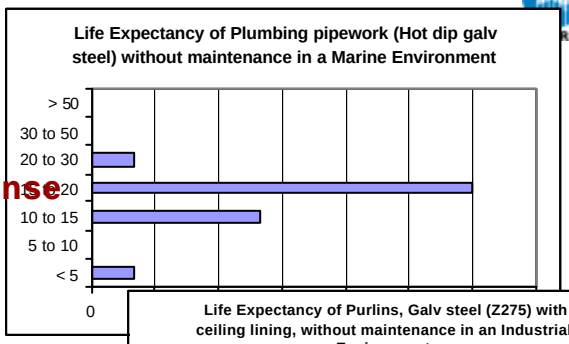
- Fully exposed – external
  - roof sheeting
  - flashings
  - gutters
  - wall cladding
- Wall cavity
  - bracing
  - nails
  - brick ties
  - bolts
  - plumbing pipework

Service life attributes

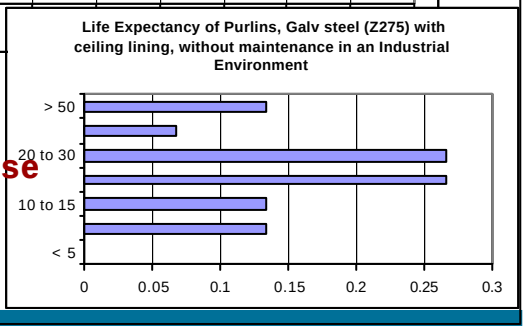
- Maintenance
  - Extends from cleaning to repainting, but not replacement
- Environments
  - Marine
  - Industrial
  - Benign
- Life
  - Failure
  - Aesthetic

Delphi survey

Class 1 response



Class 2 response



Validation of the Database

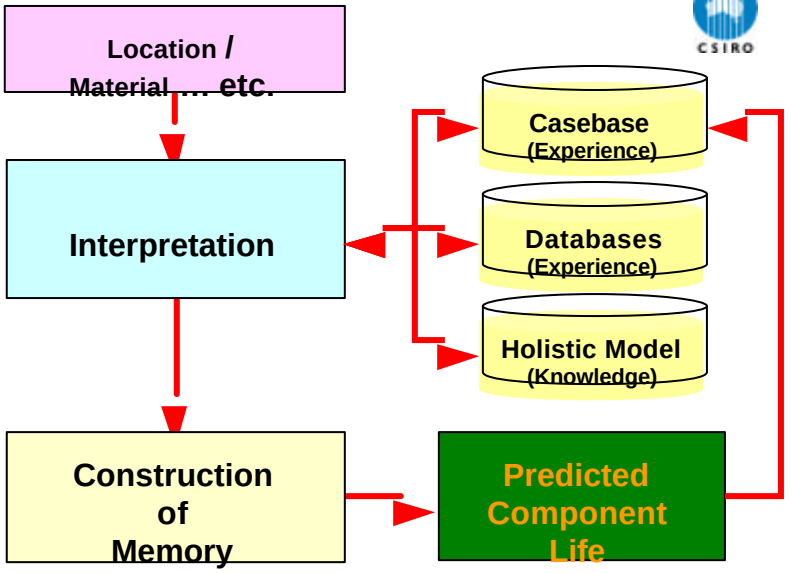
- **The accuracy and reliability of the final database was examined in several ways including:**
  - **checks for internal consistency**
  - **alignment with expected trends based on knowledge of materials performance and environmental severity, and**
  - **correlation with existing databases on component performance.**

In all of these comparisons, the Delphi survey data showed good agreement.

Case Based Reasoning

- **Objective**
  - How to combine different data sources with new cases
- **Data sources include**
  - surveys
  - maintenance records
  - research on durability
  - experience

Case Based Reasoning Method



Case Based Reasoning

- **Steps**
  - How to determine similarity of circumstances
  - Develop rules for testing for similarities
  - Decide on acceptance criteria
  - Build a case database
- **Advantages**
  - Database grows with time
  - Hard data replaces estimates
- **Progress**
  - Rules engine has been written
  - Test database exists
  - Need demonstration applications

Domain 1: Life Performance of Construction Materials and Products

- **Australian Domain**
  - Co-ordinator – Ivan Cole
- **Progress to date**
  - Committee established with representation from
    - Steel Industry ,Timber Industry, Concrete Industry, Institute of Architects, Institute of Engineers, Universities
  - Dephi study
  - Case based reasoning methodology
  - Factor method not widespread
  - Issue of breadth of “Construction Materials” - Covers Internal fixtures etc