Bridge LCC - New tool for life-cycle-costs for bridges

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Holistic perception of cost trends of a construction over its whole expected service life
- Planning costs
- Building costs
- Cost of maintenance during service life cycle period
- Unexpected costs (optional)
- Cost of demolition at the end of life cycle

Predominant investment
- after building phase
- during utilisation

Generally cost optimisation only for building phase

Only reliable cost available are production cost = construction cost

Hence reference base of further costing

Choice of system, quality of material and construction impact level of expense during utilisation phase decisively

Targets of strategic planning of structure at budgeting
- to aspire maximum of service life
- to aim for minimum of costs
- to meet function without restriction

REQUIREMENTS ON CALCULATION MODEL LCCB (LZKB)
Creation of a consistently applicable tool of calculation for life cycle cost of a single bridge

Possibilities of application:
- Comparison of bridges
- Comparison of versions
- Optimisation of planning
- Checking of costs
- Redemption
- Leasing of bridges

Redemption guideline ÖBB 2006
- Calculation of redemption cost by intervention on buildings, when initiator is not upholster or with change of upholster.
- Calculation of maintenance costs for old and new building is basis of calculation of redemption costs.

Adaption of tabular values for special cases using matching coefficients
- Variance of construction guidelines
- Exceeding of normative defaults
- Consideration of material technology
- Experiments with new material

Guideline RVS 15.01.11 – Quality criteria for planning bridges
- Adaptability for road bridges
- Additional criteria

Factors for reduction and re-evaluation
- Theoretical service life \( m \) (years)
- Annual maintenance costs \( p \) (\%)

Application
- New material technology
- Experimental projects
- Accreditation
- Assessment of alternative offers

Groups of bridge construction elements
- Structure base (foundation)
- Structure
- Level of utilization
- Equipment

Negative impact on structure may require adjustment of concrete quality.
Less than 3.5 cm concrete covering is not permissible.
- Concrete covering \( \rightarrow \) tabular values for \( d_{\text{concrete}} = 9.5 \) cm
  \( n_{\text{years}} = 70 \) years \( p_{\text{years}} = 0.8 \% \)
  \( k_1 = 3.0 \)
  \( k_2 = 1.00 \)
- Increase of concrete covering:
  \( \rightarrow \) Higher durability \( \rightarrow \) positive impact
  \( \rightarrow \) More concrete and reinforcement \( \rightarrow \) negative impact
- Increase \( > 3.5 \text{ cm} - 6.0 \text{ cm} \) \( \rightarrow \) new correction factor
  \( k_3 = 1.10 \) and \( k_4 = 0.85 \) for \( d_{\text{concrete}} = 6.0 \text{ cm} \)
Medieval Ponte Vecchio across river Arno in Florence / Italy

**BASIC CALCULATION CRITERIA**

- Base -> redemption guideline ÖBB
- Commitment of parameters -> safeguarding comparability of projects
- Fixed interest rate of capitalisation -> 4 % p.a.
- Fixed values \( m \) and \( p \) are dependent on structure and construction
  - Theoretical service life (life span) \( m \) [a]
  - Percentage of annual maintenance costs \( p \) [%] based on building cost and construction cost respectively.

Calculation basis \( LZKB \)

**Calculation basis**

- Calculation based on **CONSTRUCTION COST**
  - Only reliable well-established value
- **Construction cost** \( K_B \) contain:
  - Production cost of construction units
  - Related miscellaneous works
  - Clearance of traffic, site protection
  - Generation of execution documents/plans
  - Difficulties for third parties

**Calculation basis \( K_B \)**

- **Non-recurring administration cost** \( K_V \) (fixed 10% of \( K_B \)) contain:
  - Work in advance, preliminary and construction draft, awarding of contracts
  - Check of statics/plans, site management
  - Test and measuring devices, vehicles, test loading
  - Administration, accountancy

**Administrative cost**

- **Building cost** \( K_{er} \) contain:
  - Construction cost \( K_B \)
  - Non-recurring administration cost \( K_{VB} \) fixed with 10% of \( K_B \)
  - \( K_{er} = K_B + K_{VB} = 1.10 \times K_B \)
  - \( K_{er} \) Calculation basis of percentage \( p \) for annual maintenance cost

**Building cost \( K_{er} \)**

- **Dismantling cost** \( K_A \) contain:
  - Demolition cost in the course of replacement \( K_{RA} \)
    - Fixed with 20% of \( K_B \)
  - Administration cost of demolition \( K_{VA} \)
    - Fixed with 10% of \( K_A \) (2% of \( K_B \))
  - \( K_A = K_{RA} + K_{VA} = 0.22 \times K_B \)

**Dismantling cost**
• **Annual maintenance cost** $K_{ju}$
  - Calculated as overall fixed percentage $p$ of building cost $K_r$ according to tabular value $p$ [%] in redemption guideline
  - $K_{ju} = p \times K_r = K_a + K_v = 1,10 \times K_a$
  - $K_{ju} = p \times 1,10 \times K_a$
  - Annual maintenance cost $K_{ju}$ are handled as annuity

• **Life cycle cost** are calculated for one single life span
  - Calculation of LCC with only three input parameters $p$ [%], $m$ [a] and $C_0$ [€]
  - Calculation methods used
    - Cash value method
    - Final value method

**Calculation of life cycle cost**

- **Base** → unlimited maintenance obligation.
- **Cause** → transfer of maintenance cost when change of upholster takes place.
- **Cost** → compensation as redemption debit amount to or from next upholsterer.
- **Philosophy** → when bridge is up for next replacement at end of service life, from capitalised maintenance cost after subtraction of replacement cost a certain amount of capital keeps remaining, which has to meet the liabilities of next replacement by return on capital employed during next following service life.
- Decision between software Java and Excel.
  - Justification for Java:
    - Computer language independent of platform
    - Software library and pattern
    - Individual user interface and graphs
    - Software exempt from charges
    - Computer-oriented language
    - Source code needed for changes
    - Compatible with all systems software
    - Each kind of calculation possible
    - Software package "basis" and "factors"
    - License bound to hard disk of computer

Thank you for your attention

New software LZKB (LCCB)

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SOFTWARE LZKB (LCCB)