Implementation of Road Structure Management System KUBA – Experience Report

Jan Wunderlich & Prof. Dr. Rade Hajdin
Outline

- Introduction
- Estimation of deterioration matrices
- Collection of data on performed maintenance interventions
- Inspection workload
- Conclusions
Swiss NHS

- 12,500 road structures, which include 4,300 Bridges and 220 tunnels
- Visual inspections each 5 years
- Inspection practice: Condition state assessment for
  - Structure
  - Elements
- Segments/Damage areas → deterioration process
- Approx. 3 million US$ yearly for inspections
Road Structures Management System (RSMS) KUBA

Structure breakdown
- Structure type, function
- Location
- Geometric properties
- ...

Elements
- Element type
- Construction type
- Extent
- ...

Segments
- Segment extent
- Damage zone
- Deterioration process
- ...

Damages
- Damage type
- Location
- Description
- ...

Condition state assessment
RSMS KUBA

Markov chains / decision process for:
- Modelling deterioration
- Forecast of financial needs
- Work programs

Determination of deterioration functions, effectiveness and costs of interventions:
- Pool of experts
- Updating based on collected data
Experience report

- Estimation of deterioration matrices
  - Data in bad condition states
  - Issues related to calibration using raw data
- Data on performed maintenance interventions
  - Organizational issues
  - Technical issues
- Inspection workload
  - Analysis of scatter and distribution of the workload in function of different properties
Corrosion of reinforcement

- Average exposition

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<th>Condition State</th>
<th>Observed number of transition</th>
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Total Number of Transitions from CS:

- Condition State
- Total Number of Transitions from CS
Expansion joints

- Average exposition

<table>
<thead>
<tr>
<th>Condition State</th>
<th>CS1</th>
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<th>CS3</th>
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**Estimation of matrices**
Calibration using raw data

### Transition probability at t+5 years

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### CS distribution development for corrosion in reinforced concrete with average influence

After 80 years:
- 42% in CS1
- (72-42)= 30% in CS2
- (96-72)= 24% in CS3
- (100-97)= 3% in CS4

### Transition probability at t+5 years

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### CS distribution development for expansion joints with average influence
Conclusions

- FEDRO seldom allows structures and elements to deteriorate into the worst two condition states → Almost no data in bad condition states
- Calibration algorithms can overcome data voids but not the problem of almost no data in bad condition states
- The deterioration function from the worst two condition states rely on the estimates made by a pool of experts
- Condition data should be stored immediately before performing intervention
Organizational issues

- Spilt in responsibilities between the asset management (AM) and construction management (CM)
  → AM has no direct managerial authority towards CM
- Resources of AM are inferior to those of CM
  → Organizational weight of CM is larger than the one of AM
  → Concerns of AM treated as less important
- Priority of CM: design, building supervision and partially to as-built documentation
  → CM doesn’t see necessity of data collection
- FEDRO contracts out most of the maintenance and inspection activities
  → Strict controlling of the task execution are required
- FEDRO’s organization is relatively young
  → Awareness for the importance of data collection is not completely established.
Possible remedies

- Give AM direct managerial authority over CM
- Give AM the competence for acceptance of work and release funds for the as-built documentation of performed maintenance interventions
- Raising awareness of CM of the need for data on maintenance interventions and related advantages
Technical issues

- Breakdown of cost in practice is different from the cost breakdown in KUBA
- Element related unit costs are needed and these costs have to be stored, but in practice – during project realization – the costs relate to the type of work
- Results of research project: In order to obtain these costs, the contractor has to track them and the awarding authority has to pay for it.
Conclusions

- Spilt in responsibilities between the AM and CM seems to pose an obstacle to obtain data that can be used for planning purposes.
- Give the AM the competence for acceptance of work and release funds for the as-built documentation of performed maintenance interventions.
- Conduct additional research in order to overcome the issues related to the difference between the breakdown of cost in construction practice from the one in KUBA.
Average workload per network section

- Median
- Average
- Number
Average workload per road structure type

Big scatter

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Inspection workload
Results for bridges

Scatter still big
Reduced scatter
Newly collected damages seem to govern workload
Newly collected damages seem to govern workload.
Condition state seems to govern workload!
Conclusions

• Type of road structure, number of newly collected damages and the condition state seems to govern the workload.

• For bridges, the newly collected damages clearly seem to govern the workload.

• Information about the condition state and the newly collected damages isn’t available a-priori
  → It can be therefore used only for controlling the filed workload and not for planning purposes.

• For planning purposes the number of elements can be used, but they don’t provide accurate values for large bridges.

• Workload heavily depends on the collected data
  → be aware of the data which is required to be collected.

• Improvements in the processes and tools are most effective if done for data on damages or groups of damages.