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April 27, 2017

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Implementation of Road Structure Management System KUBA – Experience Report

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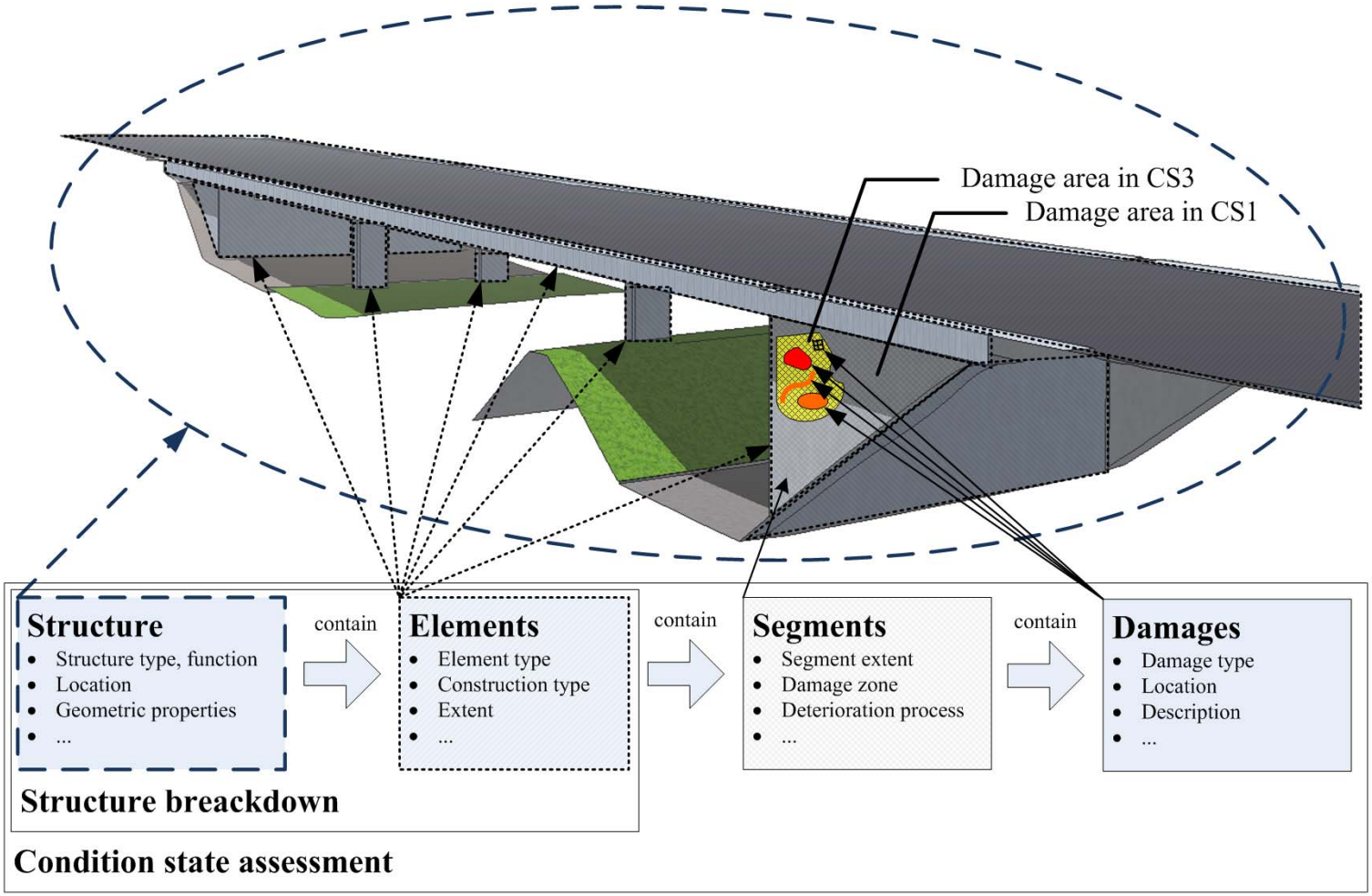
Outline

- 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



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

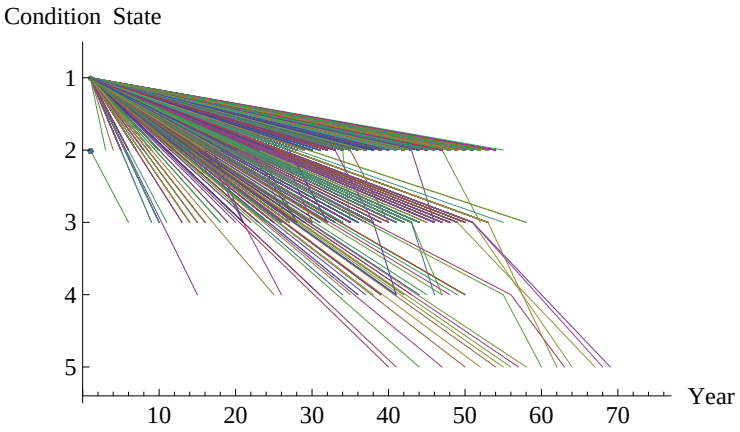
- Estimation of deterioration matrices
  - Data in bad condition states
  - Issues related to calibration using raw data
- Data on performed maintenance interventions
  - Organizational issues
  - Technical issues
- Inspection workload
  - Analysis of scatter and distribution of the workload in function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

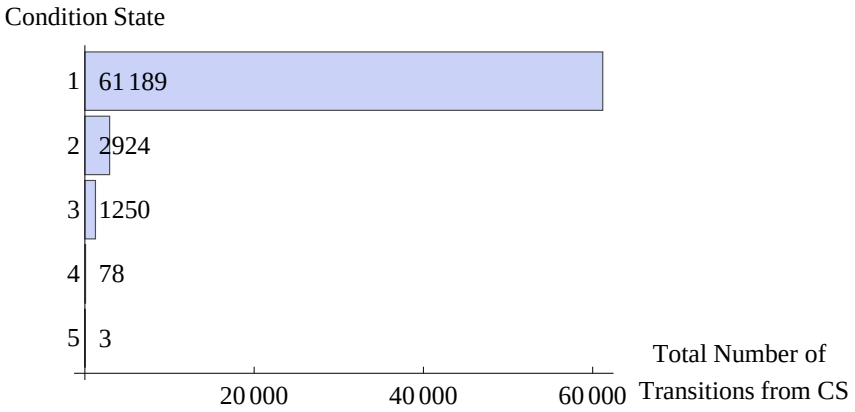
Corrosion of reinforcement

- Average exposition

Observed number of transition

	CS1	CS2	CS3	CS4	CS5
CS1	41,491	14,798	4,520	370	10
CS2	0	2,572	329	23	0
CS3	0	0	1,201	49	0
CS4	0	0	0	75	3
CS5	0	0	0	0	3



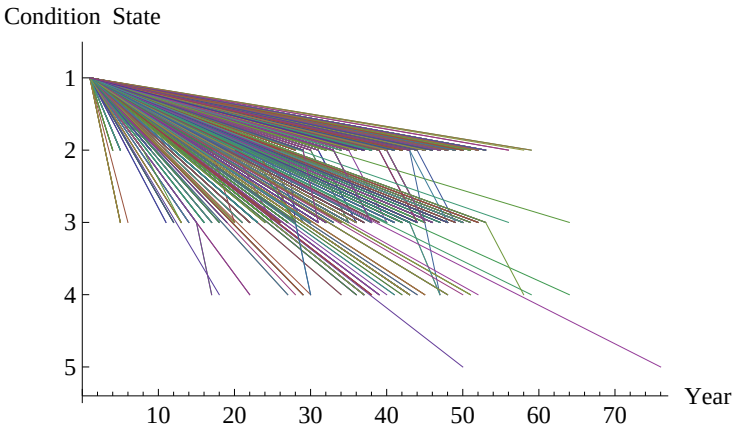


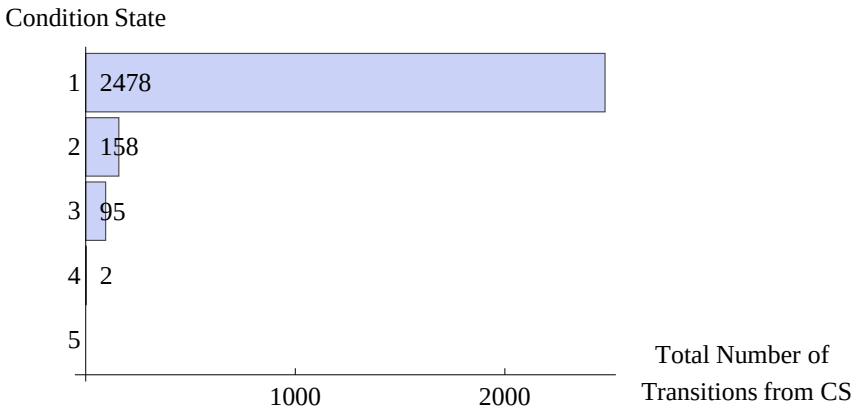
Expansion joints

- Average exposition

Observed number of transition

	CS1	CS2	CS3	CS4	CS5
CS1	1,071	843	493	70	1
CS2	0	104	52	2	0
CS3	0	0	89	6	0
CS4	0	0	0	2	0
CS5	0	0	0	0	0

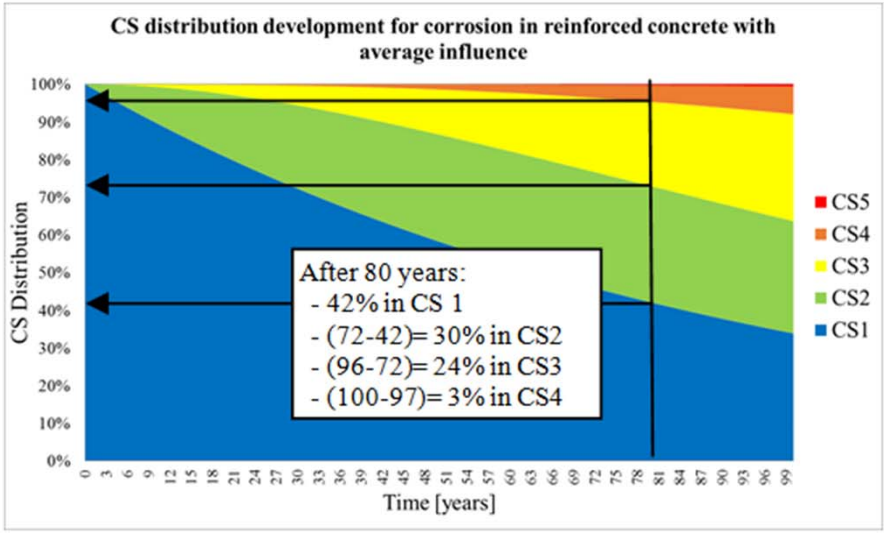




Calibration using raw data

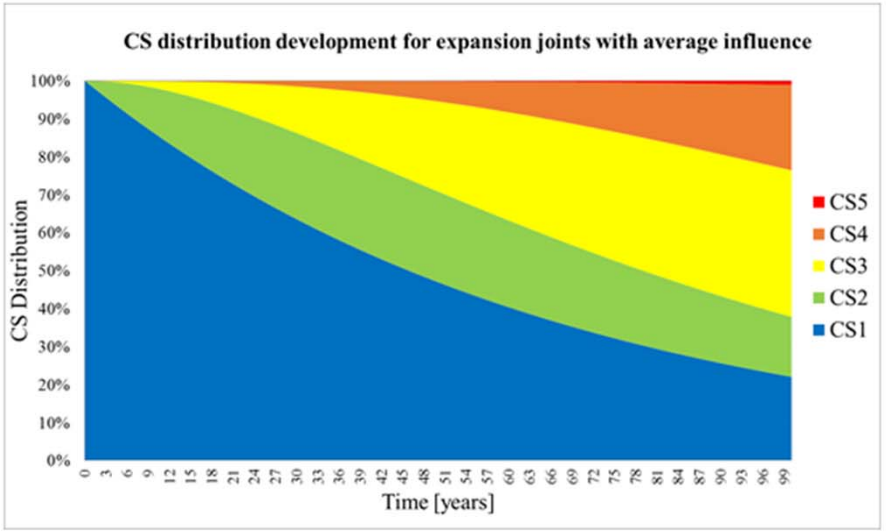
Transition probability at t+5years

	CS1	CS2	CS3	CS4	CS5
CS1	0.947	0.053	-	-	-
CS2	-	0.926	0.074	-	-
CS3	-	-	0.968	0.032	-
CS4	-	-	-	0.986	0.014
CS5	-	-	-	-	1.000



Transition probability at t+5years

	CS1	CS2	CS3	CS4	CS5
CS1	0.927	0.073	-	-	-
CS2	-	0.848	0.152	-	-
CS3	-	-	0.946	0.054	-
CS4	-	-	-	0.993	0.007
CS5	-	-	-	-	1.000



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

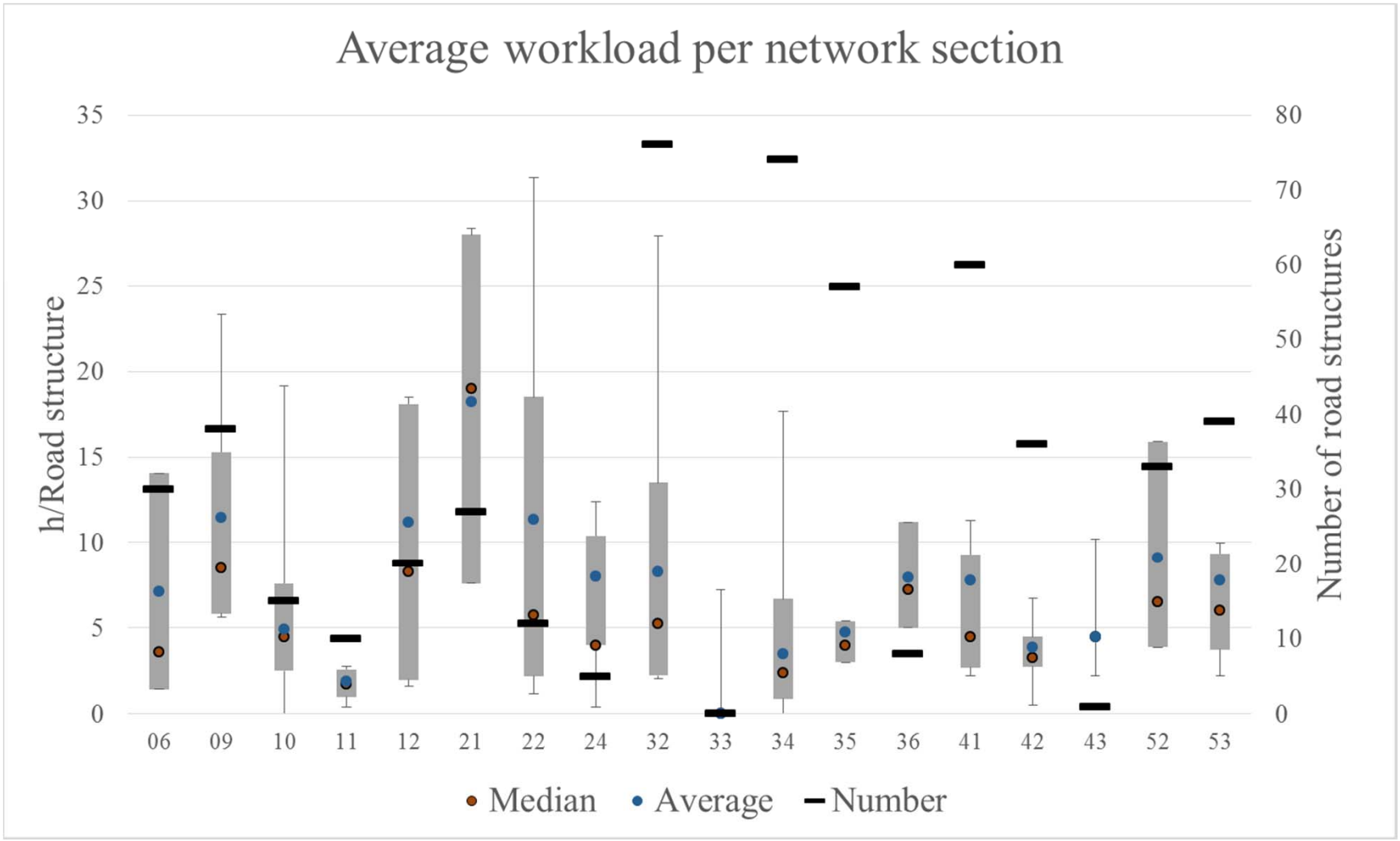
- Give AM direct managerial authority over CM
- Give AM the competence for acceptance of work and release funds for the as-built documentation of performed maintenance interventions
- Raising awareness of CM of the need for data on maintenance interventions and related advantages

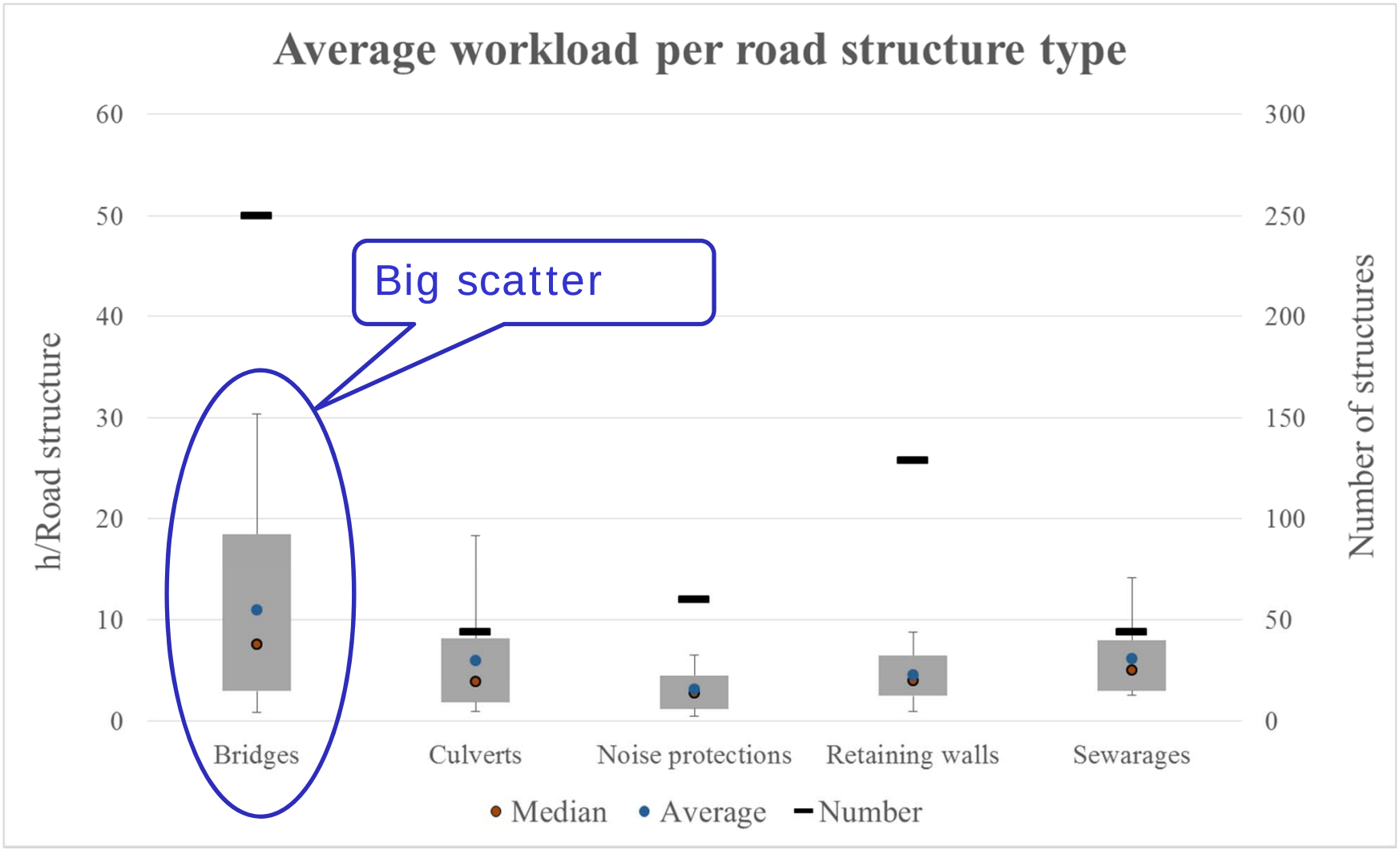
Technical issues

- 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.

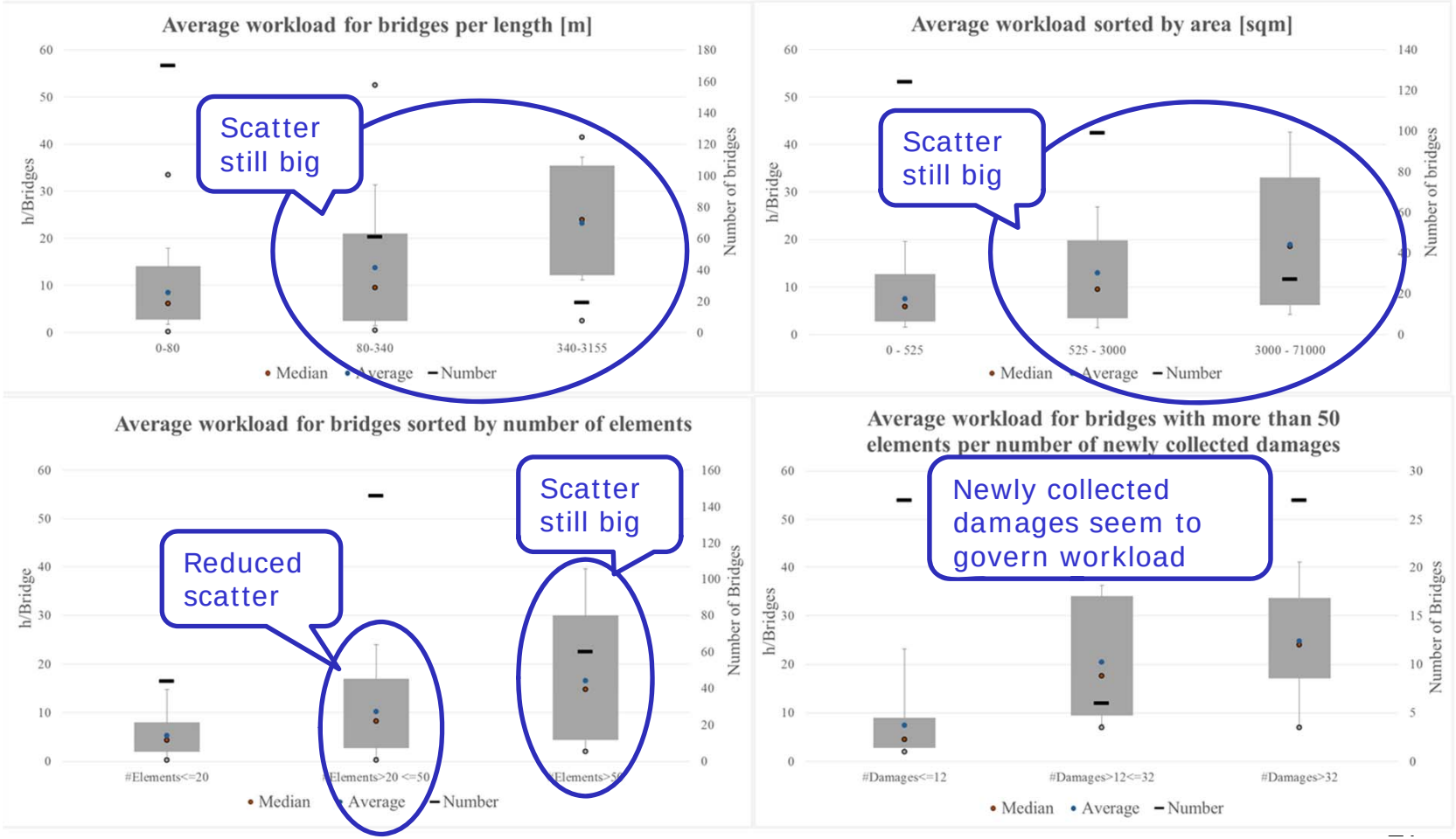
Conclusions

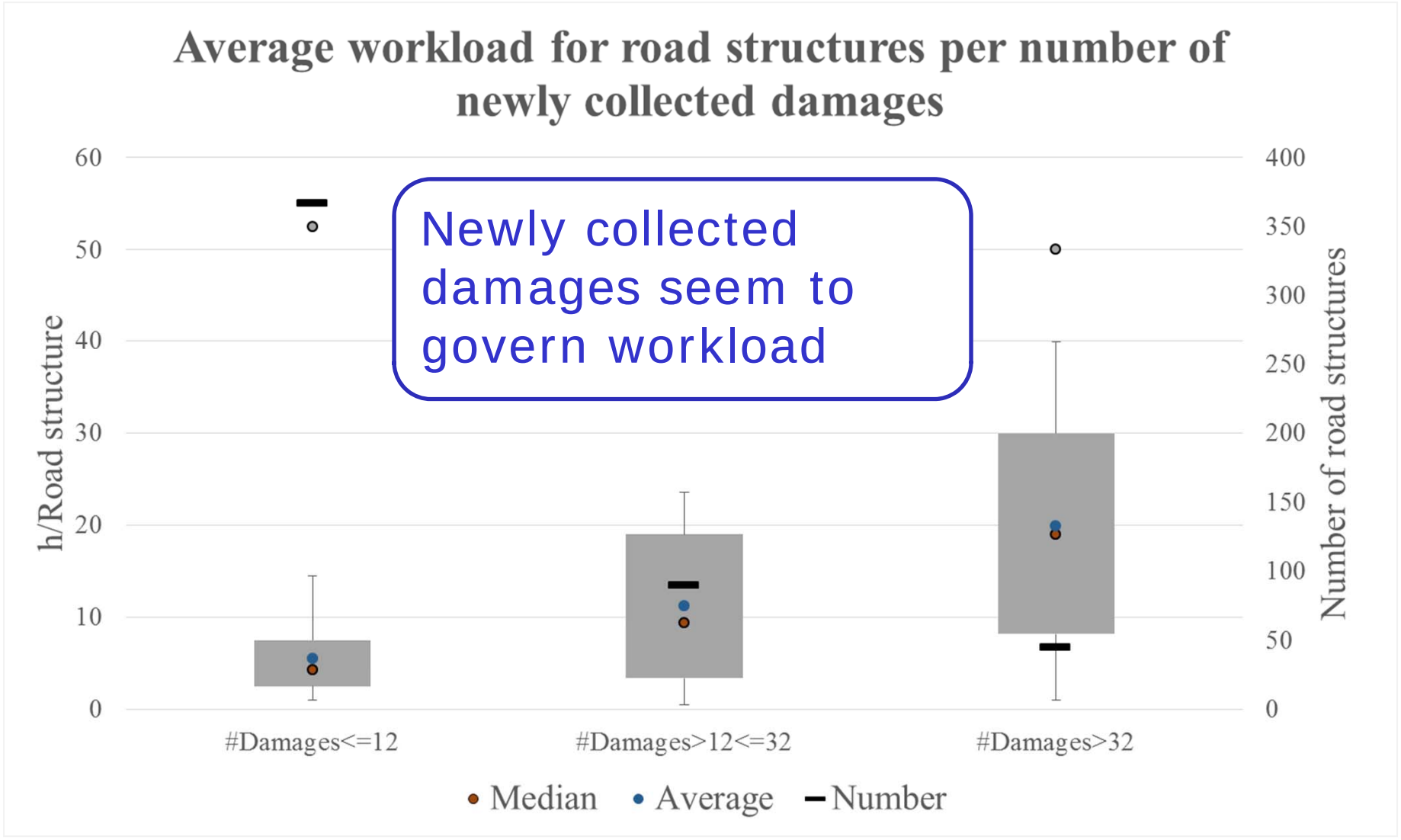
- Spilt in responsibilities between the AM and CM seems to pose an obstacle to obtain data that can be used for planning purposes
- Give the AM the competence for acceptance of work and release funds for the as-built documentation of performed maintenance interventions
- Conduct additional research in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

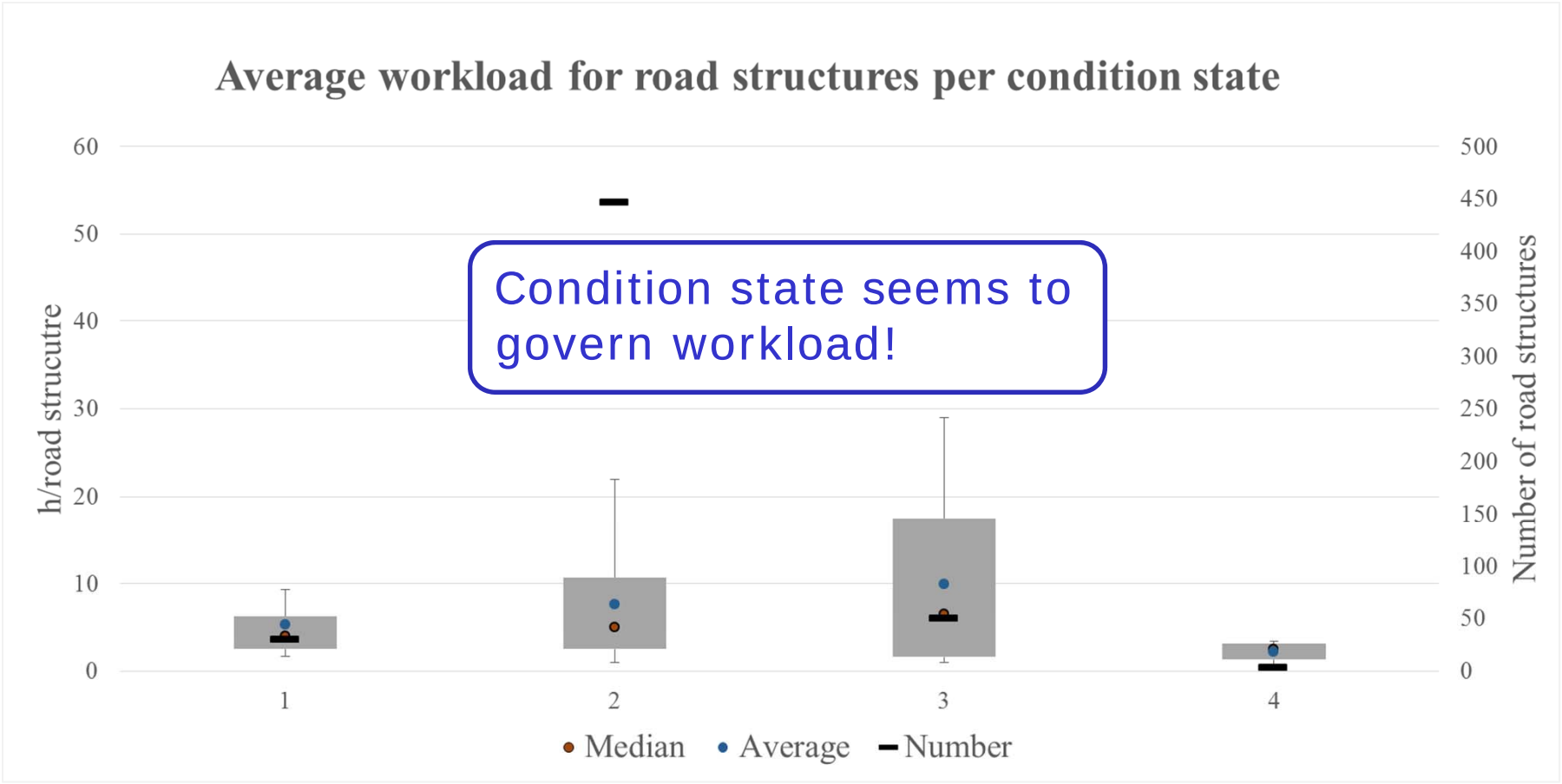

Average workload per network section
h/Road structure
Number of road structures
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
06
09
10
11
12
21
22
24
32
33
34
35
36
41
42
43
52
53
Median
Average
Number


Average workload per road structure type
h/Road structure
Number of structures
60
50
40
30
20
10
0
300
250
200
150
100
50
0
Big scatter
Bridges
Culverts
Noise protections
Retaining walls
Sewarages
Median
Average
Number

Results for bridges




Average workload for road structures per number of newly collected damages
Newly collected damages seem to govern workload
h/Road structure
Number of road structures
60
50
40
30
20
10
0
400
350
300
250
200
150
100
50
0
#Damages<=12
#Damages>12<=32
#Damages>32
Median
Average
Number


Average workload for road structures per condition state
h/road strucutre
Number of road structures
60
50
40
30
20
10
0
500
450
400
350
300
250
200
150
100
50
0
1
2
3
4
Median
Average
Number
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