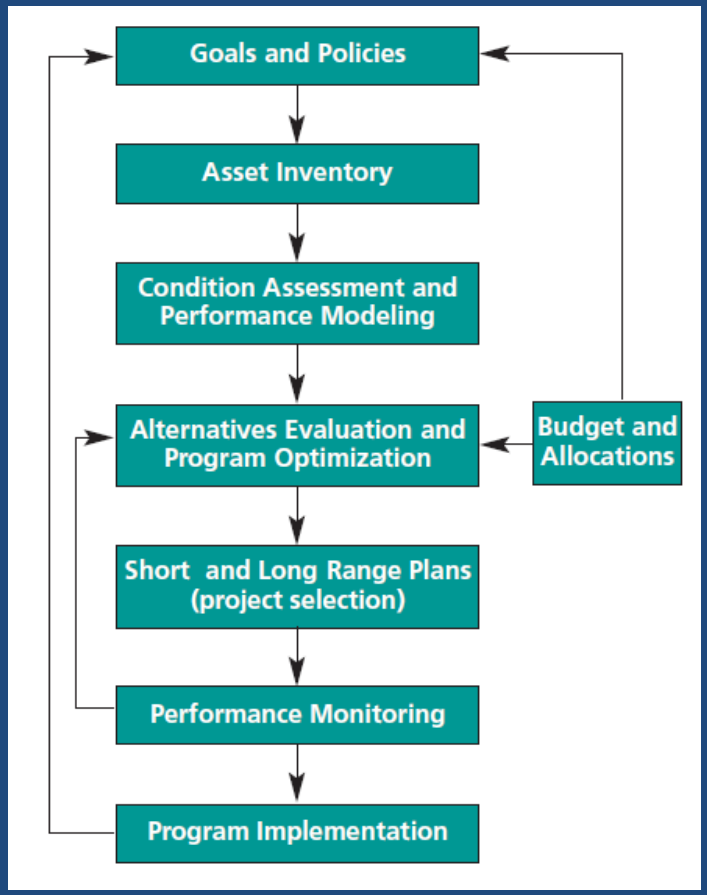
Element-Level Data
Observations & Considerations

BrMUG 2016
San Antonio, TX

Element Data - Purpose & Uses

Capital Program Development



Maintenance Work Identification

- Deck Joints
- Deck Overlays
- Railing
- Decks
- Bearings
- Coatings
- Superstructure Members
- Substructure Members
- Backwalls
- Wingwalls
- Approach Slabs
- Scour Countermeasures
- Slope Protection
- Drainage systems
- Other

Inspection Program Support

- Cross validation component and element ratings
- Critical Findings identification (CS4)
- Record of all recordable deficiencies

Element Data - National Sample

Bridge Management Elements

- Deck Joints
  - Average Health Index = 82

Element Data - National Sample

Deck Joints Cont.

- Bridges with good super and substructures
  - Are priority candidates for joint maintenance to maximize return on investment
  - Average deck joint HI = 87.7
  - 71% CS1, 24% CS2, 4% CS3, 2% CS4

Element Data – National Sample

- Deck joints cont.
  - GOOD Bridges
    - 71% CS1
    - 24% CS2
    - 4% CS3
    - 2% CS4

Defects	Condition States			
	1	2	3	4
	GOOD	FAIR	POOR	SEVERE
Leakage (2310)	None.	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.
Seal Adhesion (2320)	Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion.	Complete loss of adhesion.
Seal Damage (2330)	None.	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.
Seal Cracking (2340)	None.	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.
Debris Impaction (2350)	No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.
Adjacent Deck or Header (2360)	Sound. No spall, delamination, or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area, or loose joint anchor that prevents the joint from functioning as intended.
Metal Deterioration or Damage (2370)	None.	Freckled rust; metal has no cracks, or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal, or impact damage but joint still functioning.	Metal cracking, section loss, damage, or connection failure that prevents the joint from functioning as intended.

Element Data – National Sample

- Health Index
  - $HI_{Element} = \frac{\sum_{n=1}^{n=4} k_n q_n}{\sum_{n=1}^{n=4} q_n} * 100\%$
  - $HI_{Group/Bridge} = \frac{\sum_{n=1}^{n=j} HI_{Element\ n} * WnQn}{\sum_{n=1}^{n=j} W_n' Q_n} * 100\%$
    - q_n = condition state quantities
    - k_n = condition state weighting
    - Q_n = element total quantities
    - W_n = element type weighting

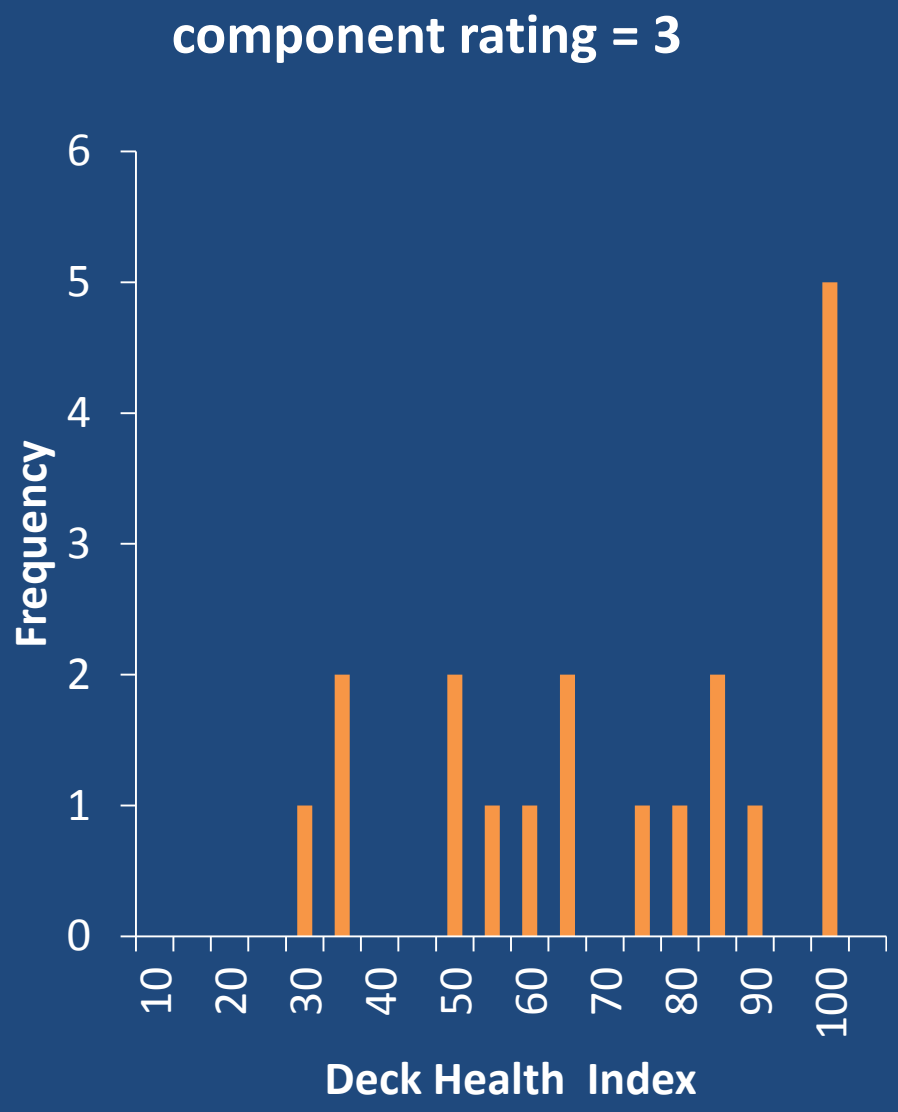
Element Data – National Sample

- Decks & Slabs

Element Data	CS Quantity (SF)	CS %
CS1	63,447,996	88.7
CS2	6,746,861	9.4
CS3	1,235,869	1.7
CS4	70,175	0.1
Total	69,035,581	100.0
Average Health Index		96

Component Data	# of Bridges
Rated 9	151
Rated 8	815
Rated 7	2,333
Rated 6	1,614
Rated 5	711
Rated 4	206
Rated 3	19
Rated 2	0
Rated 1	0
Rated 0	0
Average Rating	6.6

Decks & Slabs



HI Bins	Frequency
5	3
10	0
15	0
20	0
25	0
30	1
35	2
40	0
45	0
50	2
55	1
60	1
65	2
70	0
75	1
80	1
85	2
90	1
95	0
100	5
Total	22

CS1	CS2	CS3	CS4	HI
13737	519	32	0	98.6
2831	366	4	0	96.1
1207	1269	0	0	82.9
3011	1564	1216	0	77.0
1140	3	788	0	72.7
216	266	355	0	61.1

Element Data – National Sample

- As another check can use FHWA converter to compare component and element ratings.

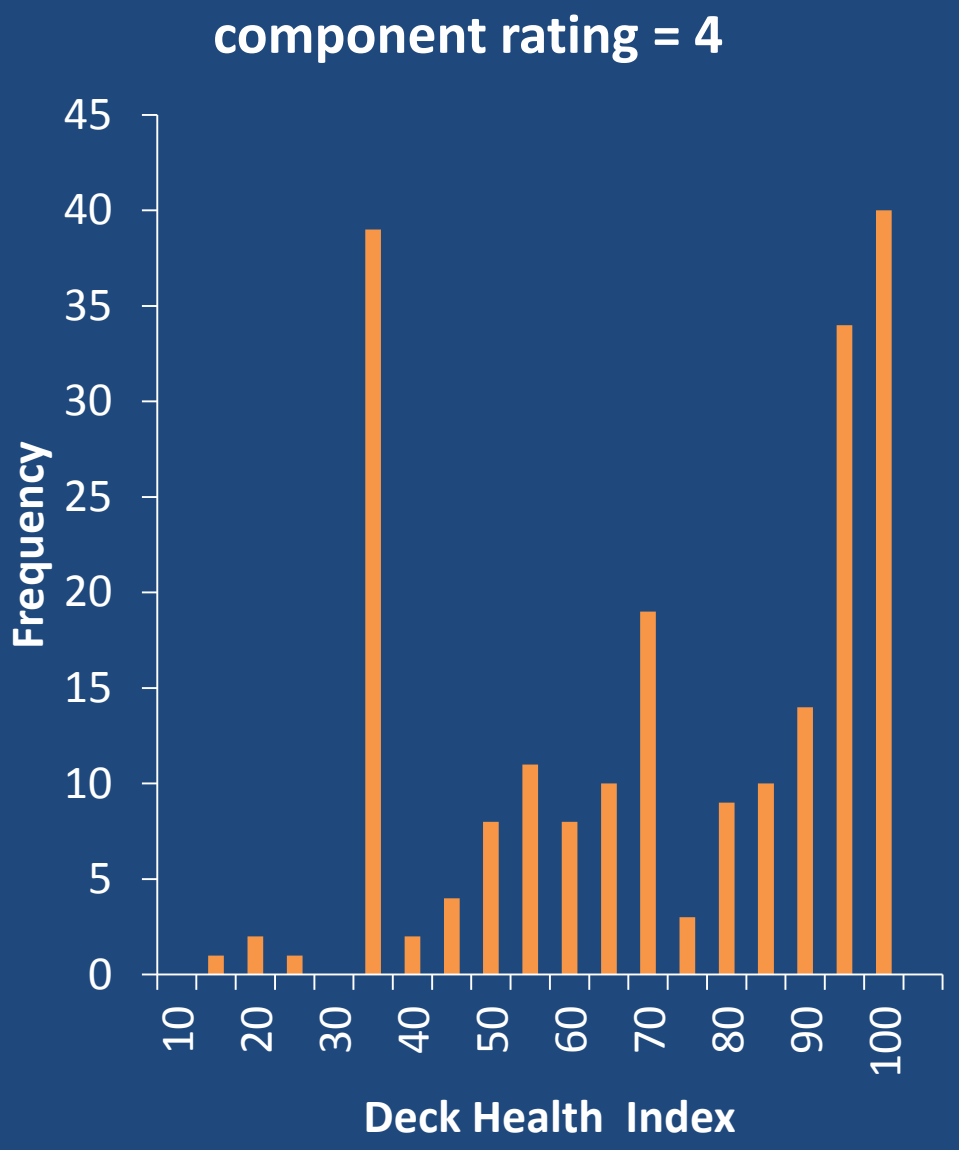
NBI	CS1%	CS2%	CS3%	CS4%
9	x	x	x	x
8	100	0	0	0
7		> 0 – 20	0	0
6			> 0 - 5	0
5			> 5 - 20	0
4				> 0 - 20
3				> 20 - 100
2	x	x	x	x
1	x	x	x	x

Decks & Slabs

Decks Rated 3

%CS1	%CS2	%CS3	%CS4	Converter Rating	Difference	Health Index
98.0	2.0	0.0	0.0	7	4	99.32
96.1	3.6	0.2	0.0	7	4	98.64
93.4	5.7	0.8	0.0	6	3	97.54
88.4	11.4	0.1	0.0	7	4	96.11
89.0	9.5	1.2	0.2	6	3	95.79
64.9	33.1	2.1	0.0	6	3	87.60
48.7	51.3	0.0	0.0	6	3	82.92
49.8	41.9	8.4	0.0	5	2	80.46
52.0	27.0	21.0	0.0	4	1	77.00
59.0	0.2	40.8	0.0	4	1	72.74
0.0	91.7	8.1	0.2	4	1	63.84
25.8	31.8	42.4	0.0	4	1	61.13
15.3	39.8	44.9	0.0	4	1	56.81
0.0	72.1	17.4	10.5	4	1	53.89
0.0	55.8	37.2	7.0	4	1	49.58
0.0	45.4	51.0	3.6	4	1	47.24
0.0	0.0	100.0	0.0	4	1	33.33
0.0	0.0	100.0	0.0	4	1	33.33
0.0	0.0	81.3	18.8	4	1	27.08
0.0	0.0	0.0	100.0	3	0	0.00
0.0	0.0	0.0	100.0	3	0	0.00
0.0	0.0	0.0	100.0	3	0	0.00

Decks & Slabs



HI Bins	Frequency
5	
10	0
15	1
20	2
25	1
30	0
35	39
40	2
45	4
50	8
55	11
60	8
65	10
70	19
75	3
80	9
85	10
90	14
95	34
100	40
Total	215

CS1	CS2	CS3	CS4	HI
471	84	6	0	94.30
12773	3514	159	27	92.08
42205	35393	927	0	84.19
2074	1498	721	0	77.17
2380	2310	2310	0	67.00
0	5724	0	0	66.67

Decks & Slabs

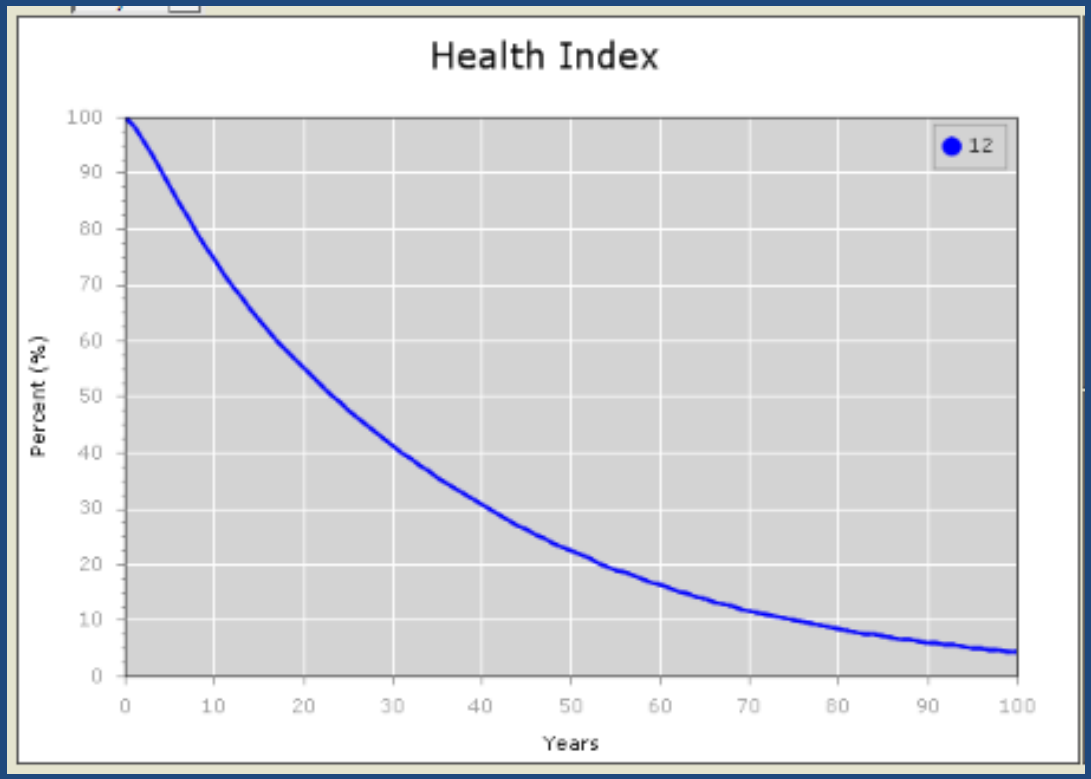
Decks Rated 4

%CS1	%CS2	%CS3	%CS4	Converter NBI Rating	Difference	Health Index
100.0	0.0	0.0	0.0	8	4	100.00
100.0	0.0	0.0	0.0	8	4	100.00
100.0	0.0	0.0	0.0	8	4	100.00
100.0	0.0	0.0	0.0	8	4	100.00
100.0	0.0	0.0	0.0	8	4	100.00
100.0	0.0	0.0	0.0	8	4	100.00
~~100.0~~	~~0.0~~	~~0.0~~	~~0.0~~	~~8~~	~~4~~	~~100.00~~
~~100.0~~	~~0.0~~	~~0.0~~	~~0.0~~	~~8~~	~~4~~	~~100.00~~
100.0	0.0	0.0	0.0	8	4	100.00
100.0	0.0	0.0	0.0	8	4	100.00
99.4	0.5	0.2	0.0	6	2	99.73
99.0	0.7	0.2	0.0	6	2	99.59
98.5	1.5	0.0	0.0	7	3	99.51
98.7	1.1	0.3	0.0	6	2	99.47
98.3	1.7	0.0	0.0	7	3	99.42
97.9	2.0	0.0	0.0	7	3	99.31
~~98.3~~	~~1.1~~	~~0.5~~	~~0.0~~	~~6~~	~~2~~	~~99.28~~
97.8	2.1	0.1	0.0	6	2	99.21
~~97.6~~	~~2.4~~	~~0.0~~	~~0.0~~	~~7~~	~~3~~	~~99.20~~
97.0	3.0	0.0	0.0	7	3	98.99
97.4	2.1	0.5	0.0	6	2	98.98
98.1	0.3	1.5	0.0	6	2	98.86
97.3	1.0	1.7	0.0	6	2	98.55
95.6	4.1	0.3	0.0	6	2	98.44

Element Data in BrM

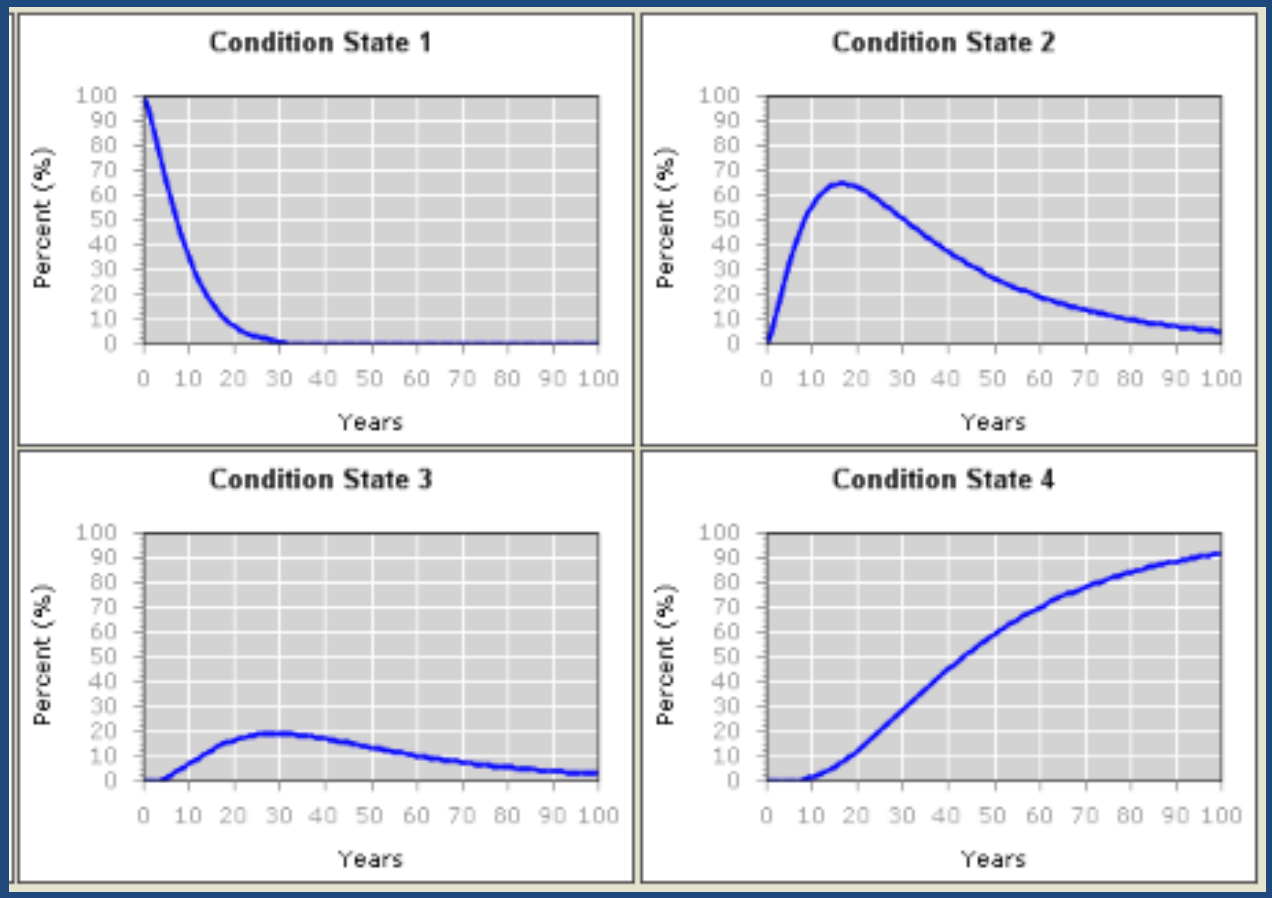
- Condition Rating
- Deterioration Forecasting
- Life-Cycle Cost Analysis Policy Rules
- Work Identification & Prioritization
- Performance Measures

Element Data in BrM - Deterioration



Reinforced Concrete Deck

Element Data in BrM - Deterioration

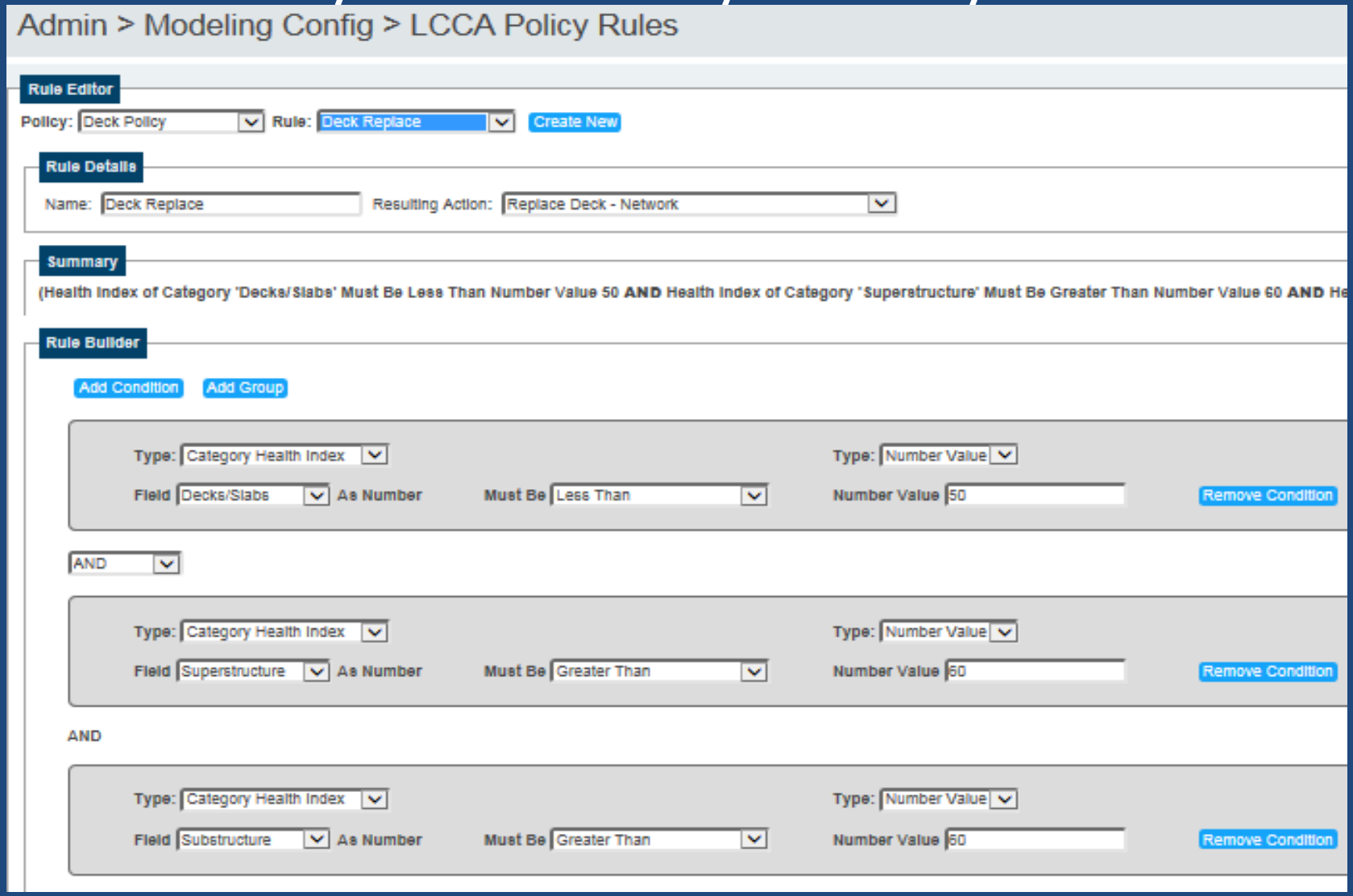


Reinforced Concrete Deck

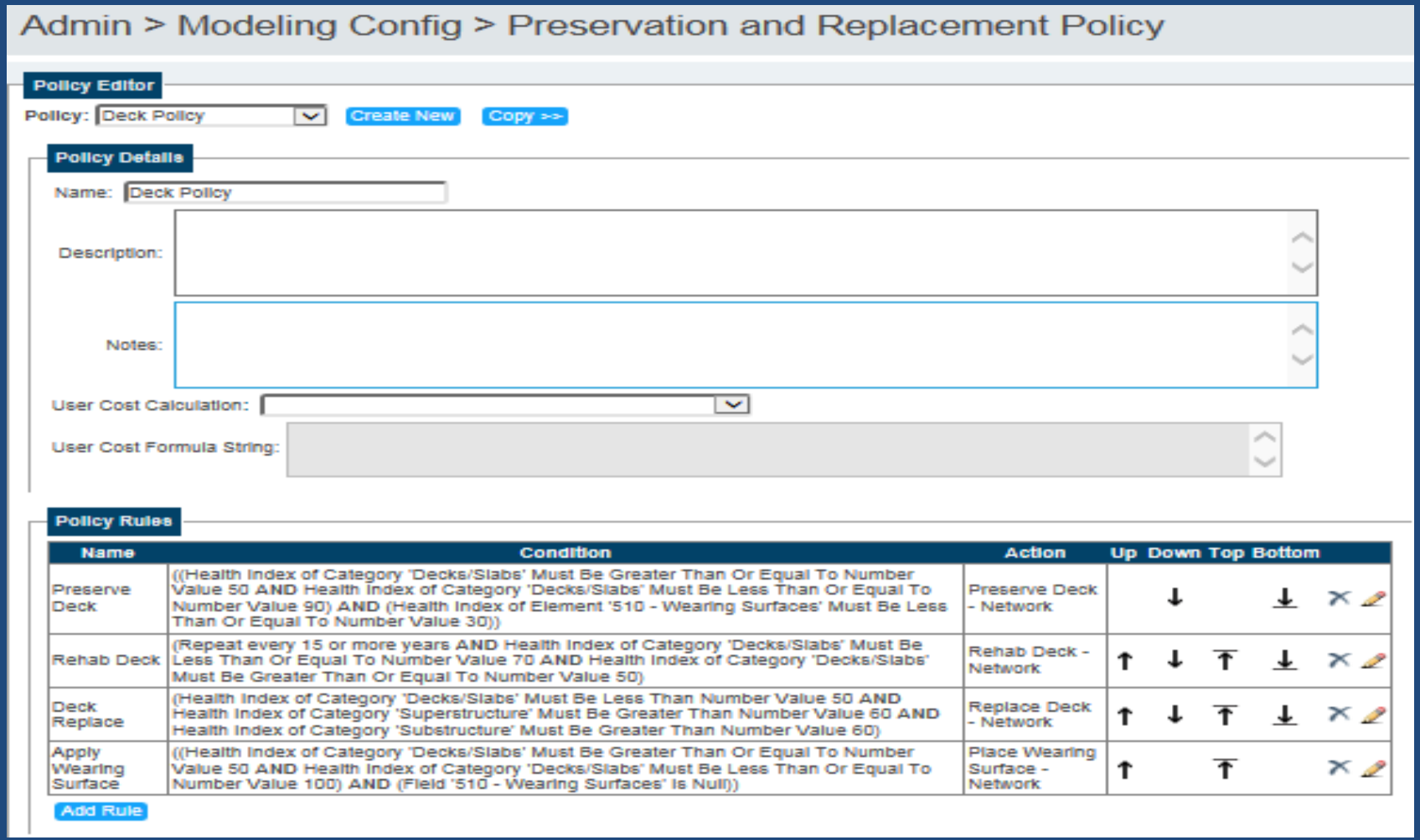
Element Data in BrM - Deterioration

Reinforced Concrete Deck

Element Data in BrM – Life-Cycle Cost Analysis Policy Rules



Element Data in BrM – Life-Cycle Cost Analysis Policy Rules



Admin > Modeling Config > Preservation and Replacement Policy

Policy Editor

Policy: Deck Policy | Create New | Copy >>

Policy Details

Name: Deck Policy

Description:

Notes:

User Cost Calculation:

User Cost Formula String:

Policy Rules

Name	Condition	Action	Up	Down	Top	Bottom
Preserve Deck	((Health Index of Category 'Decks/Slabs' Must Be Greater Than Or Equal To Number Value 50 **AND** Health Index of Category 'Decks/Slabs' Must Be Less Than Or Equal To Number Value 90) **AND** (Health Index of Element '510 - Wearing Surfaces' Must Be Less Than Or Equal To Number Value 30))	Preserve Deck - Network		↓		⤓	✂ ✎
Rehab Deck	(Repeat every 15 or more years **AND** Health Index of Category 'Decks/Slabs' Must Be Less Than Or Equal To Number Value 70 **AND** Health Index of Category 'Decks/Slabs' Must Be Greater Than Or Equal To Number Value 50)	Rehab Deck - Network	↑	↓	⤒	⤓	✂ ✎
Deck Replace	(Health Index of Category 'Decks/Slabs' Must Be Less Than Number Value 50 **AND** Health Index of Category 'Superstructure' Must Be Greater Than Number Value 60 **AND** Health Index of Category 'Substructure' Must Be Greater Than Number Value 60)	Replace Deck - Network	↑	↓	⤒	⤓	✂ ✎
Apply Wearing Surface	((Health Index of Category 'Decks/Slabs' Must Be Greater Than Or Equal To Number Value 50 **AND** Health Index of Category 'Decks/Slabs' Must Be Less Than Or Equal To Number Value 100) **AND** (Field '510 - Wearing Surfaces' Is Null))	Place Wearing Surface - Network	↑		⤒		✂ ✎

Add Rule

Element Data in BrM - Work Rules

Action Type	Bridge Health Index	General Condition State Rule	Defect Condition State Rule
Replace Deck	• low values	• large % quantity CS3 & CS4. • How know cannot be rehabbed (ex. what if CS3 is due to wear)?	• large % quantity full depth defects • large % quantity delam caused by full depth cracks (wide cracks) (defect 1080 or 1090 in combo w/ 1130) • same criteria as major rehab except major rehab previously performed
Major Rehab Deck (recon below top mat, large quantity patch & overlay)	• medium values	• large % quantity CS3 & CS4. • How know does not need replaced?	• large % quantity CS2 or CS3 delam and spall defect (defect 1080) (exclude CS2 patch quantity)
Minor Rehab Deck (mill & overlay, moderate quantity patch)	• medium to high values	• large % quantity CS2	• large % quantity CS2 or CS3 crack defect (defect 1130)
Preventive Maintenance Deck (crack sealing, local spall repair)	• large range of values	• CS2, CS3 or CS4 small quantities? How know not caused by abrasion, efflorescence with cracks already sealed, patched areas?	• any % quantity CS2 or CS3 crack defect (defect 1130) • small % quantity CS2 or CS3 spall defect (defect 1080) (exclude CS2 patch quantity)

Summary

- Element and component data quality is key to a data driven bridge management process.
- Need to ensure consistent and meaningful application of element deterioration models and work action rules.
- There are opportunities for optimization of work action rules.