

AASHTOWare Bridge Management



Deterioration
2016 MWBPP
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AASHTOWare Bridge Chair



Overview

- Background
- Weibull vs Markovian - Tuning Deterioration Rates
- Example
- Protective Systems
- NBI Deterioration Models



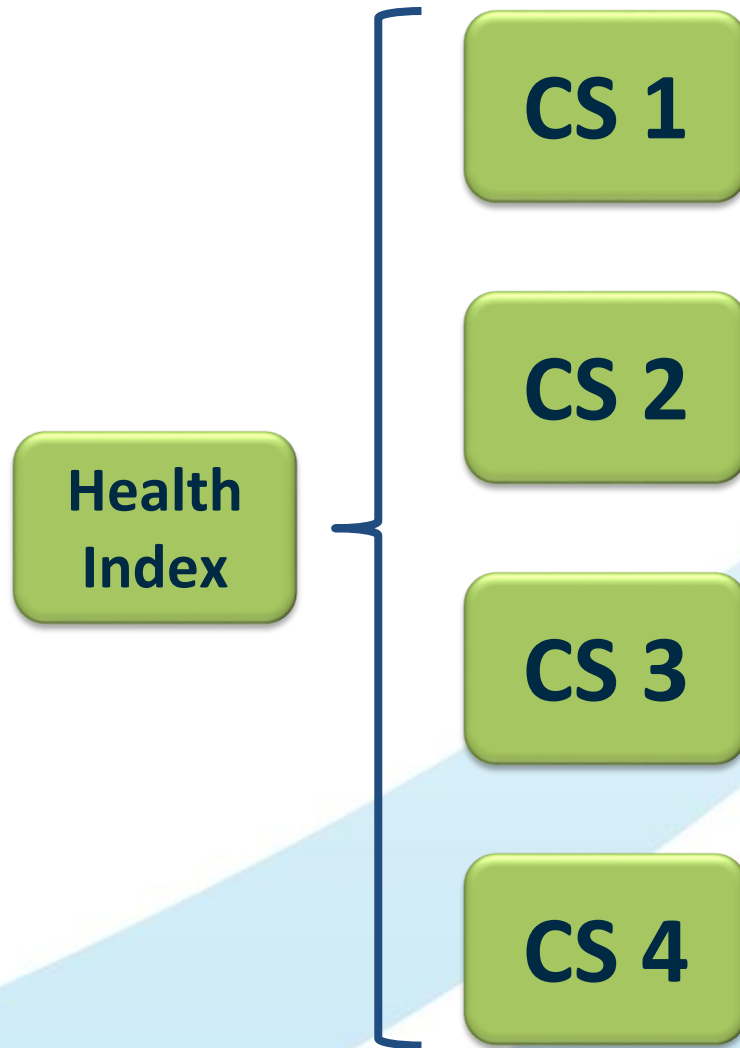
What did Pontis 4.x do?

- 4.x was Markovian based
 - Condition based model
 - Faster deterioration rates in the early stage
 - Effect of protective systems not considered
 - Expert Elicitation, History or Both
 - CoRe Elements

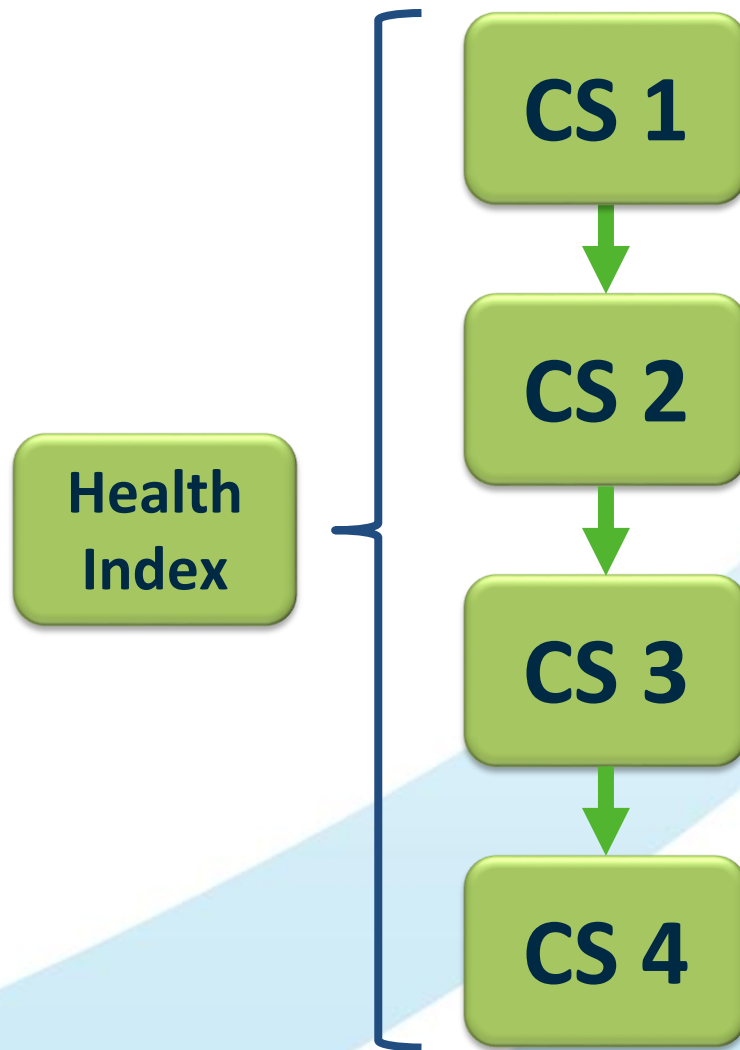
Tuning Deterioration Rates

- 5.2.2 introduces Weibull model as an enhancement to Markovian deterioration model
 - The goal is to manage known shortcomings of the Markovian model
- Dependent upon:
 - The effect that the parameter configurations have on the deterioration forecasted by the combined model
 - How an agency can tune the parameters to best meet their needs

Element Rating



Element Deterioration

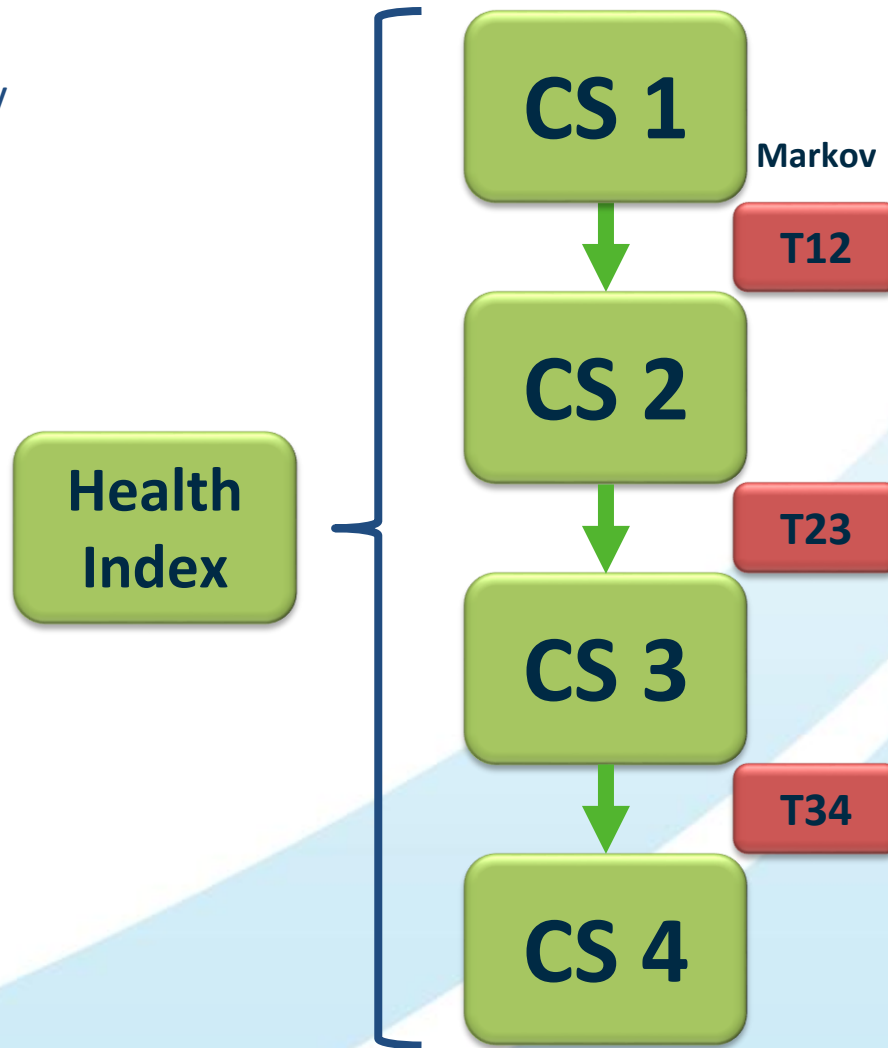


The Models

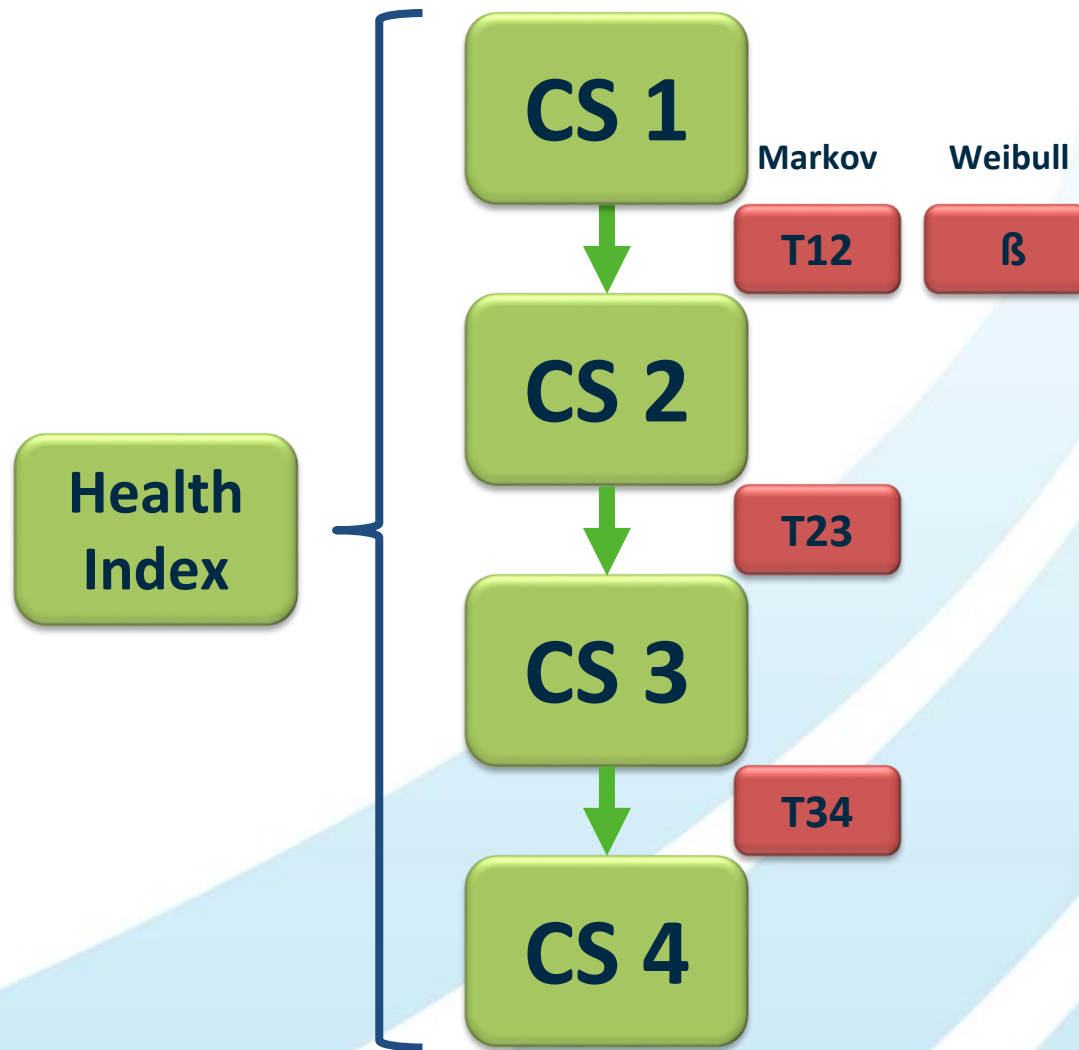
What has been
done

Regional
Variability

Element Deterioration



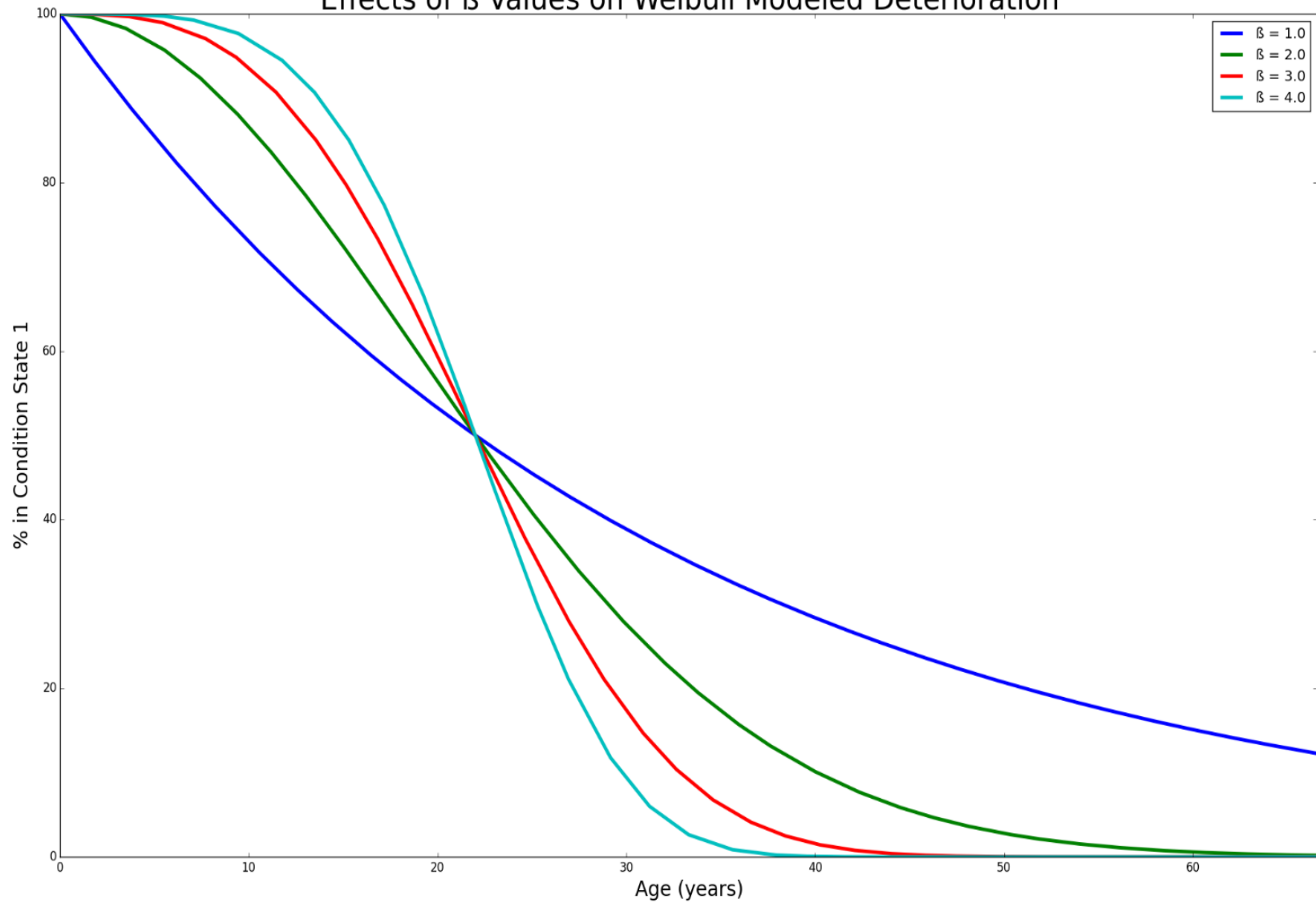
Element Deterioration



Comparison of Weibull and Markovian Models



Effects of β Values on Weibull Modeled Deterioration

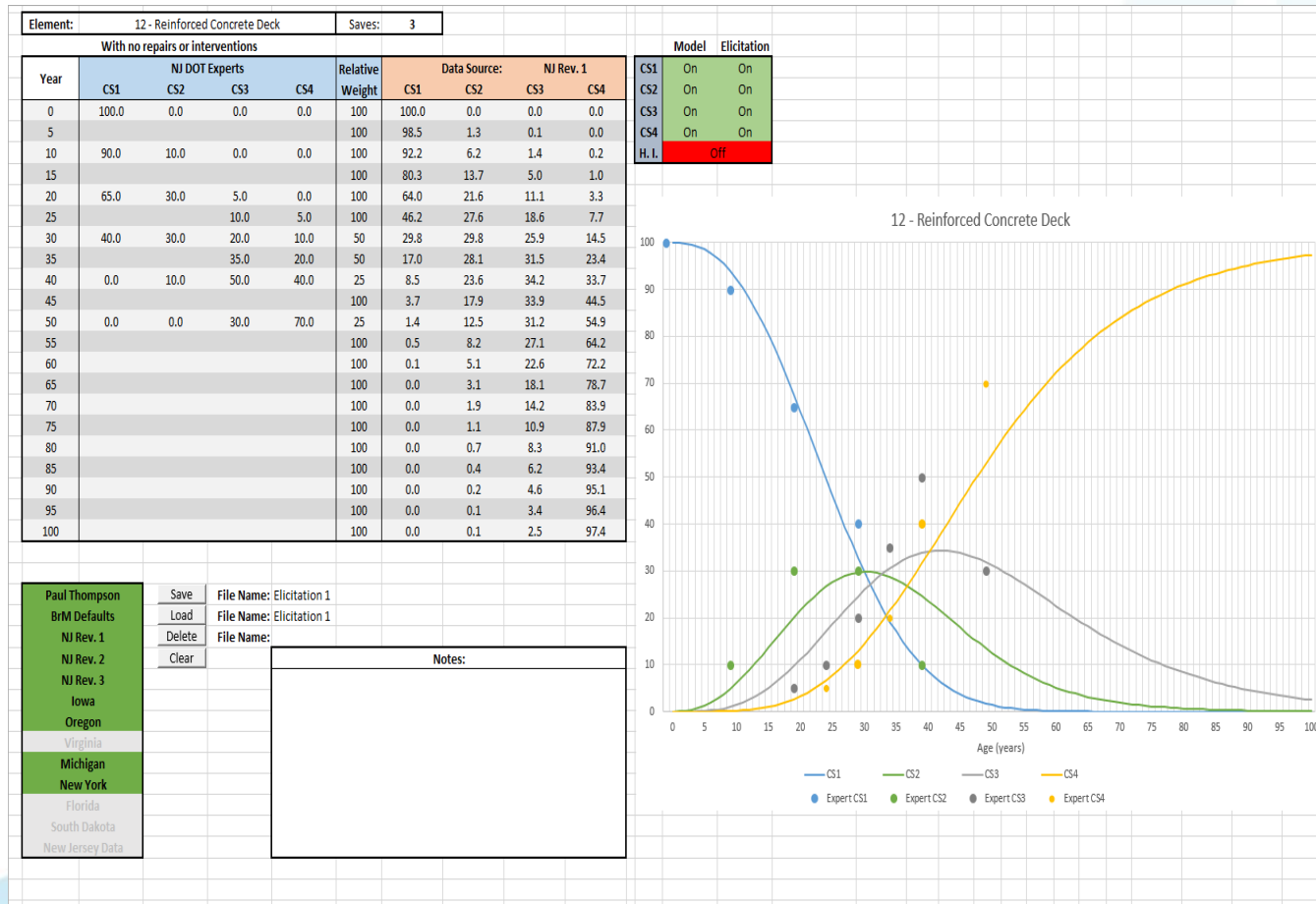


Initial Parameter Attempts

- “Given that 100% of the element is in Condition State 1 today, in how many years will only half of that element remain in the Condition State 1?”
- “Given that 100% of the element is in Condition State 2 today, in how many years will only half of that element remain in the Condition State 2?”
- “Given that 100% of the element is in Condition State 3 today, in how many years will only half of that element remain in the Condition State 3?”

Initial Parameter Attempts

- Bentley Systems / NJDOT Method – Expert Elicitation



Element 12 - Reinforced Concrete Deck									
	Paul T.	IA	OR	MI	NY	Average	Std. Dev.	(%)	NJDOT
Beta	1.3	-	-	-	-	1.3	-	-	2.3
T12	7.0	10.1	5.0	7.5	6.3	7.2	1.9	26	14.5
T23	5.0	10.1	5.0	14.5	25.0	13.7	7.4	54	6.4
T34	6.0	9.0	42.0	6.0	7.3	16.1	15.0	93	11.7



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Average Median Years to Transition chosen by each state	
Iowa	22.2
Oregon	16.3
Virginia	17.6
Michigan	24.7
New York	12.7
Florida	26.5
South Dakota	21.8
Defaults	16.4

The Models
What has been
done
**Regional
Variability**

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Average Standard Deviation (years)
8.6 (52% of average)

Elements

Element Filter

Not Filtered

	ID	Short Name
	12	Re Concrete Deck
	13	Pre Concrete Deck
	15	Pre Concrete Top Flange
	16	Re Conc Top Flange
	28	Steel Deck - Open Grid
	29	Steel Deck - Conc Fill Grid
	30	Steel Deck - Orthotropic
	31	Timber Deck
	38	Re Concrete Slab
	54	Timber Slab
	60	Other Deck
	65	Other Slab
	102	Steel Clsd Box Girder
	104	Pre Clsd Box Girder
	105	Re Clsd Box Girder
	106	Othr Clsd Web/Box Girder
	107	Steel Opn Girder/Beam
	109	Pre Opn Conc Girder/Beam
	110	Re Conc Opn Girder/Beam
	111	Timber Open Girder
	112	Other Open Girder/Beam
	113	Steel Stringer
	115	Pre Conc Stringer

Create Element

Copy Element

Save Revert

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Element Specifications

Element Rollup Key:

Element Key: 12

NBE: ☒

Short Name Re Concrete Deck

Long Name: Reinforced

Relative Weight: 6

All Relative Weights

Units: 20 sq.ft :: sq.m [0.09] ▼

Notes: This element defines all reinforced concrete bridge deck/slab regardless of the wearing surface or

Manual:  Browse... Defect: ☐

Protective

System/Wearing Surface:

Primary Defect:

~~Deterioration Modeling~~

Model: ☒

View Graphs

Model Parameters

Median years in CGA: Shaping parameter:

Median years	21	Formula:	
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in CS2:

Median

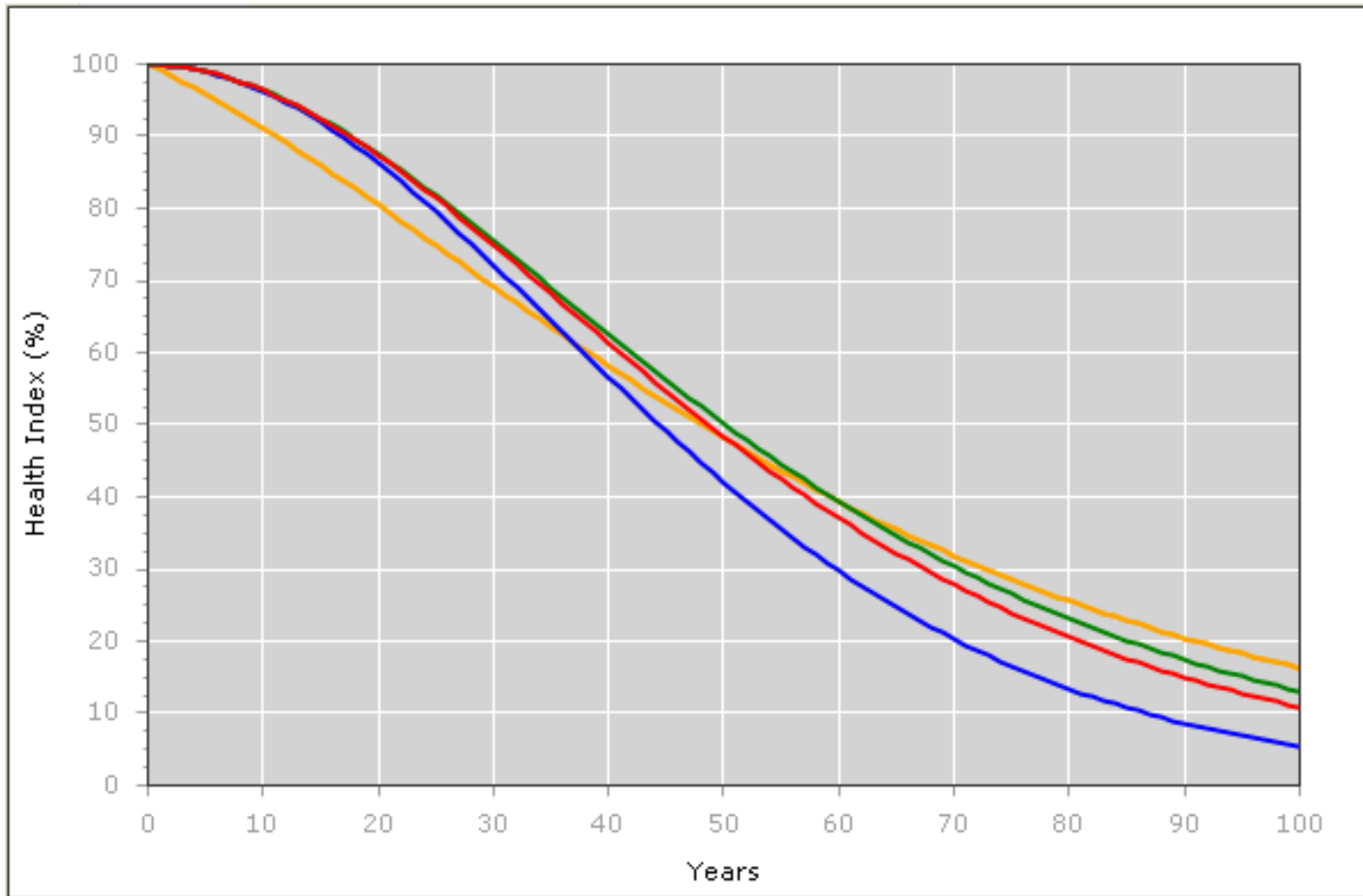
~~Classifications~~

Category: 6 Decks/Slabs

Material: 7 Decks

Type: 6 Decks/Slab

Example 1: #330 Metal Bridge Railing



- Markovian model only (T1: 29, T2: 13, T3: 9, β : 1)
- Weibull + Markovian model (T1: 29, T2: 13, T3: 9, β : 1.8)
- Increasing T2 by 50% (T1: 29, T2: 20, T3: 9, β : 1.8)
- Increasing both T2 and T3 by 50% (T1: 29, T2: 20, T3: 14, β : 1.8)

Protective Systems

- 5.2.2 includes the effects of protective systems
 - Designed to slow element deterioration
 - An element may contain several protective systems
 - Effectiveness is based on condition state of protective system

Protective Systems

- Effectiveness
 - CS1 is always 100% effective
 - CS2 and CS3 can be edited by user
 - CS4 is always 0% effective
- Maximum protection factor
 - Defines how much protection is offered

Protective Systems

Categories		
	12	Re Concrete Deck
	13	Pre Concrete Deck
	15	Pre Concrete Top Flange
	16	Re Conc Top Flange
	28	Steel Deck - Open Grid
	29	Steel Deck - Conc Fill Grid
	30	Steel Deck - Orthotropic
	31	Timber Deck
	38	Re Concrete Slab
	54	Timber Slab
	60	Other Deck
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	102	Steel Clsd Box Gird
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	109	Pre Opn Conc Girder/Beam
	110	Re Conc Opn Girder/Beam
	111	Timber Open Girder
	112	Other Open Girder/Beam
	113	Steel Stringer
	115	Pre Conc Stringer

Short Name: Wearing Surfaces **Long Name:** Wearing S

Relative Weight: 0 **All Relative Weights**

Units: 20 sq.ft :: sq.m [09:]

Notes: This element is for all decks/slabs that have overlays made with flexible (asphaltic concrete), semi rigid

Manual: **Browse...** **Upload**

Defect: ☐

Protective System/Wearing Surface: ☒

Primary Defect:

Deterioration Modeling

Model: ☒ **View Graphs**

Model Parameters

Median years in CS1: 4 **Shaping parameter:** 1

Median years in CS2: 3 **Formula:**

Median years in CS3: 2

Protection Factors

Max. protection parameter: 1.41

CS1: 1 **CS2:** 0.666666667

CS3: 0.333333333 **CS4:** 0

Classifications

Category: 5 Other Elements

NBI Conversion

Make use of element level deterioration

Maximum Allowed				
NBI	CS 1 %	CS 2 %	CS 3 %	CS 4 %
9	100	0	0	0
8	100	5	5	1
7	100	20	5	2
6	100	100	10	3
5	100	100	20	5
4	100	100	100	15
3	100	100	100	100
2	100	100	100	100
1	100	100	100	100

NBI Conversion

Group by Unit

Substructure	ELEMKEY	Element Name	Unit	Qty. 1	Qty. 2	Qty. 3	Qty. 4	Total Qty.	Pct. 1	Pct. 2	Pct. 3	Pct. 4
	210	Re Conc Pier Wall	ft	80	0	0	0	80	100.0%	0.0%	0.0%	0.0%
	215	Re Conc Abutment	ft	150	25	0	0	175	85.7%	14.3%	0.0%	0.0%
	205	Re Conc Column	each	8	4	0	0	12	66.7%	33.3%	0.0%	0.0%
				0	0	0	0					
				0	0	0	0					
				0	0	0	0					
				0	0	0	0					
				0	0	0	0					
				0	0	0	0					

Unit	Qty. 1	Qty. 2	Qty. 3	Qty. 4	Total Qty.	Pct. 1	Pct. 2	Pct. 3	Pct. 4	Health Index	NBI Conversion
sq.ft											
ft	230	25	0	0	255	90.2%	9.8%	0.0%	0.0%	96.7	
each	8	4	0	0	12	66.7%	33.3%	0.0%	0.0%	88.9	
Average						78.4%	21.6%	0.0%	0.0%	92.8	6

NBI Conversion

Weighted Average

Substructure	ELEMKEY	Element Name	Unit	Element Weight	Weight Override	Qty. 1	Qty. 2	Qty. 3	Qty. 4	Total Qty.	Pct. 1	Pct. 2	Pct. 3	Pct. 4	Health Index	NBI Conversion
	205	Re Conc Column	each	15		8	4	0	0	12	66.7%	33.3%	0.0%	0.0%	88.9	6
	210	Re Conc Pier Wall	ft	8		80	0	0	0	80	100.0%	0.0%	0.0%	0.0%	100.0	8
	215	Re Conc Abutment	ft	8		150	25	0	0	175	85.7%	14.3%	0.0%	0.0%	95.2	7
						0	0	0	0							
						0	0	0	0							
						0	0	0	0							
						0	0	0	0							
						0	0	0	0							
						0	0	0	0							
				Component Weighted Averages:		63.23	8.39	0.00	0.00	71.61	88.3%	11.7%	0.0%	0.0%	96.1	7

NBI Conversion Calibration

Network NBI Rating distributions

Bridge Filter: Entire Network ▼

Re-estimate results

Component: Bridge-Level ▼

Latest Inspection Reported Latest Inspection Converted Current +5 Years +10 Years

NBI Rating 9	296	2157	1091	67	0
NBI Rating 8	1066	1225	1651	963	845
NBI Rating 7	3262	1535	2044	2502	1191
NBI Rating 6	3893	3809	3872	4015	4192
NBI Rating 5	2283	678	728	1684	2071
NBI Rating 4	414	1419	1433	1262	1831
NBI Rating 3	114	131	135	461	824
NBI Rating 2	13	0	0	0	0
NBI Rating 1	1	0	0	0	0

Maximum Allowed

NBI	CS 1 %	CS 2 %	CS 3 %	CS 4 %
9	100	0	0	0
8	100	5	5	1
7	100	20	5	2
6	100	100	10	3
5	100	100	20	5
4	100	100	100	15
3	100	100	100	100
2	100	100	100	100
1	100	100	100	100

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Min NBI Value: 1

Max NE

Component Deterioration Modeling☒ Model**Model Parameters**

NBI Transition Time in Years 9 : 2

NBI Transition Time in Years 8 : 18.65

NBI Transition Time in Years 7 : 13.75

NBI Transition Time in Years 6 : 14.5

NBI Transition Time in Years 5 : 14

NBI Transition Time in Years 4 : 5

NBI Transition Time in Years 3 : 2.6

NBI Transition Time in Years 2 : 0

NBI Transition Time in Years 1 : 0

Work NBI Rating distributions

e Filter: State Owned

[Re-estimate results](#)

Component: Deck

	Latest Inspection Reported	Current +5 Years	+10 Years
Rating 9	2	2	0
Rating 8	3	3	5
Rating 7	526	395	226
Rating 6	492	586	660
Rating 5	200	236	319
Rating 4	29	27	19
Rating 3	4	5	13
Rating 2	0	2	7
Rating 1	0	0	2

NBI Deterioration

Assign a number of years for a bridge to spend in each NBI rating.

NBI	Years
9	1
8	3
7	6
6	8
5	8
4	10
3	
2	
1	

NBI Deterioration Calibration

Network NBI Rating distributions

Bridge Filter:

[Re-estimate results](#)

Component:

Latest Inspection Reported Current +5 Years +10 Years

NBI Rating 9	296	102	0	0
NBI Rating 8	1066	948	849	604
NBI Rating 7	3262	2244	1840	1563
NBI Rating 6	3893	3818	3637	3596
NBI Rating 5	2283	2658	2949	3162
NBI Rating 4	414	1237	1575	755
NBI Rating 3	114	281	250	1090
NBI Rating 2	13	52	170	371
NBI Rating 1	1	3	61	131

NBI	Years
9	1
8	3
7	6
6	8
5	8
4	10
3	
2	
1	

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Questions?

