Protocols for Concrete Bridge Deck Protections and Treatments

Başak Aldemir Bektaş, PhD
Associate Scientist
Iowa State University
Institute for Transportation (InTrans)

Outline

- About the Project
- Project Tasks
- Data
- Deck Life Cycle
- Analysis Approach
- Questions

About the Project

- Wisconsin Highway Research Program
- 2-year project: October 2017 – September 2019
- Objective is to develop a cost-effective lifecycle treatment plan for preservation of Wisconsin bridge decks

Project Tasks

- identify a comprehensive list of strategies through the review of current practice and DOT policies
- provide data-driven estimates of performance of treatments and optimum timing with respect to condition and age analyzing historic bridge condition data from WisDOT and other state DOTs
- develop a lifecycle treatment plan based on the research findings and engineering economics principles.

Project Tasks

Task A: Literature Review and Assessment of Current Practices

Task B: Collection of WisDOT and other DOT Policies and Practices on Deck Protection Treatments

Task C: Examination of WisDOT and other DOT Bridge Preservation Policies

- Tasks B&C are due mid-May

Initial Literature Review

- Sealers and overlays are typically advised to be used as cyclical preservation activities (3 to 5 years, and 10 to 15 years respectively).
- Guidelines for their selection and application vary by agency.
- Common criteria used in selection of the overlay type are ADT, expected life, and current condition (or level of deterioration).
- Weather conditions and level of chloride are essential factors for deciding the sealant type.

Focus

- Crack sealers, penetrant sealers, and thin polymer overlays, rigid overlays, asphalt overlays, and polyester polymer concrete overlays
- State bridges
- Bridge Preservation Policy Guide
- Analysis of both NBI component and AASHTO element condition data

Current Policy

Table 2 Bridge Preservation Activities

Bridge Component	Bridge Preservation Type	Activity Description	Preventive Maintenance Type	Action Frequency (years)
All	Preventive Maintenance	Sweeping, power washing, cleaning	Cyclical	1-2
Deck	Preventive Maintenance	Deck washing	Cyclical	1
		Deck Sweeping		1
		Deck Sealing/Crack Sealing		4-5
		Thin polymer (Epoxy) overlays		10
		Drainage cleaning/repair		As needed
		Joint cleaning		
		Deck Patching	Condition Based	1- 2
		Chloride extraction		1 -2
		Asphalt overlay with membrane		12-15
		Polymer modified Asphalt overlay		6-12
		Joint seal replacement		10
		Drainage cleaning/repair		1
	Repair or Rehab Element	Rigid concrete overlays	Condition Based	As needed
		Structural Reinforced concrete overlay		
		Deck joint replacement		
		Eliminate joints		

Data

- HSIS and region databases
  - Statewide and 8 regions
  - Treatment history
  - Condition Data
    - Element
    - NBI
  - Deicer usage data
    - Automatic Vehicle Locator (AVL) database
    - seven winter seasons from 2010 to 2016
    - total amount of deicer materials by segment and season

NC - Rhinelander
NC - Wisconsin Rapids
NE - Green Bay
NW - Eau Claire
NW - Superior
SE - Waukesha
SW - La Crosse
SW - Madison (1)
SW - Madison (2)

Data

Region	Counties Complete	Year Range	Sealant - Overlay
NE - Green Bay	Complete	2009 - 2016	S & O
NC - Wisconsin Rapids	Incomplete	2004 - 2018	S & O
NC – Rhinelander	Complete	2005 - 2020	S & O
NW - Superior	Complete	NA	NA
NW - Eau Claire	Complete	1999 - 2018	S
SW - La Crosse	Complete	2007 - 2013	S
SW - Madison (1)	Complete	2015 - 2017	S & O
SW - Madison (2)	Not submitted yet	NA	NA
SE – Waukesha	Not submitted yet	NA	NA

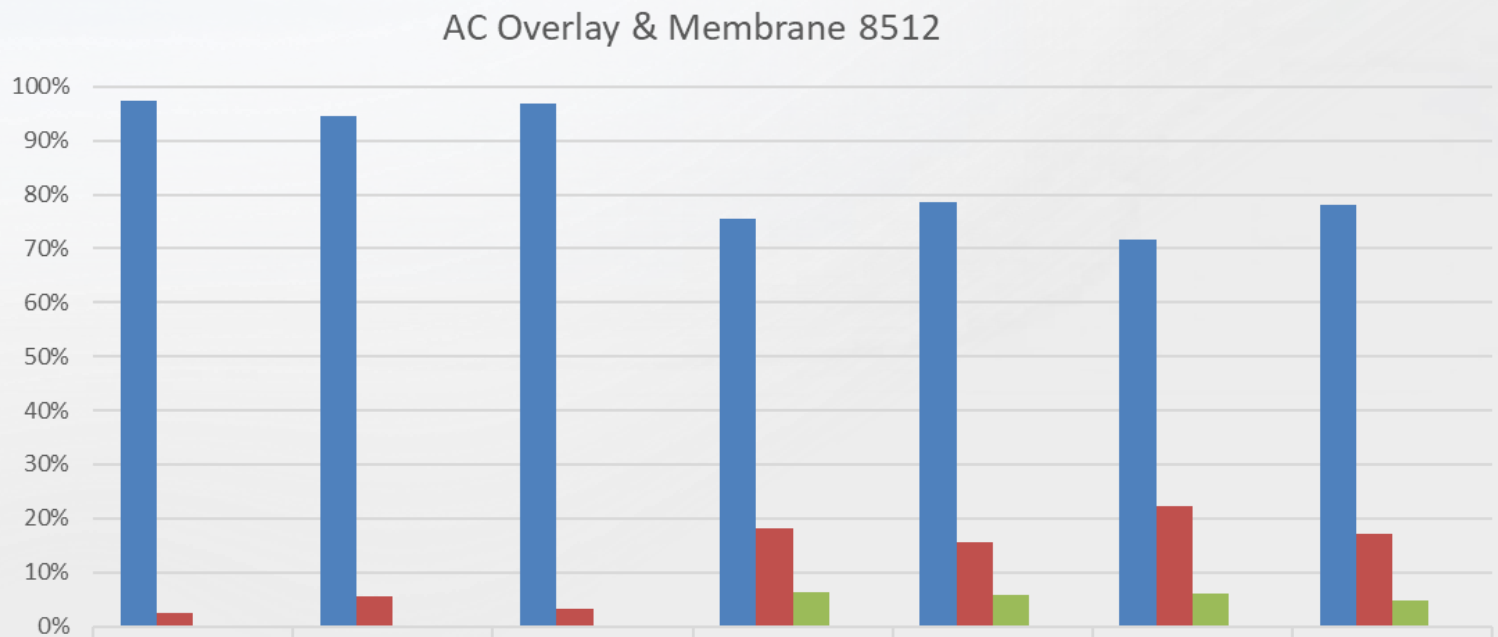
+ Project history from the DOT

Data

Decks/Slabs	
Element Number	**Element**
12	Reinforced Concrete Deck
13	Prestressed Concrete Deck
15	Prestressed Concrete Top Flange
16	Reinforced Concrete Top Flange
28	Steel Deck with Open Grid
29	Steel Deck with Concrete Filled Grid
30	Steel Deck with Corrugated/Orthotropic/Etc.
31	Timber Deck
38	Reinforced Concrete Slab
8039	Prestressed Concrete Slab
54	Timber Slab
60	Other Material Deck
65	Other Material Slab

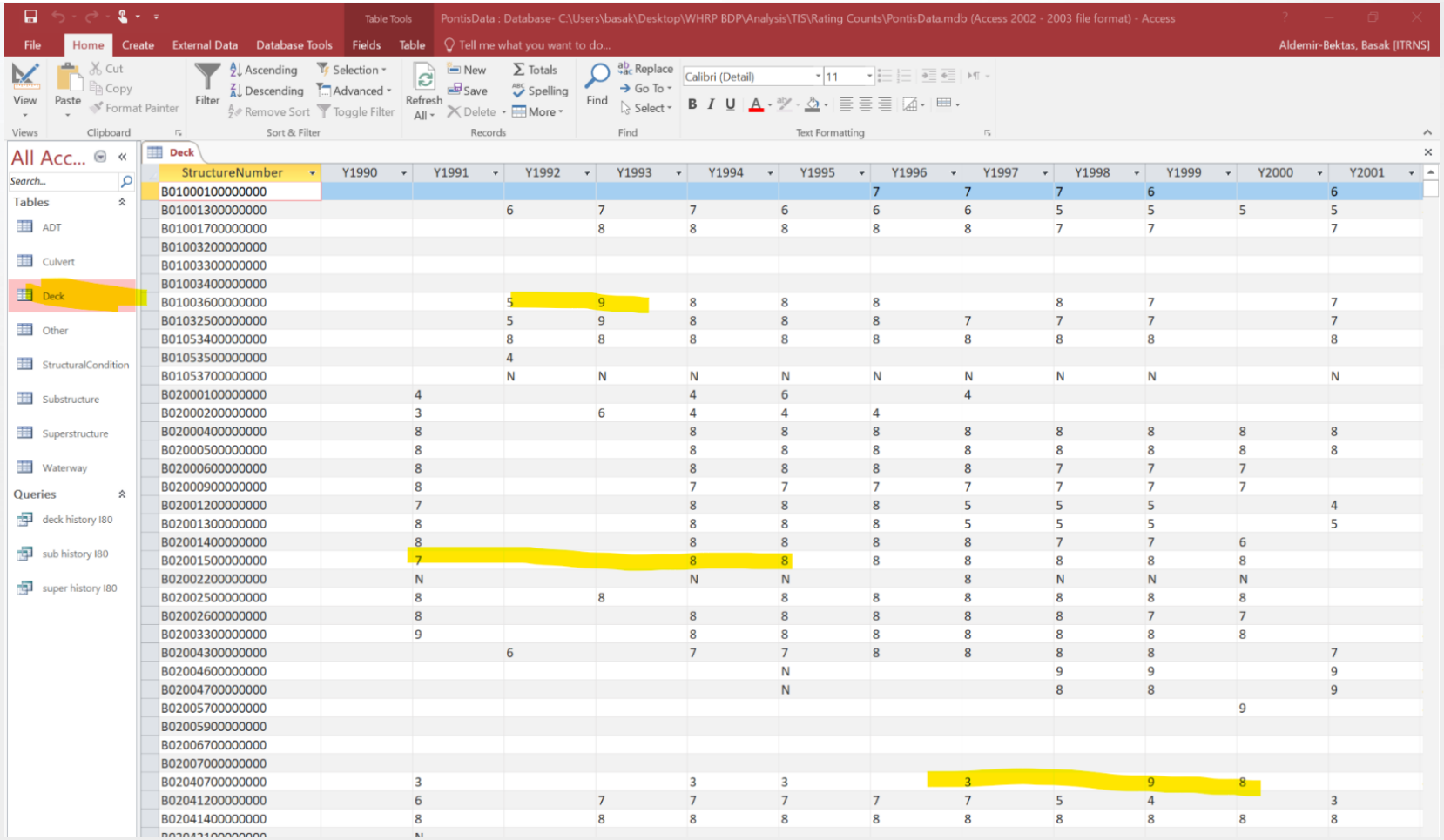
Wearing Surfaces			
510	Wearing Surfaces (Other)	SF	BME
8000	Wearing Surface (Bare)	SF	BME
8511	AC Overlay	SF	ADE
8512	AC Overlay & Membrane	SF	ADE
8513	Thin Polymer Overlay	SF	ADE
8514	Concrete Overlay	SF	ADE
8515	Polyester Concrete Overlay	SF	ADE

Data



	2011	2012	2013	2014	2015	2016	2017
QTY_STATE_1	97%	95%	97%	75%	79%	72%	78%
QTY_STATE_2	3%	5%	3%	18%	16%	22%	17%
QTY_STATE_3	0%	0%	0%	6%	6%	6%	5%
QTY_STATE_4	0%	0%	0%	0%	0%	0%	0%
No. Bridges	**49**	**81**	**45**	**112**	**67**	**107**	**51**

Data



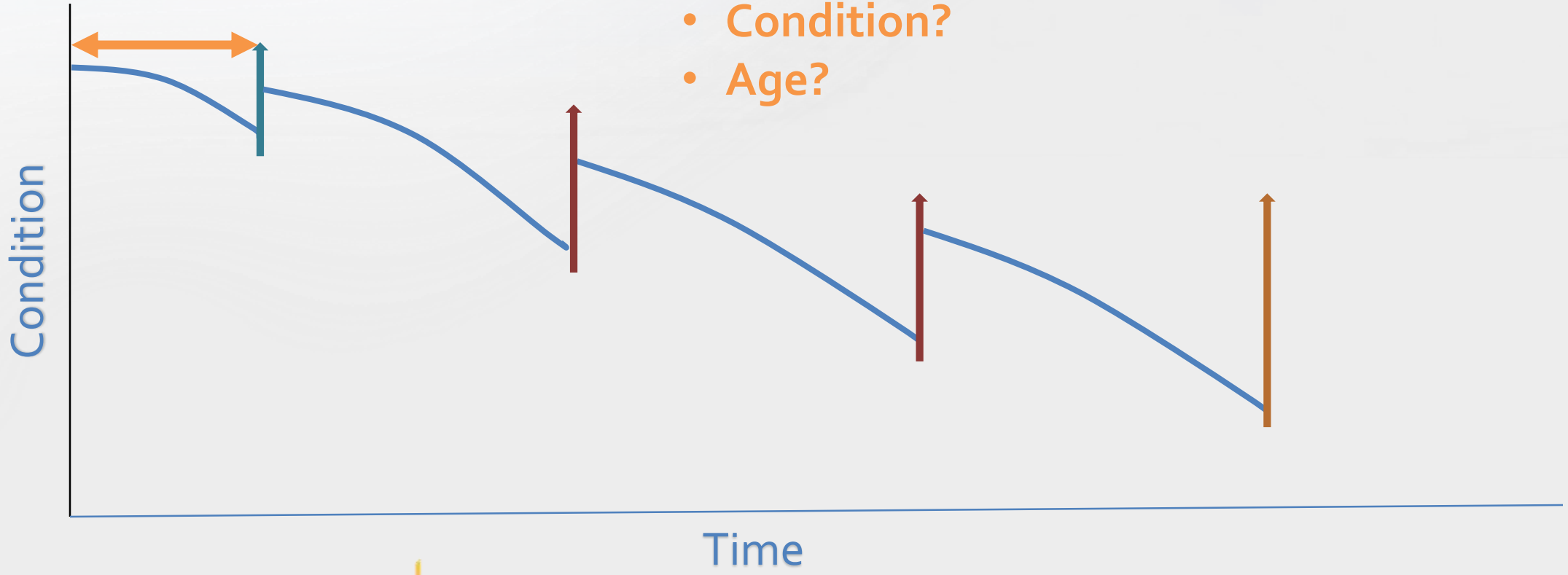
StructureNumber	Y1990	Y1991	Y1992	Y1993	Y1994	Y1995	Y1996	Y1997	Y1998	Y1999	Y2000	Y2001
B01000100000000							7	7	7	6		6
B01001300000000			6	7	7	6	6	6	5	5	5	5
B01001700000000				8	8	8	8	8	7	7		7
B01003200000000												
B01003300000000												
B01003400000000												
B01003600000000			5	9	8	8	8		8	7		7
B01032500000000			5	9	8	8	8	7	7	7		7
B01053400000000			8	8	8	8	8	8	8	8		8
B01053500000000			4									
B01053700000000			N	N	N	N	N	N	N	N		N
B02000100000000		4			4	6		4				
B02000200000000		3		6	4	4	4					
B02000400000000		8			8	8	8	8	8	8	8	8
B02000500000000		8			8	8	8	8	8	8	8	8
B02000600000000		8			8	8	8	8	7	7	7	
B02000900000000		8			7	7	7	7	7	7	7	
B02001200000000		7			8	8	8	5	5	5		4
B02001300000000		8			8	8	8	5	5	5		5
B02001400000000		8			8	8	8	8	7	7	6	
B02001500000000		7			8	8	8	8	8	8	8	
B02002200000000		N			N	N		8	N	N	N	
B02002500000000		8		8		8	8	8	8	8	8	
B02002600000000		8			8	8	8	8	8	7	7	
B02003300000000		9			8	8	8	8	8	8	8	
B02004300000000			6		7	7	8	8	8	8		7
B02004600000000						N			9	9		9
B02004700000000						N			8	8		9
B02005700000000											9	
B02005900000000												
B02006700000000												
B02007000000000												
B02040700000000		3			3	3		3		9	8	
B02041200000000		6		7	7	7	7	7	5	4		3
B02041400000000		8		8	8	8	8	8	8	8	8	8

Data

	A	B	C	D	E	F	G
1	StructureNumber	First Year	Last Year	Value	Count	NextValue	Gap Warning
2	B01000100000000	1996	1998	7	3	6	Gap(s): 0; Warning: False
3	B01000100000000	1999	2002	6	4	5	Gap(s): 1; Warning: False
4	B01000100000000	2003	2008	5	6	4	Gap(s): 1; Warning: False
5	B01000100000000	2009	2011	4	9	X	Gap(s): 6; Warning: True
6	B03001400000000	1992	1997	8	6	7	Gap(s): 1; Warning: False
7	B03001400000000	1998	1998	7	1	6	Gap(s): 0; Warning: False
8	B03001400000000	1999	2002	6	4	5	Gap(s): 1; Warning: False
9	B03001400000000	2003	2010	5	8	4	Gap(s): 1; Warning: False
10	B03001400000000	2011	2015	4	7	X	Gap(s): 2; Warning: False
11	B03001500000000	1992	1997	8	6	5	Gap(s): 1; Warning: False
12	B03001500000000	1998	2004	5	7	4	Gap(s): 1; Warning: False
13	B03001500000000	2005	2015	4	13	X	Gap(s): 2; Warning: False
14	B03001600000000	1992	1997	8	6	7	Gap(s): 1; Warning: False
15	B03001600000000	1998	2002	7	5	6	Gap(s): 1; Warning: False
16	B03001600000000	2003	2006	6	4	5	Gap(s): 1; Warning: False
17	B03001600000000	2007	2015	5	11	X	Gap(s): 2; Warning: False
18	B03001700000000	1992	1994	9	3	8	Gap(s): 0; Warning: False
19	B03001700000000	1995	1997	8	3	7	Gap(s): 1; Warning: False
20	B03001700000000	1998	2015	7	20	X	Gap(s): 2; Warning: False
21	B03001800000000	1992	1997	8	6	7	Gap(s): 1; Warning: False
22	B03001800000000	1998	2000	7	3	6	Gap(s): 1; Warning: False

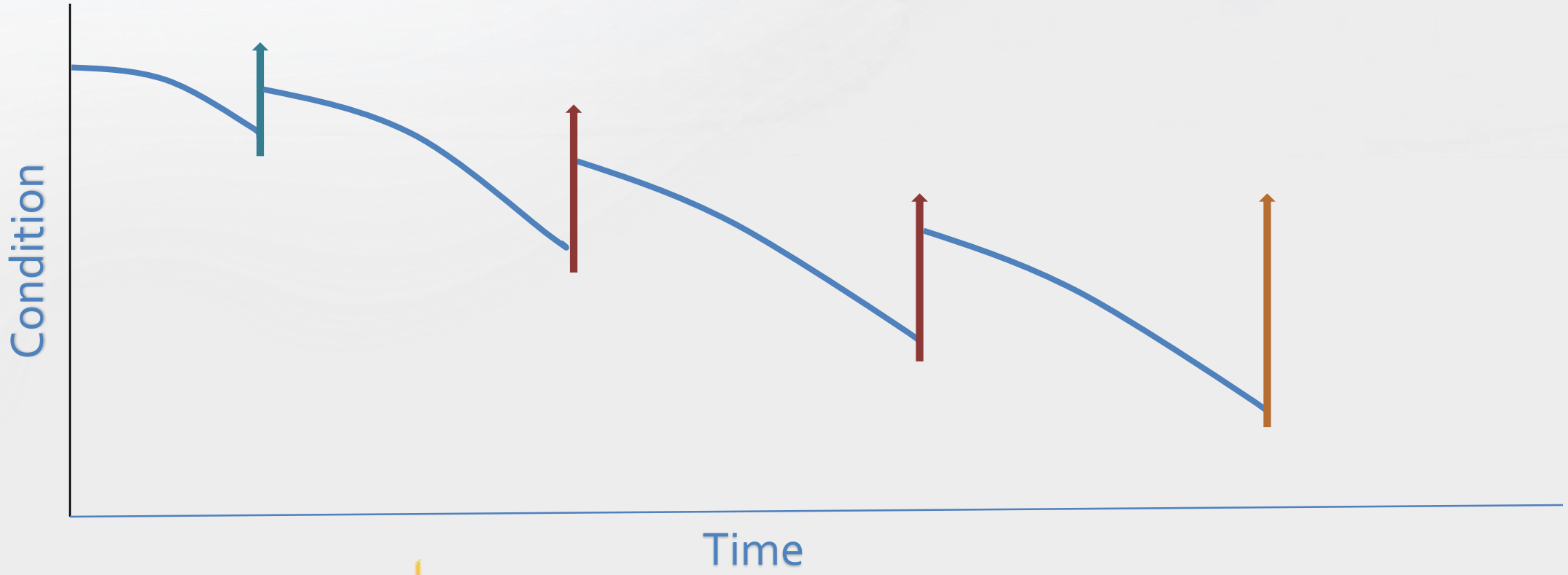
Deck Life Cycle

- Timing
  - Condition?
  - Age?



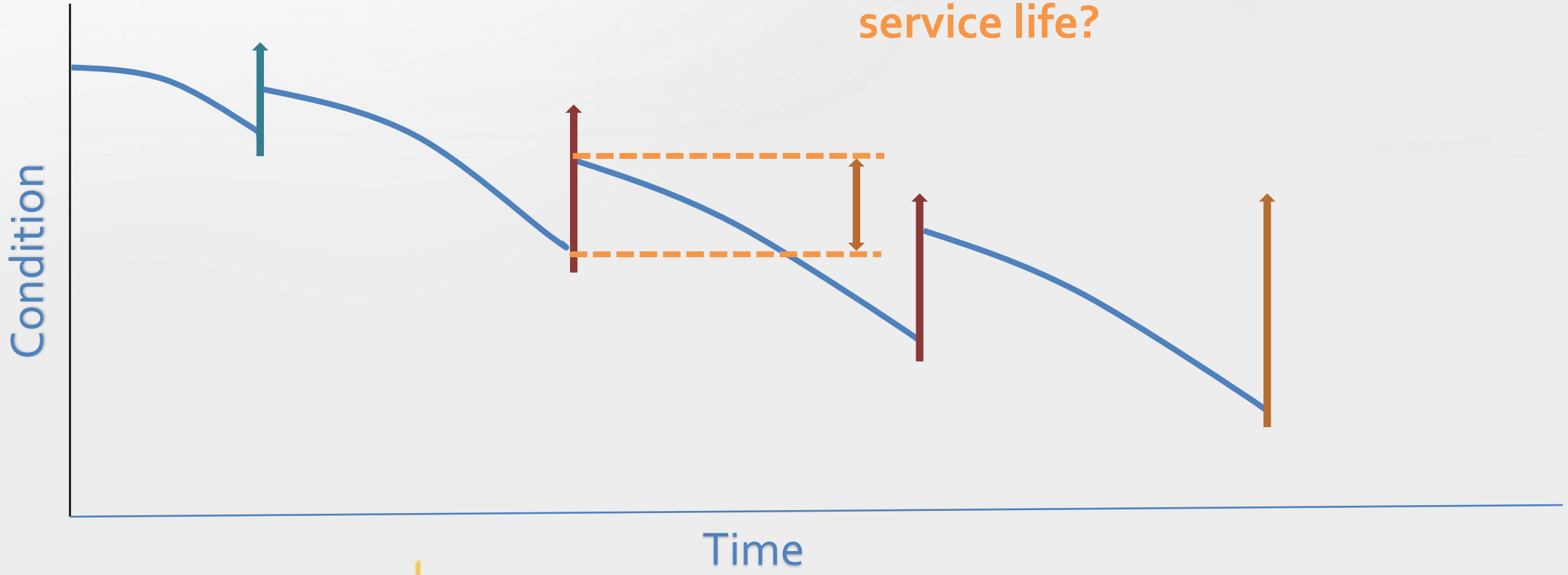
Deck Life Cycle

- Treatment?



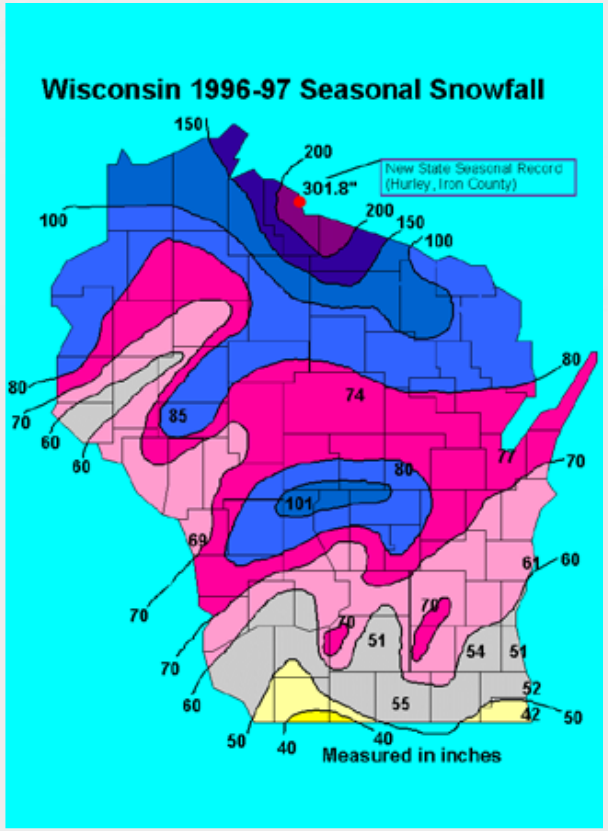
Deck Life Cycle

- Expected service life?



Analysis Approach

- Inclusion of external factors
- Selected bridge deck preservation strategies including common combinations of deck treatments
- Ideal timing of each bridge deck treatment or treatment combination, with respect to bridge condition or age
- Service life estimates of treatments



Analysis Approach

NBI Condition

Deck/Slab Condition

Wearing Surface Condition

Traffic

Deicer Usage

Treatment History

Engineering Economics

Life Cycle Plan

Analysis Approach

- A discussion on complexity

Questions?

Başak Aldemir Bektaş, PhD
Associate Scientist
Iowa State University
Institute for Transportation (InTrans)
basak@iastate.edu