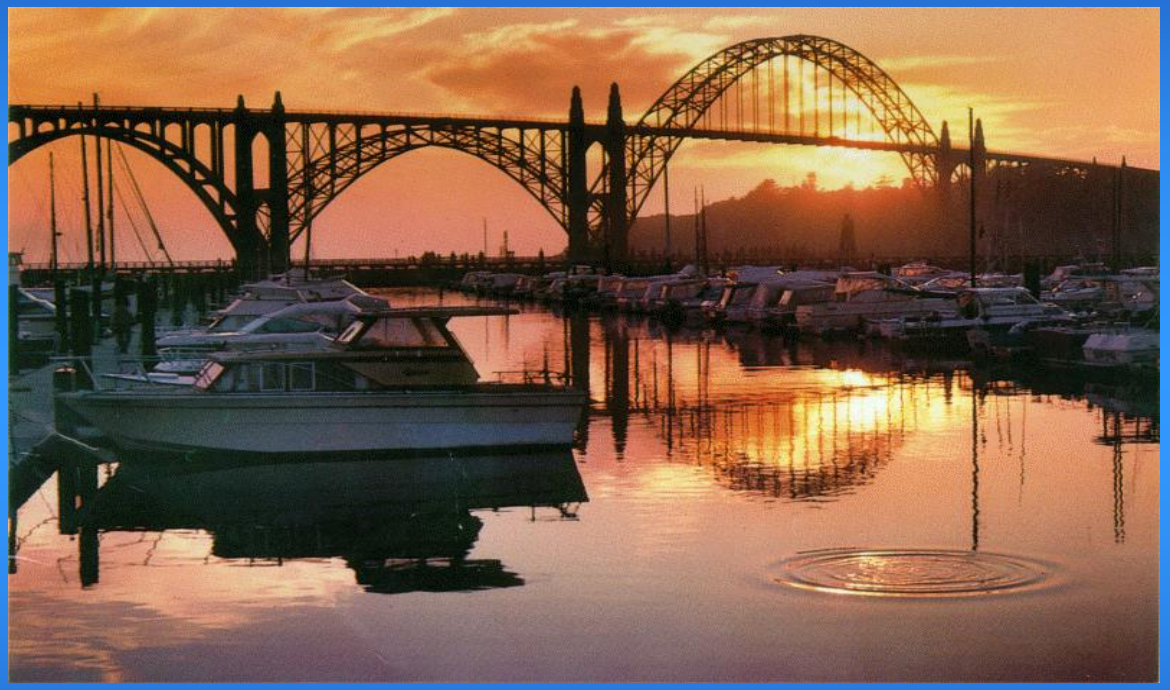
New AASHTO Bridge Inspection Process



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Oregon Department of Transportation

How we got to where we are today

The current AASHTO CoRe Element CS Descriptions use numerous general and subjective terms.

- Maximize data uniformity and consistency - - need more specific details.
- Keep the AASHTO CoRe CS descriptions pure - - crafted supplemental CS rating criteria.
- Result: In addition to the Element CS and NBI ratings, the ODOT Bridge Inspection Report contains a wealth of inspection notes and supplemental reports.

ODOT Problem Statement 1

From a programmatic standpoint, the narrative notes and supplemental reports made it impossible to query the database electronically.

- To mine the data, personnel had to physically read through every note, in order to separate the garbage from the gold.

Goal for Problem Statement 1

A model that will allow the data to be mined electronically.

4 CS model that will provide programmatic standardization:

- **CS 1 – Pristine Condition**
- **CS 2 – Bridge Preservation Activities**
- **CS 3 – Bridge Repair Activities**
- **CS 4 – Critical Findings, Load Restrictions, Shore, Replace**

ODOT Problem Statement 2

Existing CS language uses a shotgun approach,

- **list all possible deficiencies in a single CS**
- **requires bridge inspector to select the best fit.**
- **Difficult to determine the condition assessment drivers.**

Example - "Timber Element CS 3:

Decay, insect, marine borer infestation, abrasion, splitting, cracking, or crushing has produced loss of strength or deflection of the element but not of a sufficient magnitude to affect the serviceability of the bridge."

Goal for Problem Statement 2

Provide a bridge condition assessment model that uses numeric terms to clearly define:

- **What specific deficiencies are driving the condition of an element, and**
- **Report the severity of the deficiencies.**

ODOT Problem Statement 3

Difficulty showing the benefits of a Bridge Preservation Action.

Especially if all of the deficiencies are not completely addressed, resulting in a very negligible change in the sufficiency rating.

Current Process

(1) – Given the list of defects, what actions would improve the condition of the associated element?

(2) – Would improving the condition of the element change one of the NBI Bridge Component Ratings?

(3) – Would the change in the NBI Rating be reflected in the Sufficiency Rating?

Goal of the Business Decisions

- Have a model where differences from inspection to inspection can be easily compared for consistency or determining rates of deteriorations.

- Consider the criticality of observed findings.

- Relate observed conditions to planned work actions and provide delineation between Bridge Preservation and Structural Repair Actions.

ODOT Business Decision Opportunity

Strive to achieve the following attributes:

- Simplicity

- A bridge inspection report that is clear, easy to understand and interpret.

- Continue to explore ways to document the benefits gained from a bridge preservation action.

Implementation Issues

Sources of Information

Information sources to determine what we could do and what we couldn't:

- AASHTO Guide Manual for Bridge Element Inspection

- Pontis Version 5.1.2 (trial and error)

- Others

Perceived Issue 1

Listing all of the defects will make the size of our bridge inspection report to literally explode, making it unmanageable.

Solution: Created a bridge inspection report format we thought would work for us.

Run a test on a sample structure to see if the statement was valid.

ODOT Bridge Inspection Report

List of Elements	Defects	Protective System	Quantity	Units	CS 1	CS 2	CS 3	CS 4	Temp Rep.
(12) - Concrete Deck	Element Assessment		10692	SF	40	55	5		
	(358) - Conc Crack		1	SF	40	55	5		
	(359) - Efflorescence		1	SF	0	100			
	(410) - Spalls / Delams		1	SF	0	100			
	(414) Fire Damage		1	SF	90	10			
		(510) - Wearing Surface	2412	SF	50	25	25		
		(520) - Coated Rebar	705	SF	100				
(104) - P/S Conc Box Gi	Element Assessment		256	LF	100	0			
(110) - Reinf Conc Girde	Element Assessment		172	LF	0	100			
	(358) - Conc Crack		1	LF	0	100			
(111) Timber Girder	Element Assessment		1368	LF	75	25			
	(421) - Timber Checks		1	LF	75	25			
	(414) - Fire Damage		1	LF	80	20			
(113) Steel Stringer	Element Assessment		1050	LF	40	60			
	(400) - Corrosion		1	LF	0	100			
		(515) - Paint Protect Sys	2500	SF	45	30	20	5	
(135) Steel Truss	Element Assessment		300	LF	50	40	10		
	(400) - Corrosion		1	LF	50	40	10		
	(357) - Pack Rust		1	LF	70	20	10		
	(401) - Connections		1	LF	50	40	10		
	(362) - Super Incident		1	LF	90	0	10		
		(515) - Paint Protect Sys	2500	SF	40	20	30	10	
(152) Steel Floorbeam	Element Assessment		192	LF	15	45	40		
	(400) - Corrosion		1	LF	0	100			
		(515) - Paint Protect Sys	2000	SF	70	10	10	10	

Results

Existing Report:

CS Ratings – 1 page

35 elements and SF's

Narrative notes – 2 pages

New Format

CS Ratings – 1.25 pages

25 elements, defects, and preventive systems,

- did not test notes

Data Ownership

National Bridge Elements (NBE's)

- NBE's are designed to remain consistent nationwide and can not be modified or tweaked.
- But what exactly does that mean? ODOT's take:
  - The Elements, and
  - The Element Numbers
- Agencies are allowed to handle Defects as needed.

ODOT Bridge Inspection Report

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Philosophical Shifts – Get all on same page

- Shift from Element Ratings to Defect Ratings

- Shift Smart Flag Ratings (per bridge) to Defect Ratings (per elements)

- How Defects are used vs How Smart Flags were used.

Philosophical Shifts

Defects are associated with a specific element and perform 4 primary functions:

* Identify the deficiencies that are present and effecting the condition of the element.

* Influence the stratified Element CS Rating.

* More precisely define the maintenance actions.

* More precisely estimate $$$ needed to address the maintenance action.

ODOT Business Decisions

List of Defect Options

- Partial list (provided by the AASHTO Manual)

- All possible defects (Guide Manual, Sec 1.1)

ODOT Business Decisions

Guide Manual - Associate most predominant defect for that condition state.

- No definitive guidance as to what the term “predominant” meant: visible quantity or most critical quantity.

- Would require business rules to define which defect was more predominant or more critical than others.

ODOT Business Decisions

Recording Defects

ODOT settled on recording all defects that are present and effecting on the condition of the associated element.

If you think about it, we think that business decision made a lot of sense:

ODOT Business Decisions

Given 1 square foot of bridge deck, we could easily have multiples of defects occurring, like:

- Concrete Cracks
- Concrete Spalls
- Efflorescence
- Exposed Rusty Rebar
- Wheel Track Ruts

*** Simplicity - record what the inspector is seeing.

Element Table

Concrete Elements

12	Deck
15	Top Flange
38	Slab
105	Closed Web Box
110	Open Girder / Beam
116	Stringer
144	Arch
155	Floorbeam
205	Column / Pile
210	Pier Wall
215	Abutment
220	Pile Cap / Footing
227	Submerged Pile
234	Cap
241	Culvert
321	Approach Slab
331	Bridge Railing
(380)	Tunnel Liner
(381)	Tunnel Portal

Timber Elements

31	Deck
54	Slab
111	Open Girder / Beam
117	Stringer
135	Truss
146	Arch
156	Floorbeam
206	Column / Pile
208	Column Tower (trestle)
212	Pier Wall
216	Abutment
228	Submerged Pile
235	Cap
242	Culvert
252	Tunnel Liner
332	Bridge Railing

Prestressed Concrete Elem.

15	Top Flange
104	Closed Web Box
109	Open Girder / Beam
115	Stringer
143	Arch
154	Floorbeam
204	Column / Pile
226	Submerged Pile
233	Cap
320	Approach Slab

Steel Elements

28	Open Grid
29	Concrete Filled Grid
30	Corrugated/Orthotropic
102	Closed Web Box Girder
107	Open Girder / Beam
113	Stringer
120	Truss
141	Arch
147	Cable (primary)
148	Cable (secondary)
152	Floorbeam
161	Pin and Pin Hanger Ass.
162	Gusset Plate
202	Column / Pile
219	Abutment
225	Submerged Pile
231	Cap
240	Culvert
330	Bridge Railing
(382)	Tunnel liner
(390)	Bridge Paint System
(391)	Un-painted Br System

Protection System Elements

(510)	Gravel WS
(512)	AC WS
(513)	Semi-Rigid WS
(514)	Rigid WS
515	Steel Paint System
(516)	Oxide Weathering Steel
520	Dk/Slab Protect Sys
521	Conc Protect Coating

Masonry Elements

145	Arch
213	Pier Wall
217	Abutment
244	Culvert
334	Bridge Railing
(383)	Tunnel Liner
(384)	Tunnel Portal

Other Elements

211	Pier Wall
218	Abutment
243	Culvert

Expansion Joint Elements

300	Strip Seal
301	Pourable Seal
302	Compression
303	Mod Jt Assem (seal)
304	Open
305	Mod Jt Assem (no seal)
(306)	AC Plug Joint Seal
(309)	Other Expansion Joint

Bearing Elements

310	Elastomeric
311	Movable
312	Enclosed / Concealed
313	Fixed
314	Pot
315	Disk

Other Structures / Br Features

(900)	Misc Struct Abandon
(910)	Misc Struct RR
(920)	Misc Struct Sign Supp
(930)	Misc Struct Ped/Bike
(940)	Misc Struct Private
(950)	Misc Struct Flume
(960)	Misc Dwbr Elec/Mech
(980)	Appr Rdway Embankment
(990)	Misc Bridge Features
(999)	Roadway Impact

Defect Flags

356	Steel Fatigue Cracks
357	Pack Rust
358	Concrete Cracking
359	Efflorescence
360	Settlement
361	Scour / Erosion
362	Superstructure Traff Impact
363	Steel Section Loss
364	Steel Out-of-Plane Bending
366	Deck Traffic Impact
367	Substructure Traffic Impact
368	Culvert Barrel Distortion
(369)	Bridge Rail Traffic Impact
(400)	Steel Corrosion
(401)	Connections
(410)	Spalls / Delams / Patches
(411)	Concrete Rebar Corrosion
(412)	Abrasion
(413)	Rutting
(414)	Fire Damage
(420)	Timber Decay
(421)	Timber Checks
(422)	Timber Splits
(423)	Timber Cracks
(424)	Bug Infestation
(430)	Roadway Impact
(431)	Exp Jt Seal Damage
(432)	Exp Jt Metal Damage
(433)	Exp Jt Adj Dk / Header
(434)	Exp Jt Debris Impact
(440)	Bearing Movement
(441)	Bearing Alignment
(442)	Bearing Condition
(443)	Bearing Support
(450)	Masonry Mortar Breakdown
(451)	Masonry Stone Cracks
(455)	Other Element Condition
( )	
( )	
( )	
( )	
( )	
( )	

ODOT Business Decisions

Defect Units of Measure

Has to be the same as the element the defect is associated with:

Cracks in a Concrete Deck = SF
Cracks in a Concrete Column = EA
Cracks in a Concrete Girder = LF

ODOT Business Decisions

Pontis Defect Quantity Rule:

Defect quantity total can not exceed the total quantity for the element.

ODOT Business Decisions

Each defect quantity total = 1 or 100% of the element quantity,

This required all CS ratings to be recorded in percent.

Decided to stratify the defect ratings over the 4 CS's.

This made life very simple for the bridge inspectors:
Just record what they were seeing.

ODOT Bridge Inspection Report

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Protective Systems

Handle in a similar manner as the defects. However - - - Pontis does not allow defects to be associated with a protective system.

ODOT decision: consider the functionality of the protective system to gauge its effectiveness and disregard all of the other defects listed in the manual.

The unit of measure is always SF and Do not influence the Element CS Ratings.

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ODOT Business Decisions

Element CS Ratings

Considered requiring the defect ratings to roll-up numerically into the Element CS Ratings, similar to a CPA's Account Ledger. However - - -

Did not want to require calculator juggling the CS rating numbers just to make it fit numerically.

Decided to use the stratified defect ratings as a point of reference, to influence, but not control the Element CS Ratings.

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ODOT Business Decisions

NBI Ratings

Use the stratified Element CS Ratings as a point of reference, to influence, but not control the NBI Ratings.

Element ratings are specific vs NBI Ratings are an overall average for that bridge component.

ODOT Element Coding Guide

Description	Element # 12/38
This element defines all reinforced concrete bridge deck/slab regardless of the wearing surface or protection systems used.	Reinfo d Concrete Deck/Slab Squa Feet (Square Meters) N onal Bridge Elements

1

Quantity Calculation

The quantity for this elem t should include the area of the deck/slab from edge to edge including any median areas and accounti for any flares or ramps present.

2

Condition State Definitions

Defect	Condition State 1	Condition State 2	Condition State 3	Condition State 4
Cracking	None to minor	May be Moderate size and/or density	May be Severe size and/or density	The operating load capacity of the element has been reduced due to the condition.
Spalls / Delaminations/ Patched Areas	None	May be present without exposed rebar or evidence of corrosion.	May be present with exposed rebar or evidence of corrosion.	
Patched Areas	None	May have areas of sound patches	May have patche showing signs distress.	
Efflorescence	None	May be moderate without rust	May be severe with rust staining	
Load Capacity	No reduction	No reduction	No reduction	

3

Feasible Actions

Condition State 1	Condition State 2	Condition State 3	Condition Stat
Do Nothing Protect	Do Nothing Protect Repair	Do Nothing Protect Repair Rehab	Do Nothing Protect Replace

6

4

Elem Commentary

The d k/slab evaluation is three dimensional in nature with the defects observed on top and/or bottom surface being captured using the defined condition states. Deck/Slab top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive, non-destructive testing or indicators in the materials covering the surfaces.

Element Definitions

Defect	Minor	Moderate	Severe
Cracking	< 0.02 inches (0.5 mm)	0.02 – 0.08 inches (0.5 – 2.0 mm)	>0.08 inches (2.0 mm)
Cracking Density	N/A	1.0 and 3.0 feet apart (0.33 – 1.0 m)	< 1 foot (0.33 m)
Efflorescence	NA	Surface white without build-up or leaching	Heavy build-up with rust staining

5

ODOT Element Coding Guide

Update the ODOT Element Coding Guide - must be small enough to fit in the pocket of a safety vest.

Differentiate by the material type rather than the member type – the defect CS definitions are the same.

Simplify the process by integrating the CS definitions and the Element definitions into 1 table.

Associate the maintenance recommendations with the defects.

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5

Reinforced Concrete Elements

Reinforced Concrete Elements		
12	Concrete Deck	SF
38	Concrete Slab	SF
105	Closed Web / Box Girder	LF
110	Open Girder / Beam	LF
116	Stringer (stringer / floorbeam system)	LF
144	Arch (arch ribs and spandrel columns)	LF
155	Floorbeam	LF
205	Column or Pile Extension	EA
210	Pier Wall	LF
215	Abutment	EA
220	Pile Cap / Footing	EA
227	Submerged Pile	EA
234	Cap	EA
241	Reinforced Concrete Culvert	LF
321	Approach Slab	SF
331	Concrete Bridge Railing	LF
( )	Tunnel Liner	LF
( )	Tunnel Portal	EA

Concrete Protection Systems		
510	Wearing Surface	SF
520	Dk/Slab Protective System	SF
521	Concrete Protective Coating	SF

CS Definitions (Deterioration Paths & Thresholds)

Defects	CS1 (Good)	CS2 (Fair)	CS3 (Poor)	CS4
Cracks (358): Size Density	Hairline – < 0.0625 in. > 3 ft apart	Narrow – 0.0625 - 0.125 1 to 3 ft apart	Medium – > 0.125 in. < 1 ft apart	
Corrosion of Reinforcement (411)	No rust stains	No rust stains	Corrosion may be present but loss of section is incidental	determine the strength or
Delams/spalls/ Patched Areas (410)	None	Moderate no exposed rebar Patched areas are sound	Severe exposed rebar Patched areas show distress	
Efflorescence (359)	None	Moderate white, no build-up leaching, or rust stains	Severe Heavy build-up w/rust staining	
Rutting (413)	None	Wheel track rut patching inplace	Rutting is causing water to pond depth > 1 in.	
Abrasion (412)	Minor Surface level, loss of fines	Moderate Loss of large aggregate no exposed rebar	Severe exposed rebar no rebar section loss	
Local Scour (361)	None	Scour Exists bridge is stable Countermeasures in place	Scour Exists, footing exposed, No loss of bearing	Warrants a structural review
Culvert Distortion (368)	None	Tolerable Minor separation of seams, seams covered	Severe Jt Separation exposed embank in flowline	
Settlement (360)	None	Moderate Arrested or Countermeasures in place	Severe Unarrested No loss of bearing	
Fire Damage (414)	None	Loss of large aggregate, no exposed rebar.	exposed rebar no rebar section loss	
Incident Flags (366) Deck (362) Superst. (367) Subst. (369) Br Rails	Minor Damage	Moderate Exposed / bent Reinforcement, no loss of section	Severe Reinforcement Damaged, < 10% loss of section	

Feasible Actions

Defects	CS2 (Fair)	CS3 (Poor)	CS4 (Serious)
Cracks (358): Size or Density	Monitor; Seal	Monitor; Thin Overlay	Monitor; Strengthen
Reinforcement Corrosion (411)	Do Nothing; Seal	Monitor; Protect	Monitor; Strengthen
Delams/spalls/ Patched Areas (410)	Monitor	Monitor Patch	Monitor Patch
Efflorescence (359)	Monitor	Monitor; Seal	Monitor; Strengthen
Rutting (413)	Monitor	Patch	Overlay or Pave
Abrasion (412)	Monitor	Monitor; Protect	Monitor; Strengthen, Repair / Patch
Local Scour (361)	Monitor	Monitor; Protect	Close Bridge Repair Protect
Culvert Distortion (368)	Monitor	Monitor; Shore	Monitor; Rehab; Replace
Settlement (360)	Monitor	Monitor; Shore	Monitor; Rehab
Fire Damage (414)	Monitor	Monitor; or Protect exposed rebar.	Strengthen and repair
Incident Flags (386) Deck (362) Superst. (367) Subst. (369) Br Rails	Patch	Monitor; Strengthen; Shore	Load Restrict; Repair

Bridge Maintenance Details

Given the maintenance recommendation, our plan is to:

- Incorporate more detailed “How to” information into the ODOT Bridge Maintenance Manual.

- Engage material suppliers into the QPL process.

NW Beauty

NW Liquid Sunshine

Questions