Superstructure Inspection and Rating

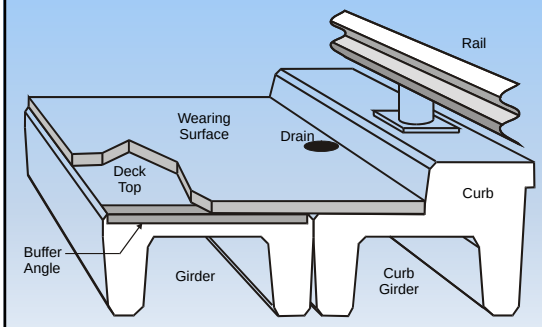
Introduction

- That portion of the bridge above the caps
- Purpose
  - Carry traffic
  - Transfer loads to substructure
- Types for Standard Bridges
  - Timber
  - Concrete
- Component materials
  - Timber
  - Concrete
  - Steel

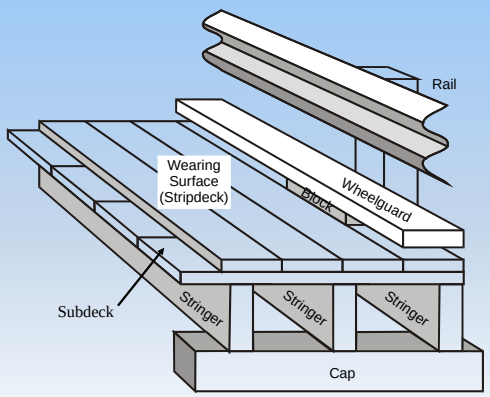
Introduction

- Components in Superstructure
  - Bearings
  - Stringers or girders
  - Deck or subdeck
  - Deck wearing surface
  - Curbs or wheelguards
  - Sidewalks
  - Bridgerail
  - Drains
  - Deck joints

Standard Girder Bridge



Timber Bridge



Introduction

- Two form types (included in Supplemental Manual);
  - TT - timber bridges
  - PCS - Standard plain reinforced & pre-stressed concrete girder bridges
- Both are tailored for components in each type of bridge

Material Defects - Timber

- Structural Failure/Degradation
  - due to loads placed on structural members
    - overloads, collisions, poor grain pattern
  - look for cracks, splits, breaks in structural members
    - stringers, timber posts, rails, etc.
- Decay
  - caused by fungi
  - needs moisture, oxygen and conducive temperature
  - pressure treatment prevents growth
  - look for discoloration (white stains coming from cracks, dampness of wood, ring shrinkage at end grain, hollow sounds, change in geometry
  - look in areas likely to retain moisture
    - bearing or contact areas, buried timber
  - look in areas where treatment is broken/cut
    - bolts, drifts, dowels, cuts, cap ends

Timber Defects – Rot

Timber Defects – Cracked Stringer – Rated 3

Material Defects - Timber

- Volume Change
  - caused by cycles of wetting and drying creating stress in wood
  - look for checks, cracks, warps, twists, etc.
- Mechanical Wear
  - caused by abrasion from traffic, snowplows, ice, debris
  - look in area subject to wear/abrasion - deck surface, wheelguard
- Fire
  - easily recognized
  - reduces the load capacity by reducing their effective size
  - removes the pressure treated zone on the exterior exposing the timber to fungal attack

Timber Defects – Abrasion

Timber Defects – Fire Damage

Material Defects - Concrete

- Structural Cracks
  - caused by stresses higher than design
  - Flexural – generally not serious unless wide or growing in width
  - Shear - most serious - can lead to failure
  - Anchorage depending on cause
- Shrinkage Cracks
  - caused by rapid drying during hydration
  - usually not serious by themselves but let moisture and salt into the concrete
- Settlement Cracks
  - caused by settlement of the falsework
- Map Cracks
  - chemical reaction of the aggregate and paste
  - usually shallow, from over-finishing
  - can cause scaling

Material Defects - Concrete

- Corrosion Cracks
  - caused by corrosion of steel in the concrete creating delaminations or spalls.
  - Maintenance or rehab problem
  - varying widths, locations and orientations
- Chipping
  - caused by external mechanical (backhoe)
- Scaling
  - caused by freeze/thaw action
  - related to poor concrete or workmanship
- Spalling
  - caused by corrosion of rebar
- Popouts
  - caused by expansive aggregates
- Punchouts
  - External mechanical that causes tension failure on opposing side

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SC Girder tops with scaling and section loss

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SC Girder-severe scaling and section loss

Material Defects - Concrete

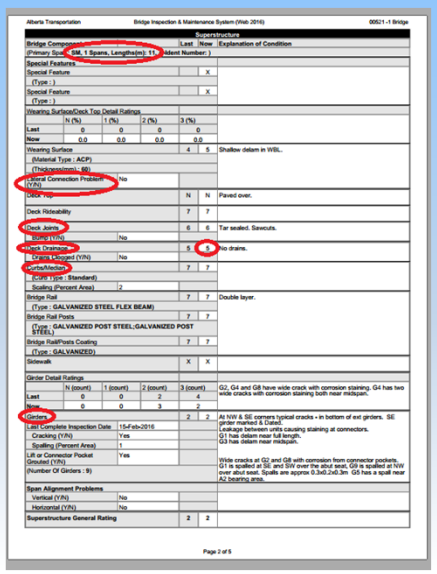
- Efflorescence
  - white salt stains
  - may be associated with cracks which allow water to get into concrete
- Exudation
  - gel-like substance deposited on surface
  - may be associated with cracks which allow water to get into concrete
- Chemical Attack
  - caused by sulfates in the soil reacting with the concrete
  - increases the volume of the concrete causing cracks

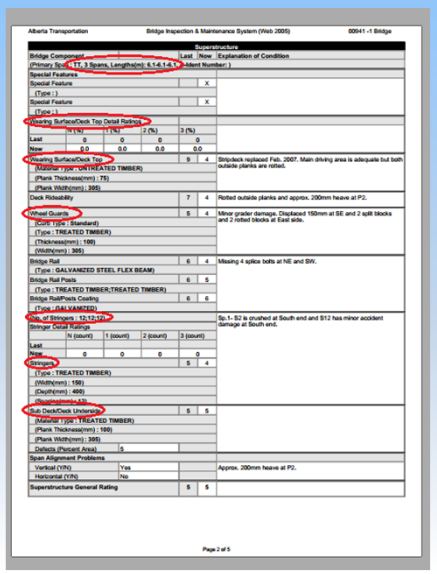
Material Defects - Steel

- Corrosion
  - caused by the presence of oxygen and moisture
  - reduces section of steel member
  - can significantly reduce the load carrying capacity
  - increases the risk of fatigue failure
  - look in areas prone to retention of moisture or exposure to salt
    - splash areas, under leaky joints or drains, dirt and debris accumulation
- Cracks
  - caused by fatigue, overload or collision
  - initially may be too small to be seen by eye
  - can progress rapidly
  - look in high stress or fatigue susceptible areas
    - welds, holes, notches, collision locations, connections, bearing locations

Material Defects - Steel

- Deformation
  - caused by fire, collision, overload or thermal stresses
  - May be local buckling of part of member I.e. web or flange
  - entire member may be bent, twisted or buckled
  - look in high stress areas
    - collision locations, bearing locations





Special Features

Superstructure				
Bridge Component		**Last**	**Now**	**Explanation of Condition**
(Primary Span : **PCS**)				
Special Features				
Special Feature				
(Type :)				
Special Feature				
(Type :)				

- Bridge elements unique to a particular bridge
- Which cannot be rated under another element or area of the form
- May be permanent or temporary
- Lights & WSC station are utilities
- Examples include:
  - strengthening systems, girder clips
  - temporary bents

Special Features

- Record Type(s) – up to 2
- Use Explanation of Condition for additional information
  - description
  - location
  - dimensions
- Check damage or defects common to the materials and type of component
- Provide suitable rating
- Refer to Section 7.3 in BIM Manual

Special Features

Wearing Surface

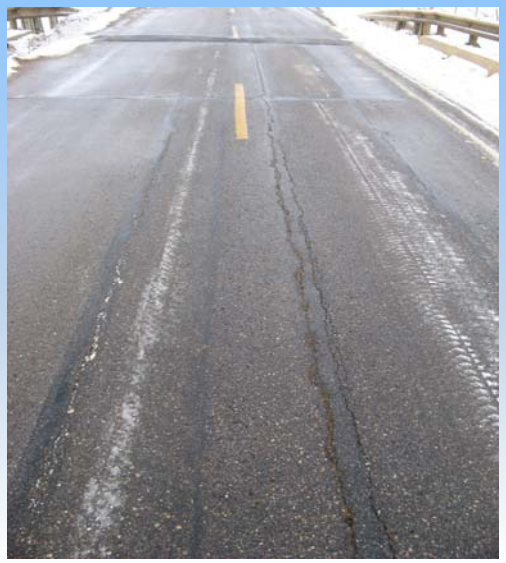
Wearing Surface/Deck Top Detail Ratings					
	N (%)	1 (%)	2 (%)	3 (%)	
Last					
Now					
Wearing Surface					
(Material Type :)					
(Thickness (mm) :)					
(Plank Width (mm) :)					

- TT forms

Wearing Surface/Deck Top Detail Ratings					
	N (%)	1 (%)	2 (%)	3 (%)	
Last					
Now					
Wearing Surface					
(Material Type :)					
(Thickness (mm) :)					
Lateral Connection Problem (Y/N)					
Deck Top					

PCS (precast or pre-stressed standard)

- PCS forms



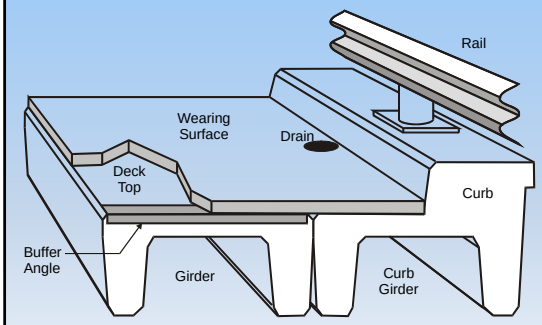
Wearing Surface

- Bonded or fastened to the bridge deck
- In direct contact with the wheels of the vehicles
- List of types in Section 7.4.2 of the BIM manual
- Loose or frozen gravel is not a wearing surface
- Purpose
  - Protect the deck
  - Provide a smooth riding surface
  - Provide skid resistance

Wearing Surface

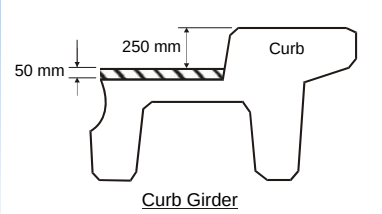
- TT form combines wearing surface and deck top
  - If no wearing surface rating is for deck top only
- Verify the wearing surface material type on the report
  - Type is “NONE” if no wearing surface
- Record or verify the average thickness in mm
- Record the width and thickness of timber planks
- Indicate Y/N whether there is a lateral connection problem between the girders
  - HC - bolted connectors; PA - bolted legs; PE - grout keys; PG - none.

Standard Girders with Wear Surface



Wearing Surface - Thickness

- Measure at curb
  - Most standards curbs 300mm high
  - Refer to plans if in doubt
- Take readings at ends and midspan, and average
- Wearing surface may be thicker at centreline than at curb



Curb Girder

Wearing Surface

- Drive over the deck at fastest safe speed
- Observe traffic to assist in rating
- Look for material defects
- For asphalt pavement wearing surfaces look for:
  - cracks (alligator, lane joint, shrinkage and slippage)
  - distortion (ruts, depressions and corrugations)
  - disintegration (potholes and ravelling)
  - segregation
- Check for delaminations in concrete and asphalt wearing surfaces and record amount in percentage of deck area

Wearing Surface

- If surface is without defects and provides a smooth riding surface with proper skid resistance - rate 9
- Asphalt longitudinal cracks rate 7 or less,
- If speed has to be reduced due to cracks, potholes, etc, - rate 4 or less
- If wearing surface does not cover entire deck and creates a wheel trap - rate 4 or less
- Asphalt raveling rate 4 or less
- Rutting, pot holes or debonding rate 4 or less
- Hazardous rate 2
- Do not rate down due to excessive thickness (100 mm or more)
  - Lower curb rating if height insufficient
  - Request load rating evaluation
  - Recommend reducing thickness

Wearing Surface

- Record % of surface area with defects and rated 1, 2 or 3 in Detail Rating boxes
- Record % of surface area rated N
- Wearing surface rated are 4 or above, detail ratings are “0”

Wearing Surface

Superstructure				
Bridge Component		**Last**	**Now**	**Explanation of Condition**
(Primary Span: HH, 3 Spans, Lengths(m): 8.5-8.5-8.5, A-Ident Number:)				
Special Features				
Special Feature			X	
(Type :)				
Special Feature			X	
(Type :)				
Wearing Surface/Deck Top Detail Ratings				
	N (%) / 1 (%) / 2 (%) / 3 (%)			
Last	0 / 0 / 0 / 5			
Now	0.0 / 0.0 / 5.0 / 25.0			
Wearing Surface		3	2	ACP Cracking between all girders up to 230mm ACP missing on S span along PG girders. Worst on NBL.
(Material Type: ACP - CHIP SEAL COAT)				
(Thickness(mm): 60)				
Lateral Connection Problem (Y/N)	No			Not connected.
Deck Top		N	N	Paved over.
Deck Rideability		4	3	Due to wide gaps up to 230mm wide along girders and missing sections of ACP.
Deck Joints		N	N	Paved over.
Bump (Y/N)	No			

Superstructure Inspection and Rating

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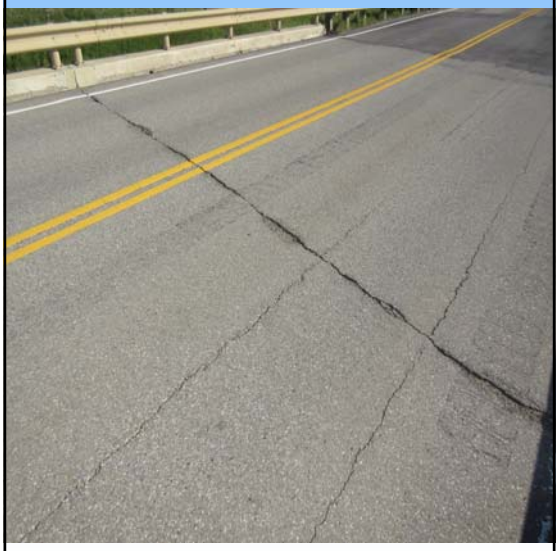
Superstructure Inspection and Rating



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Superstructure Inspection and Rating

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Superstructure Inspection and Rating

Deck Top

		Superstructure		
Bridge Component		Last	Now	Explanation of Condition
Deck Top				

- Deck Top is the “structural” part of the deck
- The surface on which the wearing surface is bonded
- If no wearing surface, the deck top is in direct contact with traffic
- Types:
  - Cast-in-place concrete
  - Precast concrete girders

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Bridge Inspection and Maintenance

Deck Top

- Purpose:
  - Carry traffic
  - Transfer traffic loads to main structural members
  - Provide smooth riding surface
  - Provide skid resistance
- Rated with wearing surface on TT forms

Deck Top

- Listen for unusual noises and look for deflections under traffic
- Look for material defects
  - Concrete - cracks, scaling, spalling, popouts, abrasion from traffic
  - Timber - missing and loose planks, cracks, splits, rot, wear from traffic
- Look for unfilled lift and connector pockets on precast girders
- Rating of wearing surface does not affect the deck top rating

Deck Top

- Deck smooth, no defects, rate 9
- Good condition with hairline cracks, rate 7
- If speed reduced due to cracks, potholes, etc., rate 4 or less
- Record % area rated 3, 2, 1 and N in Detail Rating boxes
- Deck top rating 4 or more record 0 in Detailed Rating boxes
- Rate 3 or less for severe scaling/spalling/debonded
- Hazardous conditions rate 2

Deck Top

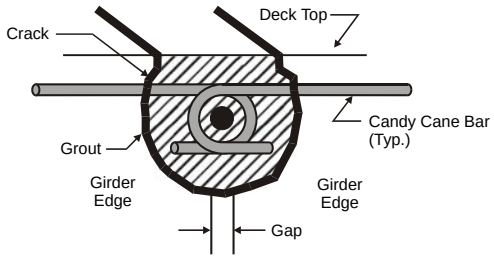
Superstructure			
Bridge Component	Last	Now	Explanation of Condition
(Primary Span: PG, 1 Spans, Lengths(m): 6.1, A-Ident Number:)			
Special Features			
Special Feature		X	
(Type :)			
Special Feature		X	
(Type :)			
Wearing Surface/Deck Top Detail Ratings			
N (%) / 1 (%) / 2 (%) / 3 (%)			
Last: 0 / 0 / 0 / 0			
Now: 20.0 / 0.0 / 0.0 / 0.0			
Wearing Surface	5	X	Remanants of chipseal at W half of deck.
(Material Type :) None			
(Thickness(mm) :)			No connection.
Lateral Connection Problem (Y/N) No			
Deck Top	5	5	

Lateral Connection Problem Y/N

Wearing Surface/Deck Top Detail Ratings				
	N (%)	1 (%)	2 (%)	3 (%)
Last				
Now				
Wearing Surface				
(Material Type :)				
(Thickness (mm) :)				
Lateral Connection Problem (Y/N)				
Deck Top				

PCS (precast or pre-stressed standard)

PE Girder Lateral Connection



Deck Rideability

- A measure of the riding comfort at the legal speed
- Influenced by the condition of the wearing surface or deck top and joints (rated separately)
- Drive over at legal speeds and assess ride quality
- Listen for unusual noise from traffic
- Observe traffic for signs of poor rideability such as slowing down or bouncing
- Smooth, no speed reduction rate 7 or more
- If speed has to be reduced due to cracks, potholes, etc. - rate 4 or less
- Slipperiness reduces rating

Deck Joints

Bridge Component		Superstructure Last	Now	Explanation of Condition
Deck Joints				
Bump (Y/N)				

- Purpose
  - Provide a structural termination of individual spans
  - Can be designed to prevent water and salt from leaking down onto substructure
  - Protects ends of precast girders (buffer angles)
  - Can be designed to span gap between spans
  - Provide a smooth transition (reduces bumps)
- On standard bridge all joints are considered fixed.
- Not applicable to standard TT bridges

Deck Joints

- Standard Bridge Types
  - Buffer angles - steel angles cast into top edge at ends of girder
  - Compression seal - a compressible seal held in place by steel angles
  - Strip seal installed at piers of overlays
  - Others - caulked sawcuts, asphaltic plug joint (Koch or Thorma-joint)
- Asphalt fiber board alone is not a joint – rate X
- Unprotected girder ends is not a joint – rate X

Deck Joints

- Observe traffic crossing over joints
  - Listen for unusual noises
  - Watch for movement
- Look for:
  - Vertical alignment
  - Corrosion
  - Deteriorating concrete around anchorages
  - Damage from snow plows
- Indicate whether or not a significant bump by Yes or No
  - If "Yes", explain location and cause

Deck Joints

- Buffer angles should not be rated down because they leak
- Damage from leakage rated in substructure
- Slightly less that adequate but no maintenance required – rate 4 (missing section of buffer angle)
- Joints requiring repair – rate 3
- Joints which are a hazard to traffic - rate 2 or less
- If joint is not visible:
  - Rate "X" if it is known that no joint exists
  - Rate "N" otherwise
  - Provide explanation

Deck Drainage

Bridge Component		Superstructure Last	Now	Explanation of Condition
Deck Drainage				
Drains Clogged (Y/N)				

- Ability of the deck to drain and properly dispose of water from its surface
- Not applicable to bridges with timber decks
- Drainage system includes gutters, inlet boxes, pipes and catch basins

Deck Drainage

- Poor drainage
  - Common cause of deck deterioration
  - May be hazardous due to hydroplaning or icing
  - Caused by inadequate design, construction or maintenance practices (grade, crown, debris, etc)
  - May affect other superstructure components, substructure, headslopes and sideslopes

Deck Drainage

- Indicate whether or not the drains are plugged by **Y**es or **N**o
  - If no drains, note in Explanation of Condition
- Check entire drainage system to determine if water is being directed off the deck in a proper manner
- If there are any deficiencies in the drainage system or significant deterioration of any components - rate 4 or less
- If erosion is being caused on the headslopes or sideslopes by deck drainage - rate 4 or less
- If water is being allowed to pond on the deck and create a hazard for traffic - rate 2 or less
- not a factor on timber decks therefore rate X

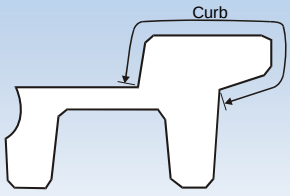
Curbs / Medians

	Superstructure		
Bridge Component	Last	Now	Explanation of Condition
Curb/Median			
Scaling (Percent Area)			

- Raised surface at the edge of the roadway
- Purpose
  - Guide or redirect traffic
  - Divide the bridge according to travel direction
  - Anchor railing posts
- Applies to concrete only - timber or steel called wheelguards

Curbs / Medians

- Curb consists of:
  - the vertical or sloped face along the edge of the roadway
  - the raised horizontal surface
  - the fascia or outside surface down to the deck or girder level



Curb Girder

Curbs / Medians

- Look for:
  - Scaling
  - Other material defects - cracks, spalls
  - Snowplow damage along inside faces
  - Accident damage
  - Holes exposing the voids
  - Water damage in voids and freezing
  - Whether curb lift hook pockets are filled
- Estimate the amount of scaling as a percentage of the total area
  - Record the percentage in the appropriate field
  - Describe the extent and location in the *Explanation of Condition*
  - Scaling is not normally a problem on gravel roads unless using calcium chloride for dust control

Curbs / Medians

- Note any loss of height due to roadway paving or accumulation of dirt or gravel
- Rate according to condition and ability to perform as designed
  - Condition of concrete
  - Ability to withstand and redirect traffic
  - Ability to contain railing anchors in the event of a collision
- Curbs with holes rate 4 or less
- Severe scaling (>25 mm deep) rate 4 or less
- Spalling or broken concrete affecting post anchorage rate 3 or less

Curb rated 3. Post rated 3 or less.

Curb and Post Rated 3

Curb holes – Rated 3

Curb rated 4 or less

SC Girder Deterioration at Plinth

- Curb is rated "X" for this example
- Plinth deterioration is rated under BR post section on form (rated 3).

Wheelguard

Bridge Component		Superstructure Last	Now	Explanation of Condition
Wheel Guards				
(Curb Type :)				
(Type :)				
(Curb Height (mm) :)				
(Width (mm) :)				

- Curbs made out of timber or steel
- Found on timber decks
- Verify type, height and width
- Record in nominal dimensions (typ. size is 100 x 300 or 150 x 300 but some variations)
- Revise as in inventory area on form
- Add this information if missing
- Record wheelguard block dimensions in comments area if needed

Wheelguard

- Look for:
  - Poor anchorage
  - Material defects
  - Missing or loose bolts
  - Poor connections
  - Mis-alignment
  - Collision damage
  - Snowplow damage
  - Missing sections
- Note any loss of height due to roadway paving or accumulation of dirt or gravel
- Rate according to condition and ability to perform as designed
- Minor splits/cracks rate 5
- Missing/broken sections, blocks, anchors rate 4 or less

Grader damage to TT Wheelguard – Rated 4 or less

Sidewalk

	Superstructure		
Bridge Component	Last	Now	Explanation of Condition
Sidewalk			

- Applicable to PCS bridges
- Designed to accommodate pedestrian traffic
- Not normally part of the load carrying system of the bridge
- If part of the load carrying system, rating & inspection procedures are similar to “Deck Top” and/or Girder”

Sidewalk

Look for:

- Smoothness, adequate traction and debris
- Accessibility for pedestrians to the sidewalk at both ends of the bridge
- Material defects
- Condition of structural members and connections
- Condition of railings (rate under bridge rail)

- Hazards to pedestrian traffic (tripping, slipping, holes, loose boards, etc. rate 2 or less
- Rate according to condition and ability to perform as designed
- Rails systems rated with Bridgerails
- Some defects may be less serious on a sidewalk than on the bridge

Bridge Rail / Posts

Bridge Component		Superstructure Last	Now	Explanation of Condition
Bridge Rail				
(Type :)				
Bridge Rail Posts				
(Type :)				
Bridge Rail/Posts Coating				
(Type :)				

- Considered to be safety features
- Do not contribute to the strength or load carrying capacity of the bridge
- Refer to Section 7.11.2 in the manual for a list of railing and post types
- Verify railing and post types – correct/add in inventory area
- Record coating type on rails and posts
- Record number of layers of flexbeam in comments

Bridge Rail / Posts

- Look for:
  - Material defects
  - Collision damage
  - Horizontal and vertical mis-alignment
  - Loose connections
  - Missing nuts or bolts
  - Inadequate thread engaged on post anchor nuts
  - Broken or spalled post anchors
  - Correct lap direction of flexbeam
    - lapped in direction of traffic
- Includes pedestrian rails found on sidewalks

Bridge Rail / Posts

- Rate according to condition and not the standard of the rail, posts or coating
  - timber rail is substandard but can be rated 9 if in new condition
  - timber posts with wrong orientation
- Rating for rail and posts does not include the condition of the coating – rated separately unless severe corrosion
- If coating on rail and posts is different then record and rate rail coating. Note post coating type and condition in Comment area
- Railing with minor collision damage but still functional and has good connections rate 5
- Timber with signs of rot rate 4 or less
- Rail connections with missing bolts, improper laps nuts rate 4 or less
- Railing with missing sections - rate 2 or less

Bridge Rail / Posts

- Post anchor bolts that are engaged with nuts (at least flush nut) rate 5 or more
- Post anchor bolts with insufficient thread rate 4 or less
- Post anchors that are broken or missing anchor nuts and bolts rate 3 or less

Rotted Timber BR – Rated 3 Coating Rated 3 or less

Missing A/B – Post Rated 3 Missing Splice Bolts and Incorrect Lap – Rail Rated 4

Missing BR Section – Rated 2

Missing Rail and Posts – Rated 2

Deterioration Affecting Post Anchorage – SC Girders

Typ. TT wheelguard, TT posts, galv. rail

Subdeck

Bridge Component		Superstructure Last	Now	Explanation of Condition
Sub Deck/Deck Underside				
(Material Type :)				
(Plank Thickness (mm) :)				
(Plank Width (mm) :)				
Defects (Percent Area)				

- Applies only to Standard timber bridges
- The “structural” part of the deck
- Strip deck usually installed on top to protect
- If no wearing surface, subdeck is in contact with traffic
- Consists of timber planks nailed to stringers
- Often only visible to inspect at underside and ends
- Verify type and revise or add as needed
  - Record in Inventory area of form.
- Record nominal width and thickness – normally 100 x 300mm

Subdeck/Underside

- Look for:
  - Material defects
  - Loose or broken planks
  - Deflection under traffic
- Estimate the percentage of the area which has defects and record value
  - Decay, staining, split or broken planks
- Minor stains/cracks (concrete) rate 5
- Spalls or severe scaling rate 4
- Rot/Decay in timber rate 4 or less
- Note location in Manual – Section 7.21

Rot/bulging in Subdeck – Rate 3 or less

Rot in Subdeck Ends – Rate 4 or less

Stringers

Bridge Component		Superstructure Last	Now	Explanation of Condition

(No. of Stringers :)				
Stringer Detail Ratings				
	N (count)	1 (count)	2 (count)	3 (count)
Last				
Now				
Stringers				
(Type :)				
(Width (mm) :)				
(Depth (mm) :)				
(Spacing (mm) :)				

- Longitudinal beams resting on the caps and supporting the deck
- The main load carrying members of the superstructure
- Verify number per span or add if missing
- Verify type, size (width and depth), and spacing in nominal dimensions and record in Inventory area of form

Stringers

- Purpose:
  - Support the deck
  - Transfer loads to substructure
  - Critical load carrying members
- Repaired or “sistered” stringers count as one stringer (repair must be with equivalent size stringer)
- Record if stringers are notched including location

Stringer and Girder Numbering

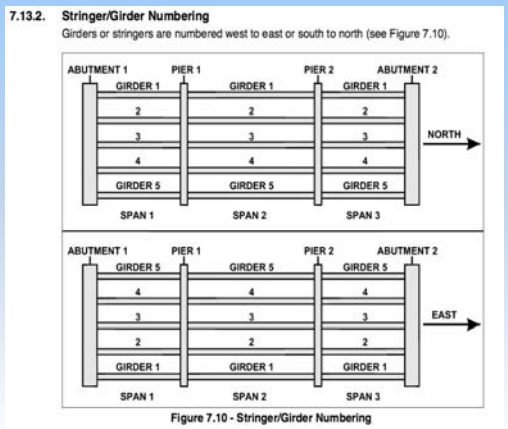
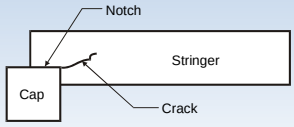


Figure 7.10 - Stringer/Girder Numbering

Stringers

- Look for:
  - Material defects
    - decay, cracks, checks, fire damage, sags, twists
  - Broken or missing stringers
  - Adequate bearing, proper connections and any splitting, crushing or decay in bearing area
  - Collision damage or abrasion from ice or drift
  - Notches at ends of girders



Stringers

- Stringers with notches at the ends - rate 7 or less and note in comments area
- Cracked or broken stringers which have been repaired with additional stringer(s) of equal size may be rated 5 or more
- Stringers with less than 75mm bearing rate 4 or less
- Stringers that are bowed or twisted significantly - rate 4 or less
- Cracked stringers rate 3 or less
- Record number of stringers rated N, 1, 2 & 3 in Detailed Rating boxes
- If all stringers are rated 4 or more, Detail Ratings are recorded as ”0”

Rotted subdeck & rotted/cracked timber stringer. Both rated 3 or less.

Cracked Timber Stringer – Rated 3

Superstructure Inspection and Rating

Cracked Timber Stringer – Rated 3

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Cracked Timber Stringer – Rated 3

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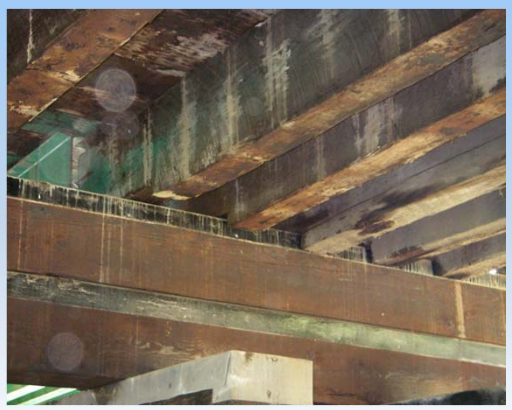
Notched Timber Stringers – Rate 7 or less. Cracked Stringer Rate 3



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Girders

Superstructure				
Bridge Component		Last	Now	Explanation of Condition

Girder Detail Ratings				
	N (count)	1 (count)	2 (count)	3 (count)
Last				
Now				
Girders				
Last Complete Inspection Date				
Cracking (Y/N)				
Spalling (Percent Area)				
Lift or Connector Pocket Grouted (Y/N)				
(Number Of Girders :)				

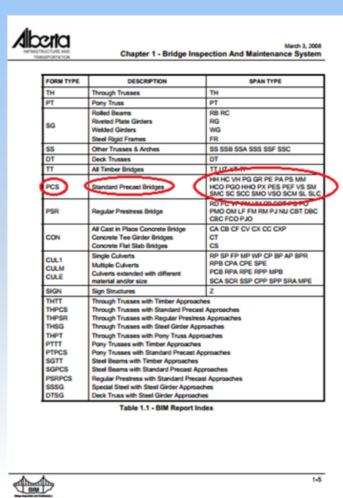
- Applies only to concrete girder bridges
- Longitudinal beams resting on the caps
- The main load carrying members of the superstructure
- The deck is integral with the girder
- Detail ratings only on PCS
- Last Complete Inspection Date

Girders

- Purpose:
  - Support the deck
  - Transfer loads to substructure
- Two types in Standard bridges
  - Channel Girders - conventionally reinforced channel girders
  - Standard Prestressed – short girders with pre-tensioned reinforcement

Refer to BIM Reference Manual for types of girders

Table 1.1 from BIM Manual



Alberta INFRASTRUCTURE AND TRANSPORTATION

March 3, 2008

Chapter 1 - Bridge Inspection And Maintenance System

FORM TYPE	DESCRIPTION	SPAN TYPE
TH	Through Trusses	TH
PT	Pony Truss	PT
SG	Rolled Beams Riveted Plate Girders Welded Girders Steel Rigid Frames	RB RC RG WG FR
SS	Other Trusses & Arches	SS SSB SSA SSS SSF SSC
DT	Deck Trusses	DT
TT	All Timber Bridges	TT UT XT TP
PCS	Standard Precast Bridges	HH HC VH PG GR PE PA PS MM HCO PGO HHO PX PES PEF VS SM SMC SC SCC SMO VSO SCM SL SLC
PSR	Regular Prestress Bridge	RD FC VF PM VM PB DBT PG FO PMO OM LF FM RM PJ NU CBT DBC CBC FCO PJO
CON	All Cast in Place Concrete Bridge Concrete Tee Girder Bridges Concrete Flat Slab Bridges	CA CB CF CV CX CC CXP CT CS
CUL1 CULM CULE	Single Culverts Multiple Culverts Culverts extended with different material and/or size	RP SP FP MP WP CP BP AP BPR RPB CPA CPE SPE PCB RPA RPE RPP MPB SCA SCR SSP CPP SPP SRA MPE
SIGN	Sign Structures	Z
THTT THPCS THPSR THSG THPT PTTT PTPCS SGTT SGPCS PSRPCS SSSG DTSG	Through Trusses with Timber Approaches Through Trusses with Standard Precast Approaches Through Trusses with Regular Prestress Approaches Through Trusses with Steel Girder Approaches Through Trusses with Pony Truss Approaches Pony Trusses with Timber Approaches Pony Trusses with Standard Precast Approaches Steel Beams with Timber Approaches Steel Beams with Standard Precast Approaches Regular Prestress with Standard Precast Approaches Special Steel with Steel Girder Approaches Deck Truss with Steel Girder Approaches	

Table 1.1 - BIM Report Index

1-5

Girders

- Cracks are often the first visible sign of distress or failure
- Types of cracks:
  - Vertical hairline cracks on precast channel girders - common not serious
  - Vertical cracks in the tension zone – flexure – usually not serious unless wide
  - Diagonal cracks near the supports - shear or combination of shear and flexure, can be serious
  - Longitudinal cracks in bottom of legs in precast girders - corrosion of rebar
  - Wide longitudinal cracks in bottom of legs with corrosion may lead to spalling
  - Longitudinal cracks in ends of prestressed girders - stresses from pre-tensioned reinforcement
  - Wide longitudinal cracks with corrosion in girder undersides of prestressed girders may be from strands

Girders

- Look for:
  - Cracks
  - Spalling on bottom of legs
  - Other defects - scaling, staining, etc.
  - Damaged connectors - deteriorating grout, loose or broken bolts, corrosion on bolts or connector channels
  - Spalls at dowel locations
  - Collision damage or abrasion from ice or drift
  - Punchouts in deck
- Look for excessive vibrations or deflections under traffic
  - Observe whether girders with lateral connections deflect independently

Girders

- Indicate cracking by **Y**es or **N**o
  - Applies to all types except shrinkage and hairline or narrow flexural cracks
  - If Yes explain - location, type, size
  - Mark and date cracks
- Record the percentage of spalling on the bottom of the legs
  - Record 0% if none
  - Explain if any
- Indicate Lift or Connector Pockets Grouted
  Yes or **N**o
  - If Yes explain
- Verify total number of girders or record number per span if blank

Girder Rating Guide

- Rating guidelines are provided in Table 7.2 for standard reinforced channel girder
- Provided in Tables 7.3, 7.4 and 7.7 for prestressed girders
- Ratings given are *maximums*
  - Decrease as needed
  - Reflect condition and functionality
- If curb girder *only* affected, can increase ratings by one
- Provide girder count for N, 1, 2 & 3 ratings
- If girder ratings are 4 or above detail ratings are “0”

Rating Guide for Standard Reinforced Concrete Channel Girders

Rating	Spalling or Longitudinal Cracks on Legs	Shear Cracks (not greater than 60° from horiz.)	Other Defects
No effect			• Narrow flexural cracks.
6			• End diaphragm spall. • Narrow map cracks.
5	• Medium crack within anchorage zone with sound concrete (must be accessible and confirmed by inspector) • Wide crack or spall outside anchorage zone	• Narrow (reduce by one if wide longitudinal crack or spall within anchorage zone)	• Top slab transverse crack
4	• Medium crack within anchorage zone with unsound concrete or concrete soundness not confirmed by inspector • Wide crack within anchorage zone with sound concrete (must be accessible and confirmed by inspector) • Moderate loss of section on main bars or stirrup bends (up to 10%)		• Medium or wide map cracking or any map cracking with staining • Medium flexural cracks • Small punchouts, 150 mm or less in diameter • Narrow concrete grout key cracks
3	• Wide crack within anchorage zone with unsound concrete or concrete soundness not confirmed by inspector • Spall within anchorage zone with top half of main reinforcing steel embedded in sound concrete	• Medium (reduce by one if wide longitudinal crack or spall within anchorage zone)	• Other punchouts • Medium or wide concrete grout key cracks • Failed girder connections
2	• Spall within anchorage zone with unsound concrete extending above top half of main reinforcing steel • Severe loss of section on main bars or stirrup bends (greater than 20%)	• Wide or growing (reduce by one if wide longitudinal crack or spall within anchorage zone)	• Wide flexural cracks • End diaphragm spall extending into legs
1			

Table 7.2 - Rating Guide - Standard Reinforced Concrete Girders

Rating Guide for Standard Reinforced Concrete Channel Girders

Table 7.2 - Rating Guide – Standard Reinforced Concrete Girders

Notes:

- Reduce as needed to reflect condition and functionality of structure.
- Longitudinal crack rating is eligible for a one rating point increase if girder type has hooked or cranked longitudinal bars (Type PA and PG girders only) OR longitudinal cracking or spalling is limited to a single leg on the girder. These rating point increases are not cumulative.
- If defects listed are limited to curb girder only the ratings can be raised by one to reflect the lower live load carrying function of this unit.
- Reduce rating by one for punchouts if punchout occurs at lift hook pockets, connector pockets, or at midspan of girder.
- Anchorage zone defined as 1.2 m from the end of the girder for all spans less than 10 m.
- Anchorage zone defined as 2.0 m from the end of the girder for all spans 10 m or longer.

Cracks Widths:

- Hairline — less than 0.1 mm
- Narrow — 0.1 mm to less than 0.3 mm
- Medium — 0.3 mm to less than 1.0 mm
- Wide — equal to or greater than 1.0 mm

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Precast Channel Girder Rating Guide

- Crack widths:
  - Hairline < 0.1mm
  - Narrow ≥ 0.1mm and < 0.3mm
  - Medium ≥ 0.3mm and < 1.0mm
  - Wide ≥ 1.0mm
- Use a crack gauge to measure widths
- Anchor Zone is 1.2m when girder less than 10m & 2.0 when 10m or more (channel girders only)
- Increase longitudinal crack rating by 1 for PA and PG girders OR if only one leg (HC girders). Increase is not cumulative
- Reduce by 1 if punchout at pockets, connectors, or mid-span.
- Defect in curb girder only increase by 1

Superstructure Inspection and Rating

Superstructure Inspection and Rating

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Superstructure Inspection and Rating

Rating Pre-stressed Girders

- Refer to Sections 7.14 to 7.15.2.7 for general information.
- Refer to Section 7.15.4 for specific information.
- Suggest using “3-strike” rule when determining ratings for pre-stressed girders.

1. Start with Table 7.7 – Exception List for common std. girder types (VS, SM, SC, SL).
   - ➢ Note that crack width must be narrow – reduce by 1 if corrosion staining is present.
   - ➢ If defect in field matches description in Table 7.7 then rate accordingly.
2. Refer to Table 7.4 – Exception List for ALL Pre-stressed Girders.
   - ➢ If defect in field matches description in Table 7.4 then rate accordingly.
3. Refer to Table 7.3–strike 3 – rate accordingly

Rating Guide for Prestressed Girders – Table 7.7

Girder Type: VS, SM, SC, RD, RM, PM, VM, SL

Crack	Rating	Description
1.	5	Diagonal crack on bottom of girder, not longer than 0.5 m. Crack length must be continuous and not intermittent or staggered. Crack lengths to be measured from the face of the pier cap or abutment seat and along the length of the crack (with no signs of corrosion staining).
	3	Diagonal crack on bottom of girder, not longer than 0.5 m. Crack length must be continuous and not intermittent or staggered. Crack lengths to be measured from the face of the pier cap or abutment seat and along the length of the crack (with signs of corrosion staining).
2.	5	Longitudinal crack on girder underside.
3.	5	Longitudinal crack at lower curb fascia.
4.	5	Crack in poured connection at fascia over piers (RM, RD, SMC, SCC, SCM, SLC).

Table 7.7 - Exception List- Girder Type: VS, SM, SC, RD, RM, PM, VM, SL

Rating Guide for Prestressed Girders – Table 7.4

Exception List - All Prestressed Girders

Crack	Rating	Description
1	6	• Narrow map cracks
	4	• Medium, wide or any map cracking with staining
2	3	• Vertical crack 50 to 100 mm from end of girders with or without signs of corrosion stains

Rating Guide for Prestressed Concrete Girders – Table 7.3

Rating	Defects
4	• Hairline cracks with no staining except as noted below.
3	• All other cracks except as noted below. • Corrosion stains originating from prestressed strands.
2	• Cracks with signs of corrosion in webs or bottoms of boxes or flanges except as noted below. • Any cracks which are growing.
1	• Any cracks which are opening or closing under traffic or with slippage along the cracks.

Typical Diagonal Crack

Longitudinal Crack – No Corrosion

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Typical Corrosion Spots

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BIM Bulletin 6 – SC Girder Deterioration

- AT First learned of problem in 2012
- 6 SC girder bridges showing signs of accelerated freeze thaw deterioration on exterior girders.
- Investigation revealed deterioration due to substandard aggregates in concrete mixes used in girders fabricated 2003-2007
- 88 SC girder bridges built in this time frame
- 36 of 88 bridges now showing deterioration with various degrees of severity.
- 16 - significant premature deterioration
- 20 - deterioration may soon become severe
- Severe deterioration typically on exteriors especially if exposed to direct sunlight but interior girders are also affected

BIM Bulletin 6 – SC Girder Deterioration

Issues include:

- failure of the bridgerail where it anchors into exterior girder,
- structural capacity of the exterior girders due to loss of concrete and reinforcing steel embedment,
- signs that damage to the tops of girders may soon become a concern for sites with no wearing surface.

Guidelines for BIM Ratings and Maintenance Recommendations for SC girder bridges showing signs of premature freeze thaw deterioration are presented in the Bulletin.

Bulletin 6 – SC Girder Deterioration Ratings

Table 1: Level 1 BIM Rating for SC Girders

Element	Rating	Defects
Interior and exterior girders	4	• Aggregate popouts, minor scaling and other signs of freeze thaw damage with no visible signs of concrete section loss.
	3	• Concrete section loss of the side face of the girder that does not extend more than 50 mm from the top or bottom edges of girder. • Concrete section loss of the side and/or end face of the girder that does not extend more than 50 mm from the vertical edge of the girder ends. • Concrete section loss of the girder top surface less than 35 mm in depth.
	2	• Concrete section loss on the side face of the girder that extends more than 50 mm from the top or bottom edges of girder. • Concrete section loss of the side and/or end face of the girder that extends more than 50 mm from the vertical edge of the girder ends. • Concrete section loss of the girder top surface more than 35 mm in depth. • Exposed steel stirrups. • Exposed prestressing strands.
Bridgerail posts	3	• Concrete section loss of the exterior girder top or plinth that does not extend to the edge of the bridgerail post base plate.
	2	• Concrete section loss of the exterior girder top or plinth that extends up to or below the edge of the bridgerail post base plate. • Exposed exterior girder steel stirrups within 500 mm longitudinally of the centreline of a bridgerail post.

Bulletin 6 – SC Girder Deterioration

Extensive scaling exterior girder surfaces , section loss along top and bottom corners. No exposed stirrups or prestressing strand. Section loss of BR post plinth. Girder rated 3. BR posts rated 3.

Bulletin 6 – SC Girder Deterioration

Section loss along top and bottom corners of exterior girder. Girder rated 3. Bridgerail posts rated 3.

Bulletin 6 – SC Girder Deterioration

Section loss along top corners and top surfaces of interior girders. Interior girders rated 3.

Bulletin 6 – SC Girder Deterioration

Significant section loss all surfaces extending beneath BR post baseplate. Exposed stirrups. Exterior girder rated 2. BR post rated 2.

Bulletin 6 – SC Girder Deterioration

Scaling of exterior face, section loss on top and bottom corners extending beneath the BR post bases. No exposed strands or stirrups. Exterior girder rated 3. BR posts rated 2.

Bulletin 6 – SC Girder Deterioration

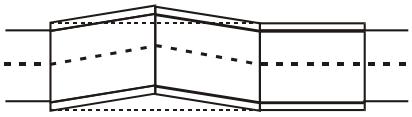
Section loss top corner of exterior that does not extend to the edge of the BR post base plate. Aggregate popouts on exterior face. Concrete section loss of BR plinth. Girder rated 3. Bridgerail post rated 3.

Span Alignment Problems

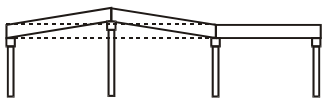
Bridge Component		Superstructure Last	Now	Explanation of Condition
Span Alignment Problems				
Vertical (Y/N)				
Horizontal (Y/N)				

- Applies only to
  - the vertical and horizontal alignment of the superstructure
- No rating is required
- Mis-alignments may indicate distress in the superstructure and/or substructure

Span Alignment Problems



Horizontal Misalignment



Vertical Misalignment

Span Alignment Problems

- Look along edges of girders, curbs, railing for signs of sags, bows, movement, buckling, twisting, etc.
- Look for vertical mis-alignment and uneven gaps at deck joints
- Indicate whether there is a vertical and horizontal alignment problem by **Y**es or **N**o
- Provide an explanation of the location, type, possible cause and seriousness

General Rating

- Governed by
  - Structural load carrying members
  - Subdeck or deck underside
  - Stringers
  - Girders
- Span alignment problem if related to serious structural
- Hazardous conditions such as missing rail, conditions potentially harmful to motorists

Superstructure Inspection and Rating

Questions??

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