BRIDGE MAINTENANCE

Introduction

- Inspection identifies maintenance needs
- Inspection determines priorities for repair
- "Maintenance Recommendations" difficult for inexperienced inspectors
- Good judgement and common sense an asset.

BIM Rating System

Rating		Commentary	Maintenance Priority
9	Very Good	New condition.	No repairs in foreseeable future.
8		Almost new condition.	No repairs in foreseeable future.
7	Good	Could be upgraded to new condition with very little effort.	No repairs necessary at this time.
6		Generally good condition. Functioning as designed with no signs of distress or deterioration.	No repairs necessary at this time.
5	Adequate	Acceptable condition and functioning as intended.	No repairs necessary at this time.

BIM Rating System (Cont'd)

4		Below minimum acceptable condition.	Low priority for repairs.
3	Poor	Presence of distress or deteriora-tion. Not functioning as intended.	Medium priority for replacement, repair, and/or signing.
2		Hazardous condition or severe distress or deterioration.	High priority for replacement, repair, and/or signing.
1	Immediate Action	Danger of collapse and/or danger to users.	Bridge closure, replacement, repair, and/or signing required as soon as possible.
N	Not Accessible	Element cannot be visually inspected.	
X	Not Applicable	Element not applicable to this bridge.	

Table 1.2 - Condition Rating System

Types of Maintenance

- Preventative Maintenance
- Routine or Minor Maintenance
- Rehabilitation or Major Maintenance

Duffy says, “Guess I should have washed off the road salt.”

Preventative Maintenance

- Reduces rate of deterioration and extends life
- Carried out on regular basis
- Before problems or deficiencies occur
- Examples:
  - washing bridges
  - remove gravel from deck
  - sealing concrete deck and curbs
  - Asphalt cracks
  - washing signs
  - Cleaning, replacing, adding signs

Dunvegan Bridge with coating of salt. Estimated damage is $400,000 per year (Plus User Cost).

Applying concrete sealers to bridge curbs and medians.

Routine or Minor Maintenance

- Correct reductions in condition or functionality of bridge elements
- Primarily “patch up” work
- Generally low cost

Routine or Minor Maintenance

- Examples:
  - patch concrete
  - patch strip deck
  - repair bridge rail
  - scour / erosion
  - replace signs
  - replace seals
  - etc.

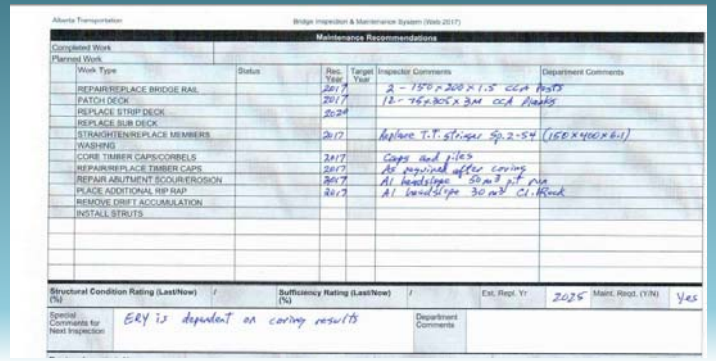
Rehabilitation or Major Maintenance

- Restores bridge to original condition or function or upgrades functionality
- High cost
  - do bridge assessment
  - life cycle cost or cost benefit

Rehabilitation or Major Maintenance

- Examples:
  - deck overlays
  - cap / pile replacement
  - culvert liners
  - cathodic protection
  - girder replacement
  - etc.

Treated Timber Bridge Maintenance Recommendations



Alberta Transportation — Bridge Inspection & Maintenance System (Web 2017)

Maintenance Recommendations

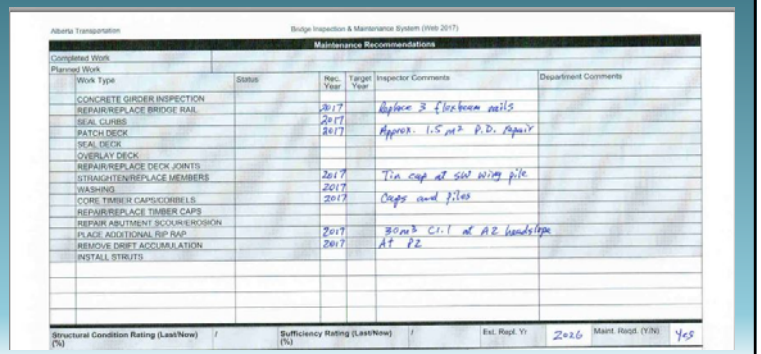
Completed Work

Planned Work

Work Type	Status	Rec. Year	Target Year	Inspector Comments	Department Comments
REPAIR/REPLACE BRIDGE RAIL		2017		2 - 150 x 200 x 1.5 CCA posts	
PATCH DECK		2017		12 - 76 x 305 x 3M CCA Planks	
REPLACE STRIP DECK		2024			
REPLACE SUB DECK					
STRAIGHTEN/REPLACE MEMBERS		2017		Replace T.T. stringer Sp. 2-54 (150 x 400 x 6.1)	
WASHING					
CORE TIMBER CAPS/CORBELS		2017		Caps and piles	
REPAIR/REPLACE TIMBER CAPS		2017		As required after coring	
REPAIR ABUTMENT SCOUR/EROSION		2017		At headslope 50 m³ pit run	
PLACE ADDITIONAL RIP RAP		2017		At headslope 30 m³ Cl. II Rock	
REMOVE DRIFT ACCUMULATION					
INSTALL STRUTS					

Structural Condition Rating (Last/Now) (%)	/	Sufficiency Rating (Last/Now) (%)	/	Est. Repl. Yr	2025	Maint. Reqd. (Y/N)	Yes
Special Comments for Next Inspection	ERY is dependent on coring results			Department Comments			

Reinforced Concrete Bridge Maintenance Recommendations



Alberta Transportation — Bridge Inspection & Maintenance System (Web 2017)

Maintenance Recommendations

Completed Work

Planned Work

Work Type	Status	Rec. Year	Target Year	Inspector Comments	Department Comments
CONCRETE GIRDER INSPECTION					
REPAIR/REPLACE BRIDGE RAIL		2017		Replace 3 floorbeam rails	
SEAL CURBS		2017			
PATCH DECK		2017		Approx. 1.5 m² P.D. Repair	
SEAL DECK					
OVERLAY DECK					
REPAIR/REPLACE DECK JOINTS					
STRAIGHTEN/REPLACE MEMBERS		2017		Tin cap at SW wing pile	
WASHING		2017			
CORE TIMBER CAPS/CORBELS		2017		Caps and piles	
REPAIR/REPLACE TIMBER CAPS					
REPAIR ABUTMENT SCOUR/EROSION					
PLACE ADDITIONAL RIP RAP		2017		30 m³ Cl. I at A2 headslope	
REMOVE DRIFT ACCUMULATION		2017		At A2	
INSTALL STRUTS					

Structural Condition Rating (Last/Now) (%)	/	Sufficiency Rating (Last/Now) (%)	/	Est. Repl. Yr	2026	Maint. Reqd. (Y/N)	Yes

Approach Road Maintenance

- Horizontal & Vertical alignment rated for functionality not condition (no maintenance)
- Approach bump (all bridges)
  - increases impact loading on girders
  - repair by patching or grading to restore grade line

Approach bump and potholes

Approach Maintenance

- Guardrail (all bridges)
  - primarily accident damage
  - repair or replace posts, flexbeam, or hardware
  - upgrade standard when repairing
- Drainage (all bridges)
  - remove “windrow” under guardrail
  - eliminate ponding
  - drain water off approach, not onto bridge (undermining of trough drains)
  - seal gaps at wingwalls

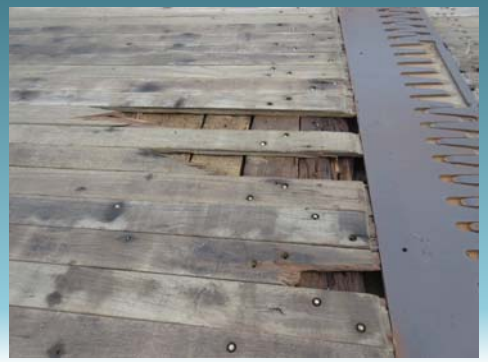
Scour hole in bridge approach caused by flood water erosion. (Battle River Hwy 2)

Superstructure Maintenance

- Wearing surface
  - remove gravel
  - wash where salt or calcium chloride used
  - concrete spalled / scaled
    - patch concrete
    - seal concrete
  - strip deck rotten / holes
    - patch / replace strip deck

Gravel abrasion/worn edges on precast girders.

Missing and broken stripdeck



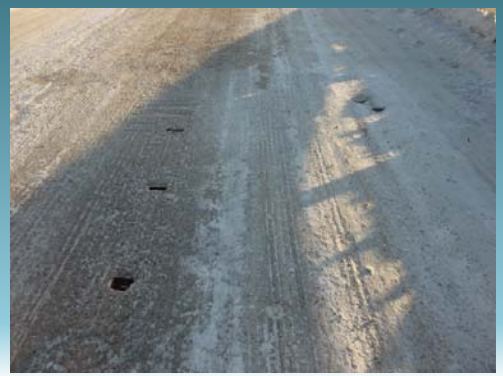
Worn/rotten timber strip deck.

Rotten timber sub-deck.

Superstructure Maintenance (Cont'd)

- Deck
  - subdeck rotten / “punky” nails don’t hold
    - replace subdeck
  - concrete girders worn or abraided
    - concrete or ACP overlay
  - concrete spalled or chipped
    - repair concrete
  - lift pocket grout failing
    - patch / replace

Punch-out in deck of precast girder.



Bottom of punch-out in precast girder.

Superstructure Maintenance

- Deck joints
  - loose or missing buffer angles
    - patch or replace
  - torn / leaking seals
    - repair / replace seals
  - rough joint
    - patch / repair ACP

Superstructure Maintenance

- Deck drainage
  - plugged drains
    - clean (by inspector)
  - deck ponding
    - mark area & arrange for retrofit drains

Ponding water on bridge.

Superstructure Maintenance (Cont'd)

- Curbs and Medians
  - holes in voids
    - patch before winter
  - spalling
    - partial depth repair
  - split, broken wheel guards
    - replace timber and/or hardware

Holes in curb from low cover and plow abrasion.

Partial depth repair to curb and post anchorage

Rotten wheelguard & sub-standard rail.

Superstructure Maintenance (Cont'd)

- Bridge Rail
  - accident damage
    - repair broken concrete
    - replace post and / or rail
  - rotten posts
    - replace
  - corroded posts / rail
    - galvanize or replace
  - when replacing, upgrade to current standard

Missing section of rail and posts

Rotted timber raill

Damaged curb and post anchorage

Damaged posts and rails.

Superstructure Maintenance (Cont'd)

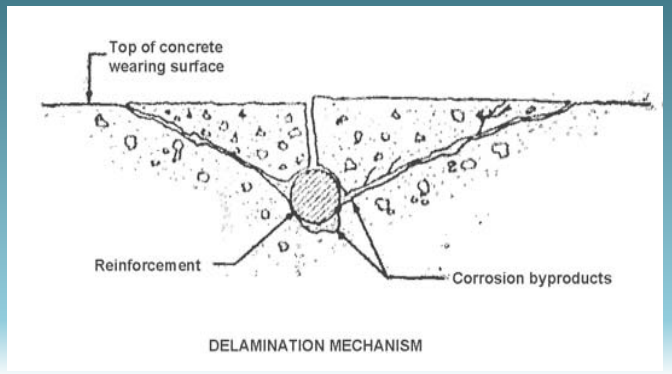
- Girders
  - cracked timbers
    - repair / replace
  - spalled concrete
    - shotcrete repair (do cost benefit)
    - replace stringers
  - girder longitudinal joint connections
    - replace bolts, replace grout
  - lift hook pockets
    - replace grout
  - concrete / ACP overlay (do cost benefit)

Bending crack on timber stringer.

Rotten timber stringer.

Spalled girder legs.

Concrete spalling mechanism by rebar corrosion.



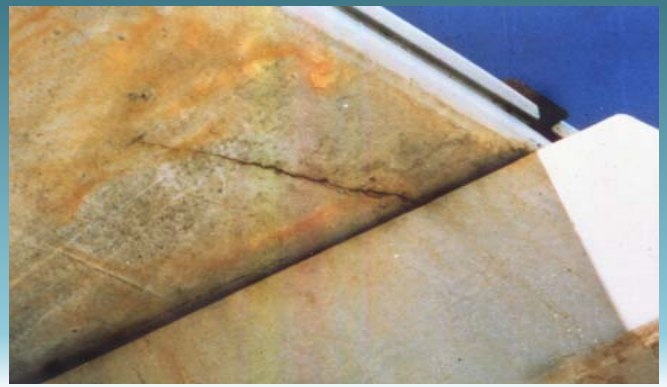
Corrosion cracking on pre-stressed girder underside

Girder being repaired with strand and stirrups exposed but still bonded

Repaired pre-stressed girder

Non-functional bolted connectors.

SM-SC prestressed girder cracks.

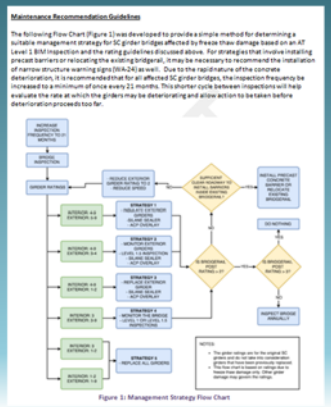


Water Damage to SM Curb Girder - Drilled holes to release trapped water in void

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.

BIM Bulletin 6 – SC Girder Deterioration



Maintenance Recommendation Guidelines

The following Flow Chart (Figure 1) was developed to provide a simple method for determining a suitable management strategy for SC girder bridges affected by freeze thaw damage based on an AT Level 1 BIM inspection and the rating guidelines discussed above. For strategies that involve installing precast barriers or relocating the existing bridgerail, it may be necessary to recommend the installation of narrow structure warning signs (W4-24) as well. Due to the rapid nature of the concrete deterioration, it is recommended that for all affected SC girder bridges, the inspection frequency be increased to a minimum of once every 21 months. This shorter cycle between inspections will help evaluate the rate at which the girders may be deteriorating and allow action to be taken before deterioration proceeds too far.

Figure 1: Management Strategy Flow Chart

Superstructure Maintenance (Cont'd)

- Span alignment
  - not a rated item, if Y then:
    - reset curb (bumped by grader)
    - strut / repair substructure
    - redrive piles
    - shim caps

Vertical misalignment - pier heave

Substructure Maintenance

- Bearing seats / Caps / Corbels
  - Timber
    - sounds hollow, has moss
      - core
    - bulging, end rot, hollow
      - replace
        (consider replacing with steel, depends on age)
    - rolling
      - strut between piles

Substructure Maintenance (Cont'd)

- Concrete
  - spalled
    - patch
  - scaled / stained
    - seal (where salt applied)

Rotten cap on abutment (bulging & crushing).

Pier cap crushing over piles.

Consequence of pier cap failure.

Collapsed girder where cap has failed.

Bottom view of collapsed girder and failed pier cap.

Substructure Maintenance (Cont'd)

- Pier shaft / piles
  - Timber
    - split piles
      - band or replace
    - not bearing
      - shim or redrive
    - rotten or broken
      - replace
    - leaning
      - strut or replace

Substructure Maintenance (Cont'd)

- Pier shaft / piles
  - Steel
    - corroded
      - paint (depending on age)

Settled abutment pile.

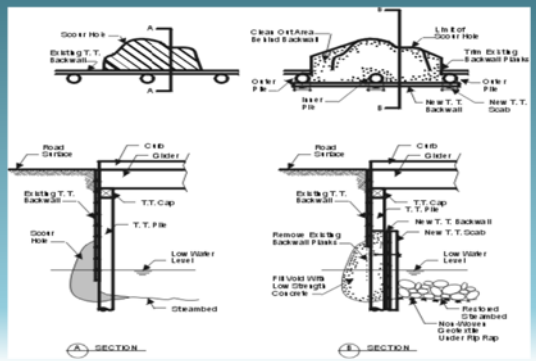
Substructure Maintenance (Cont'd)

- Backwalls and Breastwalls
  - rotten / broken timber sheeting:
    - replace
  - undermined
    - lower backwall sheeting
    - Install breastwall (streamside of piles)
    - place rock rip-rap

Void under abutment seat.

Erosion under abutment seat by improper drainage of headslopes.

Substructure Maintenance (Cont'd)



Breastwall added to repair erosion

Substructure Maintenance (Cont'd)

- Wingwalls
  - piles broken / rotten
    - replace
  - sheeting broken / rotten
    - Replace
  - Damaged tin caps
    - Replace to prevent pile rot

Leaning abutment wingwall.

Substructure Maintenance (Cont'd)

- Bracing / struts / sheathing
  - split or broken
    - replace timber
  - broken connections
    - replace bolts or reweld connection

Substructure Maintenance (Cont'd)

- Nose plate
  - loose
    reconnect
  - not high or low enough
    if a problem, reposition or extend
  - corroded
    usually not a problem – replace if severe

Substructure Maintenance (Cont'd)

- Paint / Coating
  - concrete
    - pressure wash & recoat with sealer
  - steel
    - blast & paint
  - often coating only aesthetic

Substructure Maintenance (Cont'd)

- Abutment / Pier stability
  - can be serious problem
  - if minor
    - strutting may help
    - allow to stabilize (monitor)
  - if serious
    - eventually replace substructure

Substructure Maintenance (Cont'd)

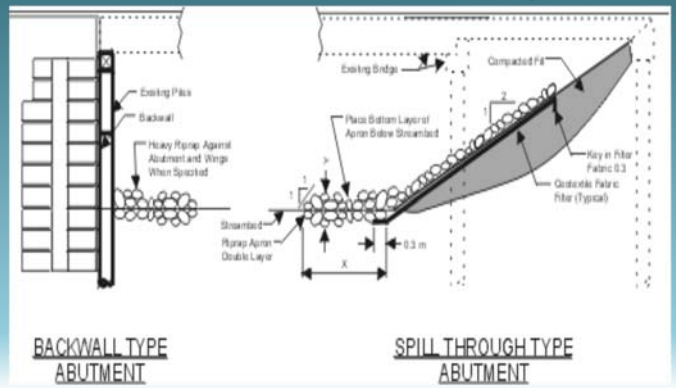
- Scour / Erosion
  - erosion of headslope
    - repair / place rock rip-rap
  - scour at piers
    - fill hole with rock

Headslope erosion, water coming through girder joints.

Headslope erosion due to flood. Trough drains still intact.

Eroded abutment and approach road.

Maintenance of Headslopes



Substructure Maintenance (Cont'd)

- Debris
  - remove and dispose of drift or old piles
  - cut up large drift into 1m lengths

Drift upstream of the bridge.

Channel Maintenance

- Channel alignment
  - poor alignment causing damage or endangering bridge
    - spurs or guidebanks
      (not usual for standard bridges)
    - place bank protection

Spurs to prevent erosion on outside bend.

Channel Maintenance (Cont'd)

- Bank stability
  - sliding or undermining near bridge
    - place rock rip-rap
    - add span/flatten slope
- Drift
  - if a problem
    - remove and dispose or cut up
- Slope protection
  - eroded or scoured
    - repair with rock rip-rap

Channel Maintenance (Cont'd)

- Guidebanks /Spurs
  - eroded or scoured
    - repair with rock rip-rap
- Adequacy of Opening
  - add spans to bridge
  - raise bridge
  - not common

Beaver dam under a timber bridge.

Repair Materials

- Concrete
  - silica-fume concrete
  - fibre reinforced concrete
  - latex modified concrete
  - corrosion-inhibiting concretes

Repair Materials (Cont'd)

- Polymers
  - polymer concretes
  - polymer overlays
- Specialty products
  - patching materials
  - grouts
  - sealers

Approved Products

- Standard testing procedures
- Certified laboratories
- Testing paid by manufacturer
- Approved products list
  - concrete sealers
  - concrete patching & grouting
  - Paints
  - http://www.transportation.alberta.ca/4822.htm

Concrete Sealers

- Type 1a - relatively dry decks RMC ≤55%
- Type 1b - outdoor exposure decks RMC ≤70%
- Type 1c - outdoor exposure decks RMC <80%
- Type 2a - one component coating RMC ≤70%
- Type 2b - two component coating RMC ≤70%
- Type 3 - pigmental coating RMC ≤70%
- http://www.transportation.alberta.ca/689.htm

Concrete Patching Materials

- Type NH
  - poured horizontal patches, 3 day curing
- Type OH-V
  - trowelled overhead or vertical patch
- Type LTH
  - low temperature poured horizontal patch
- Type HEH
  - high early strength poured horizontal patch
  - http://www.transportation.alberta.ca/689.htm

Paints

- Type B2
  - Truss / River / little experience
- Type B3
  - Girder / River / much experience
- Type B5 & B6
  - Freeway / Overpass
- Type 8
  - Submerged pipe piles
  - http://www.transportation.alberta.ca/689.htm