

Bridge Maintenance

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# BRIDGE MAINTENANCE



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## Introduction

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



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## BIM Rating System

BIM RATING SYSTEM

BIM RATING	CONDITION/FUNCTIONALITY	MAINTENANCE PRIORITY
9	NEW CONDITION	NOT APPLICABLE
8	ALMOST NEW	NOT APPLICABLE
7	LITTLE EFFORT TO UPGRADE TO NEW CONDITION	NOT REQUIRED
6	NO DISTRESS OR DETERIORATION CAUSING LOSS OF FUNCTIONALITY	NOT REQUIRED
5	ACCEPTABLE CONDITION AND FUNCTIONING AS INTENDED	NOT REQUIRED TO MAINTAIN FUNCTIONALITY



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## BIM Rating System (Cont'd)

4	BELOW MINIMUM DESIRABLE CONDITION	LOW PRIORITY - NOT LIKELY BEFORE NEXT INSPECTION
3	DISTRESS/DETERIORATION SIGNIFICANTLY AFFECTING FUNCTIONALITY	MEDIUM PRIORITY - REPAIR/REPLACE/REINFORCE IN NEAR FUTURE, BEFORE NEXT INSPECTION
2	MAJOR DETERIORATION AND/OR DISTRESS ENDANGERING FUNCTIONALITY	HIGH PRIORITY - FOR REPLACE/REPAIR/REINFORCE, CONTINUED OBSERVATION REQUIRED UNTIL WORK DONE
1	COLLAPSE IMMINENT/DANGER TO USERS	CLOSE/REPAIR/REINFORCE AND/OR REPLACE AS SOON AS POSSIBLE - IMMEDIATE ACTION REQUIRED



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## Types of Maintenance

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



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





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## 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



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





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Applying concrete sealers to bridge curbs and medians.



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Routine or Minor Maintenance

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

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Routine or Minor Maintenance

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

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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

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## Rehabilitation or Major Maintenance

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



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## Treated Timber Bridge Maintenance Recommendations

Substructure						
Inspector Recommendations	Year	Inspector Comments	Department Comments	Target Year	Est. Cost	Cat #
REPAIR/REPLACE BRIDGE RAIL						
PATCH DECK						
REPLACE STRIP DECK						
REPLACE SUB DECK						
STRAIGHTEN/REPLACE MEMBERS						
WASHING						
CORE TIMBER CAPS/CORBELS						
REPLACE TIMBER CAPS/CORBELS						
REPAIR ABUTMENT SCOUR/EROSION						
PLACE ADDITIONAL RIP RAP						
REMOVE DRIFT ACCUMULATION						
INSTALL STRUTS						
OTHER ACTION						
OTHER ACTION						
OTHER ACTION						
OTHER ACTION						



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## Reinforced Concrete Bridge Maintenance Recommendations

Substructure						
Inspector Recommendations	Year	Inspector Comments	Department Comments	Target Year	Est. Cost	Cat #
REPAIR/REPLACE BRIDGE RAIL						
REPAIR/SEAL CURBS						
PATCH DECK						
OVERLAY DECK						
STRAIGHTEN/REPLACE MEMBERS						
WASHING						
SHOTCRETE REPAIRS						
CORE TIMBER CAPS/CORBELS						
REPLACE TIMBER CAPS/CORBELS						
REPAIR ABUTMENT SCOUR/EROSION						
PLACE ADDITIONAL RIP RAP						
REMOVE DRIFT ACCUMULATION						
INSTALL STRUTS						
OTHER ACTION						
OTHER ACTION						
OTHER ACTION						
OTHER ACTION						



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## 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



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**Approach bump and potholes**



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**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

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



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**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

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Gravel abrasion/worn edges on precast girders.



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Missing and broken stripdeck



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Worn/rotten timber strip deck.



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Rotten timber sub-deck.



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## Superstructure Maintenance (Cont'd)

- Deck
  - subdeck rotten / “punky” nails don’t hold
    - replace subdeck
  - concrete girders worn or abraded
    - 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

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## Superstructure Maintenance

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



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## Ponding water on bridge.





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## 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



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## Holes in curb from low cover and plow abrasion.





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Partial depth repair to curb and post anchorage







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Rotten wheelguard & sub-standard rail.










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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

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Missing section of rail and posts







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**Rotted timber rail**



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**Damaged curb and post anchorage**



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**Damaged posts and rails.**



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**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)

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**Bending crack on timber stringer.**



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**Rotten timber stringer.**



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**Spalled girder legs.**



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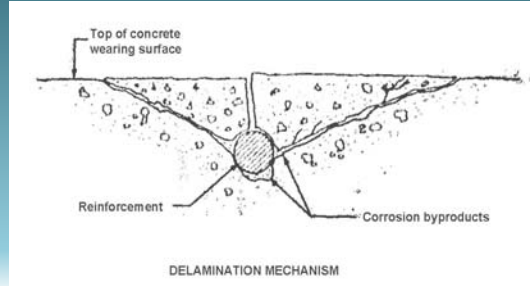


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**Concrete spalling mechanism by rebar corrosion.**




DELAMINATION MECHANISM

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Corrosion cracking on pre-stressed girder underside



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Girder being repaired with stand and stirrups exposed but still bonded



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Repaired pre-stressed girder



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Non-functional bolted connectors.



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SM-SC prestressed girder cracks.



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Frost damage to an SM curb girder.  
(Teepee Creek Hwy 34)



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Superstructure Maintenance  
(Cont'd)

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

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Vertical misalignment - pier heave



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## 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

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## Substructure Maintenance (Cont'd)


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

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### Rotten cap on abutment (bulging & crushing).




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### Pier cap crushing over piles.




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Consequence of pier cap failure.



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Collapsed girder where cap has failed.



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Bottom view of collapsed girder and failed pier cap.



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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

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## Substructure Maintenance (Cont'd)


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

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## Settled abutment pile.




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## 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

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## Void under abutment seat.





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Erosion under abutment seat by improper drainage of headslopes.





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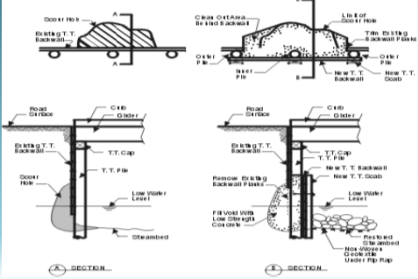



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Substructure Maintenance  
(Cont'd)





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Breastwall added to repair erosion





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Substructure Maintenance  
(Cont'd)

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



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## 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


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## 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

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## Substructure Maintenance (Cont'd)


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

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### Headslope erosion, water coming through girder joints.




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### Headslope erosion due to flood. Trough drains still intact.




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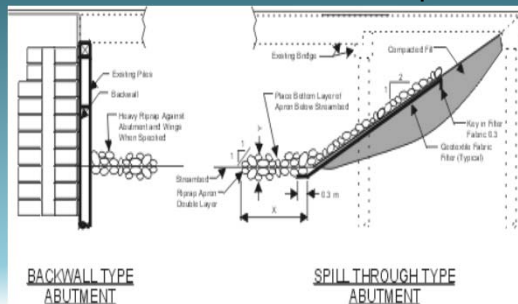


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Eroded abutment and approach road.



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.




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## Channel Maintenance


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

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## Spurs to prevent erosion on outside bend.





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## 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

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## 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

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Beaver dam under a timber bridge.



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## Repair Materials

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

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## Repair Materials (Cont'd)

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

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## 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>

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## Concrete Sealers

- Type 1a - relatively dry decks RMC  $\leq 55\%$
- Type 1b - outdoor exposure decks RMC  $\leq 70\%$
- Type 1c - outdoor exposure decks RMC  $< 80\%$
- Type 2a - one component coating RMC  $\leq 70\%$
- Type 2b - two component coating RMC  $\leq 70\%$
- Type 3 - pigmental coating RMC  $\leq 70\%$
- <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>