

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

Rating		Commentary	Maintenance Priority
9	Very Good	New condition.	No repairs in foreseeable future.
8		Almost new conditions.	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.



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BIM Rating System (Cont'd)

Rating		Commentary	Maintenance Priority
4	Fair	Below minimum acceptable conditions.	Low priority for repairs.
3	Poor	Presence of distress or deterioration. Not functioning as intended.	Medium priority for replacement, repair, and/or signing.
2	Hazardous	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 at this bridge.	



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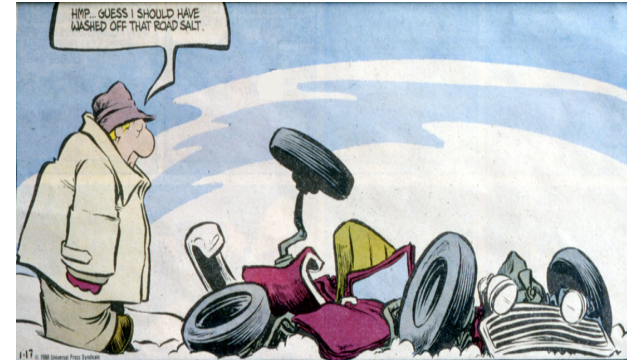
Types of Maintenance

- 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 curb



Confirm moisture content in concrete prior to application of sealer using a moisture meter

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Applying concrete sealers to bridge curb



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Freshly Patched and Sealed Concrete Curb



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Routine or Minor Maintenance

- Correct reductions in condition or functionality of bridge elements Primarily "patch up" work
- Generally low cost
- Examples:
 - patch concrete
 - patch strip deck
 - repair bridge rail
 - scour / erosion
 - replace signs
 - replace seals

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



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Treated Timber Bridge Maintenance Recommendations

Completed Work		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 - 75 x 305 x 3M CCA Planks	
REPLACE STRIP DECK			2024			
REPLACE SUB DECK						
STRAIGHTEN/REPLACE MEMBERS			2017		Replace T.T. string sp. 2-54 (150 x 400 x 61)	
WASHING						
CORE TIMBER CAPS/CORBELS			2017		Caps and piles	
REPAIR/REPLACE TIMBER CAPS			2017		As required after coring	
REPAIR ABUTMENT SCOUR/EROSION			2017		At handstop - 20 m ² rip rap	
PLACE ADDITIONAL RIP RAP			2017		At handstop - 30 m ² CL Riprap	
REMOVE DRIFT ACCUMULATION						
INSTALL STRUTS						

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



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Reinforced Concrete Bridge Maintenance Recommendations

Completed Work		Status	Rec. Year	Target Year	Inspector Comments	Department Comments
CONCRETE GIRDER INSPECTION			2017		Replace 3 hexhead nails	
REPAIR/REPLACE BRIDGE RAIL			2017			
SEAL CURBS			2017		Approx. 1.5 m ² P.B. repair	
PATCH DECK						
SEAL DECK						
OVERLAY DECK						
REPAIR/REPLACE DECK JOINTS			2017		Tin cap at sub wing pile	
STRAIGHTEN/REPLACE MEMBERS			2017			
WASHING			2017		Caps and piles	
CORE TIMBER CAPS/CORBELS						
REPAIR/REPLACE TIMBER CAPS						
REPAIR ABUTMENT SCOUR/EROSION			2017		30 m ² C.I. at A2 handstop	
PLACE ADDITIONAL RIP RAP			2017		At P2	
REMOVE DRIFT ACCUMULATION						
INSTALL STRUTS						

Structural Condition Rating (Last Now)	/	Sufficiency Rating (Last Now)	/	Est. Repl. Yr	2026	Maint. Rest. (Y/N)	Yes
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Approach Road Maintenance

- Horizontal & Vertical alignment rated for functionality not condition (do not require maintenance recommendations)
- 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

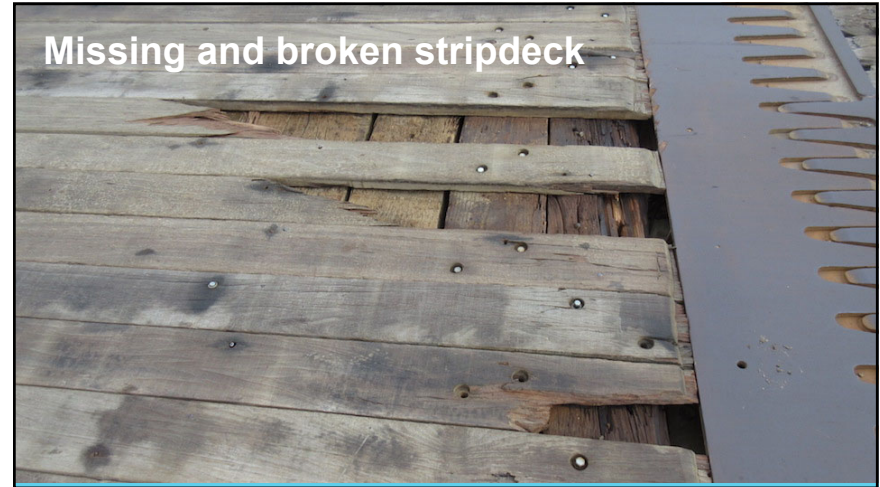
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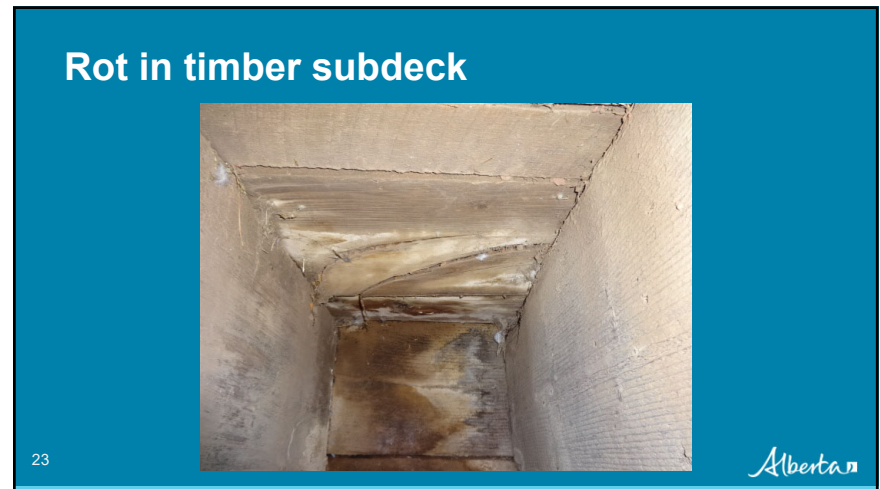
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Superstructure Maintenance (Cont'd)

- Deck
 - subdeck rotten / "punky" nails don't hold
 - replace subdeck
 - concrete girders worn or abraded
 - concrete repairs
 - concrete or ACP overlay
 - concrete spalled or chipped
 - repair concrete
 - Lift or connector pocket grout failing
 - patch / replace

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Punch-out at lift pocket in
deck of precast girder.

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Underside of punch-out in precast girder.

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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/open during spring washing (also done on site by inspector)
 - deck ponding
 - mark area & arrange for retrofit drains

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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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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, recommend considering upgrade to current standard

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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
 - replace
 - spalled concrete
 - Partial or full depth repair
 - replace select girders
 - girder longitudinal joint connections
 - replace bolts, replace grout
 - lift hook pockets
 - replace grout
 - concrete / ACP overlay

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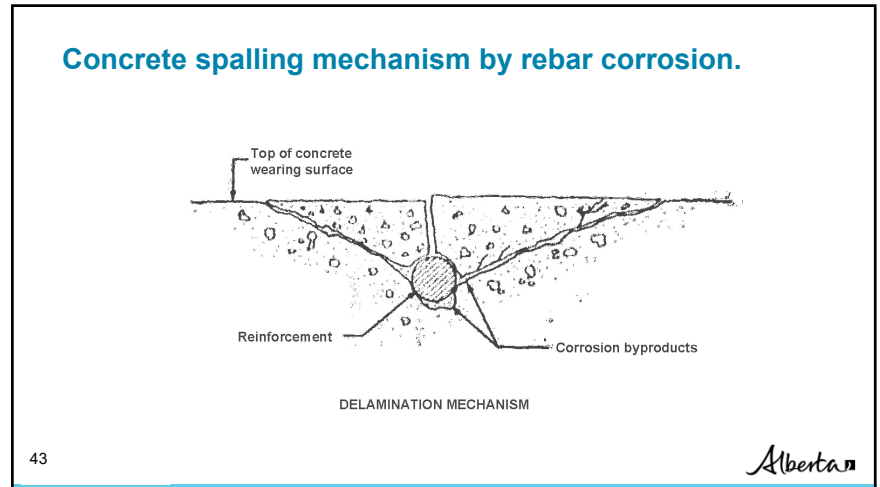
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Corrosion cracking on pre-stressed girder underside



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Girder being repaired with strand and stirrups exposed but still bonded



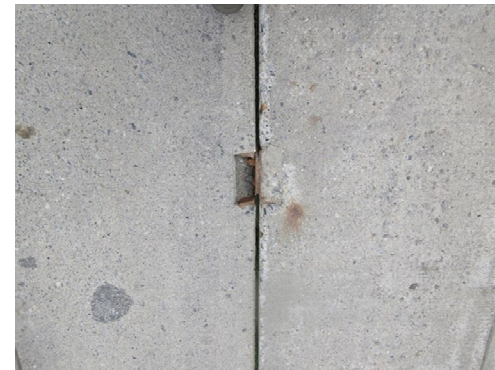
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Repaired pre-stressed girder



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Failed bolted connector



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Wide Cracks with Corrosion Staining in Prestressed Girder

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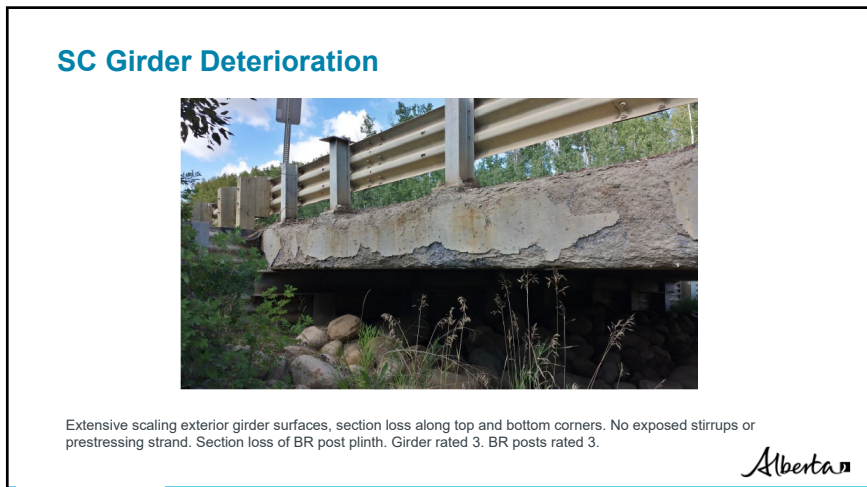


Water Damage to SM Curb Girder - Drilled holes to release trapped water in void

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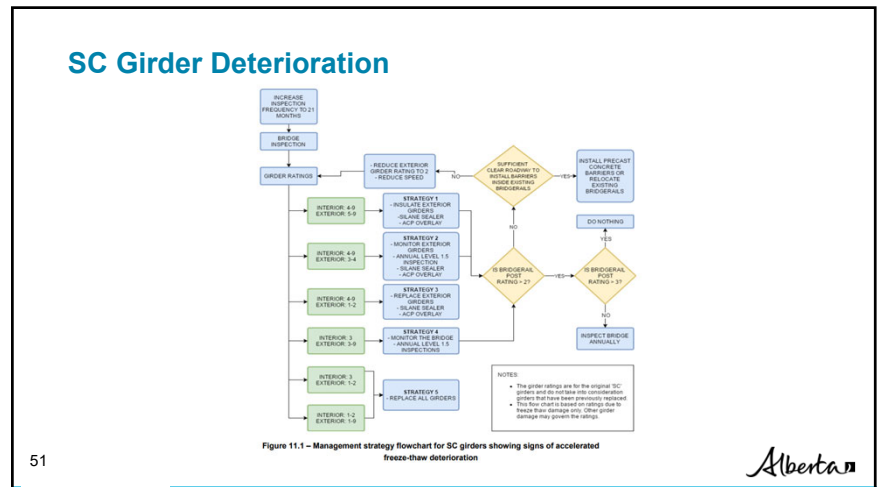


SC Girder Deterioration

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.

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SC Girder Deterioration

Figure 11.1 - Management strategy flowchart for SC girders showing signs of accelerated freeze-thaw deterioration

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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 un-supported caps

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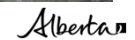


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Vertical misalignment - pier heave



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Substructure Maintenance

Bearing seats / Caps

- Timber
 - sounds hollow, suspect rot
 - 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
 - partial or full depth repair with product from approved list
 - scaled / stained
 - clean and seal (where salt applied)



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Substructure Maintenance (Cont'd)

- Steel
 - Corrosion and / or section loss
 - paint or possible replace
 - Damaged galvanized coating (new piles)
 - field metalize damaged areas
 - touch up with 2 brush coats of zinc rich paint.

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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
 - rotten or broken
 - repair with steel splice (shown)
 - leaning
 - strut or replace



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Substructure Maintenance (Cont'd)

- Pier shaft / piles
 - Steel
 - paint loss / corrosion
 - paint (age dependent)



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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 due to fill settlement



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Erosion under backwall sheathing – not low enough



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Breastwall added to repair erosion / undermining



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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.



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Rebuilt wingwall with concrete lock-blocks



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Substructure Maintenance (Cont'd)

- Bracing / struts / sheathing
 - split or broken
 - replace timber
 - broken connections
 - replace bolts or reweld connection (steel bracing)

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Substructure Maintenance (Cont'd)

- Nose plate
 - loose
 - reconnect
 - not high or low enough
 - reposition or extend
 - corroded
 - re-coat – replace if severe

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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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Erosion Gully in Headslope



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Headslope erosion in flood



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Headslope rebuilt



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Eroded abutment and approach road.

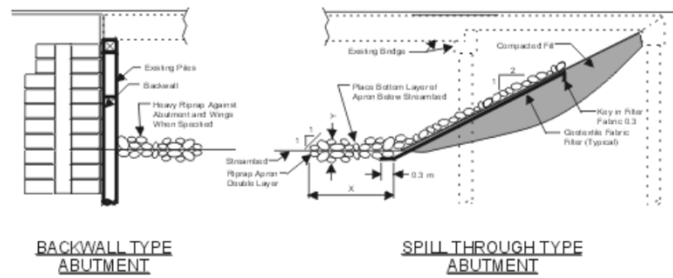


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Maintenance of Headslopes



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Substructure Maintenance (Cont'd)

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

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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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Extended guidebank to contain and direct flow



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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 on standard bridges

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Beaver dam under a timber bridge.



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Table 11.1 Maintenance Work Types – Bridges & Culverts

LEVEL 1 INSPECTION	CORE TIMBER CAPS/CORBELS
CONCRETE DECK INSPECTION	REPAIR/REPLACE TIMBER CAPS
CONCRETE GIRDER INSPECTION	REPAIR ABUTMENT SCOUR/EROSION
VERTICAL CLEARANCE MEASUREMENT	PLACE ADDITIONAL RIP RAP
CHLORIDE TESTING	REMOVE DRIFT ACCUMULATION
COPPER SULPHATE ELECTRODE TESTING	INSTALL CATHODIC PROTECTION
PAINT INSPECTION	INSTALL CONCRETE/STEEL LINING
STEEL CULVERT BARREL MEASUREMENT	INSTALL STRUTS
SPECIAL STRUCTURE MONITOR	INSTALL CONCRETE COLLAR/CUTOFF
ULTRASONIC TRUSS INSPECTION	REPAIR SEAMS
SCOUR SURVEY INSPECTION	OBTAIN CORROSION ANALYSIS DATA
REPAIR/REPLACE BRIDGERAIL	REPAIR/REPLACE SIGNING
GALVANIZE/PAINT BRIDGERAIL	PATCH/REPAIR ACCESS PLATFORM
RETROFIT BRIDGERAIL	ADJUST/PAINT PEDESTAL BEARING AREA
SEAL CURBS	OTHER ACTION
PATCH DECK	REPAIR/REPLACE TIMBER CORBELS
SEAL DECK	REPAIR/REPLACE TIMBER PILES
OVERLAY DECK	LOAD POST BRIDGE
REPAIR/REPLACE DECK JOINTS	REPLACE MEMBERS
REPLACE STRIP DECK	STRAIGHTEN MEMBERS
REPLACE SUB DECK	REPAIR MEMBERS
RESET/PAINT BEARINGS	INSTALL BOLTS
REPAINT SUPERSTRUCTURE	REPAIR BEARINGS
STRAIGHTEN/REPLACE MEMBERS	CRACK REPAIRS/TREATMENT
WASHING	PATCH CURBS/PARPETS
FILL BOLT HOLES	REPAIR STRUTS
SHOTCRETE REPAIRS	REPLACE CULVERT

Table 11.1 – Maintenance work types

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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
 - concrete patching materials (commonly used for standard bridge repairs)
 - 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/planningtools/GMS/ProductList/Product%20List%20Index.pdf>

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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/PlanningTools/GMS/ProductList/BridgeConcreteSealerList.pdf>

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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/PlanningTools/GMS/ProductList/patchinglist.pdf>

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Bridge Coating Systems

- 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/PlanningTools/GMS/ProductList/ApprovedBridgeCoatingSystemsPaint.pdf>

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Questions?



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