



Bridge Maintenance

BRIDGE MAINTENANCE




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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.




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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.



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BIM Rating System (Cont'd)

4		Below minimum acceptable condition.	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 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




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Types of Maintenance

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



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Bridge Inspection and Maintenance

Bridge Maintenance

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





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Bridge Inspection and Maintenance

Bridge Maintenance


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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Bridge Inspection and Maintenance

Bridge Maintenance

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





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Bridge Inspection and Maintenance

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Applying concrete sealers to bridge curbs and medians.



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Bridge Maintenance

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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Bridge Maintenance

Treated Timber Bridge Maintenance Recommendations

Maintenance Recommendations						
Work Type	Status	Req. Year	Target Year	Inspector Comments	Department Comments	
REPAIR/REPLACE BRIDGE RAIL		2017		2 - 150 x 200 x 1.5 CGP Posts		
PATCH DECK		2017		12 - 25 x 200 x 30M OCA Panels		
REPLACE STRIP DECK		2024				
REPLACE SUB DECK						
STRAIGHTEN/REPLACE MEMBERS		2017		Replace T.T. stringer Sp. 2-54 (150 x 400 x 8.1)		
WASHERS						
CORR. TIMBER CAPS/CORNELS		2017		Caps and piles		
REPAIR/REPLACE TIMBER CAPS		2017		As required after coring		
REPAIR ABUTMENT SCOUR/EROSION		2017		All bankslope = 30 m ² pit. Pile		
PLACE ADDITIONAL RIP RAP		2017		All bankslope = 30 m ² rip. Pile		
REMOVE DRIFT ACCUMULATION		2017		All bankslope = 30 m ² rip. Pile		
INSTALL BRUTE						



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Bridge Maintenance

Reinforced Concrete Bridge Maintenance Recommendations

Maintenance Recommendations						
Work Type	Status	Req. Year	Target Year	Inspector Comments	Department Comments	
CONCRETE GIRDER INSPECTION						
REPAIR/REPLACE BRIDGE RAIL		2017		Replace 3 & 4 broken rails		
SEAL CURBS		2017		Approx. 1.5 m ² P.D. Repair		
PATCH DECK		2017				
SEAL DECK						
OVERLAY DECK						
REPAIR/REPLACE DECK JOINTS		2017		Tin cap at steel string pile		
STRAIGHTEN/REPLACE MEMBERS		2017				
WASHERS		2017				
CORR. TIMBER CAPS/CORNELS		2017		Caps and piles		
REPAIR/REPLACE TIMBER CAPS						
REPAIR ABUTMENT SCOUR/EROSION		2017		30 m ² C.I. at RR bankslope		
PLACE ADDITIONAL RIP RAP		2017		At RR		
REMOVE DRIFT ACCUMULATION		2017				
INSTALL BRUTE						



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Bridge Maintenance

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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Bridge Maintenance


Approach bump and potholes



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Bridge Maintenance


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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Bridge Maintenance


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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Bridge Maintenance

Gravel abrasion/worn edges on precast girders.



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Bridge Maintenance

Missing and broken stripdeck



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Bridge Maintenance


Worn/rotten timber strip deck.



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Bridge Maintenance


Rotten timber sub-deck.



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Superstructure Maintenance (Cont'd)

- Deck
 - subdeck rotten / “punk” 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




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Bridge Maintenance


Punch-out in deck of precast girder.






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Bridge Maintenance


Bottom of punch-out in precast girder.





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Bridge Maintenance


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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Bridge Maintenance

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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Bridge Maintenance


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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Bridge Maintenance


Holes in curb from low cover and plow abrasion.



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Bridge Maintenance

Partial depth repair to curb and post anchorage






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Bridge Maintenance

Rotten wheelguard & sub-standard rail.





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Bridge Maintenance

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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Bridge Maintenance

Missing section of rail and posts



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Bridge Maintenance

Rotted timber rail




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Bridge Maintenance

Damaged curb and post anchorage



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Bridge Maintenance

Damaged posts and rails.



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Bridge Maintenance

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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Bridge Maintenance


Bending crack on timber stringer.



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Bridge Maintenance

Rotten timber stringer.



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Bridge Maintenance

Spalled girder legs.



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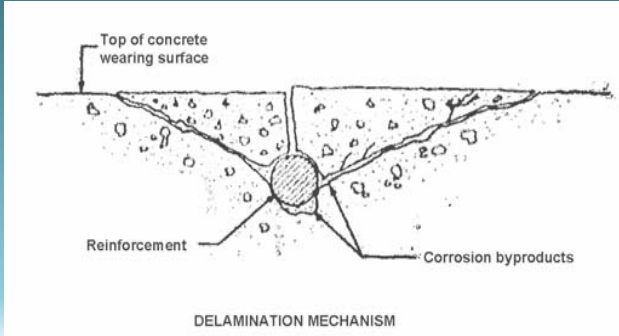
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Concrete spalling mechanism by rebar corrosion.




DELAMINATION MECHANISM

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Bridge Maintenance


Corrosion cracking on pre-stressed girder underside



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Bridge Inspection and Maintenance

Bridge Maintenance

Girder being repaired with strand and stirrups exposed but still bonded



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Bridge Inspection and Maintenance

Bridge Maintenance

Repaired pre-stressed girder



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Bridge Inspection and Maintenance

Bridge Maintenance


Non-functional bolted connectors.



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Bridge Inspection and Maintenance

Bridge Maintenance

SM-SC prestressed girder cracks.





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Bridge Maintenance

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






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Superstructure Inspection and Rating




Bulletin 6 (DRAFT) – 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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Bridge Maintenance

BIM Bulletin 6 (DRAFT) – SC Girder Deterioration

Maintenance Recommendation Guidelines

The following Flow Chart (Figure 3) was developed to provide a simple method for determining a suitable management strategy for SC girder bridges affected by these types of damage based on an all Level 2 BIM inspection and the rating guidelines discussed above. For strategies that involve installing guard barriers or relocating the existing bridge, it may be necessary to recommend the installation of new structure warning signs to be 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 2.5 months. This greater work 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.

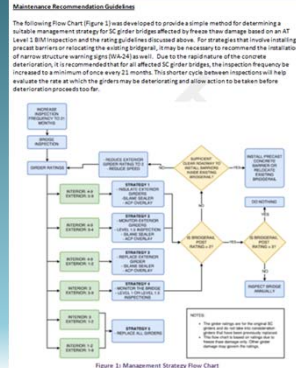




Figure 3: Management Strategy Flow Chart



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Bridge Maintenance


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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Bridge Inspection and Maintenance

Bridge Maintenance


Vertical misalignment - pier heave





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Bridge Inspection and Maintenance

Bridge Maintenance


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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Bridge Inspection and Maintenance

Bridge Maintenance


Substructure Maintenance (Cont'd)

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



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Bridge Inspection and Maintenance

Bridge Maintenance

Rotten cap on abutment (bulging & crushing).



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Bridge Maintenance

Pier cap crushing over piles.



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Bridge Maintenance


Consequence of pier cap failure.



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Bridge Maintenance


Collapsed girder where cap has failed.



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Bridge Maintenance

Bottom view of collapsed girder and failed pier cap.



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Bridge Inspection and Maintenance

Bridge Maintenance


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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Bridge Inspection and Maintenance

Bridge Maintenance


Substructure Maintenance (Cont'd)

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

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Bridge Inspection and Maintenance

Bridge Maintenance

Settled abutment pile.



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Bridge Inspection and Maintenance

Bridge Maintenance


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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Bridge Inspection and Maintenance

Bridge Maintenance


Void under abutment seat.





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Bridge Inspection and Maintenance

Bridge Maintenance


Erosion under abutment seat by improper drainage of headlopes.





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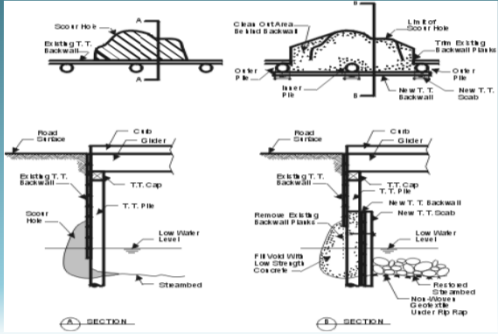
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Bridge Inspection and Maintenance

Bridge Maintenance


Substructure Maintenance (Cont'd)





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Bridge Inspection and Maintenance

Bridge Maintenance

Breastwall added to repair erosion





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Bridge Maintenance

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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Bridge Maintenance

Leaning abutment wingwall.





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Bridge Maintenance

Substructure Maintenance (Cont'd)


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

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Bridge Maintenance

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



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Bridge Inspection and Maintenance

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Bridge Maintenance

Substructure Maintenance (Cont'd)

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



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Bridge Inspection and Maintenance

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Bridge Maintenance

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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Bridge Inspection and Maintenance

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Bridge Maintenance

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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Bridge Inspection and Maintenance

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Bridge Maintenance


Headslope erosion, water coming through girder joints.



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Bridge Maintenance


Headslope erosion due to flood. Trough drains still intact.



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Bridge Maintenance

Eroded abutment and approach road.



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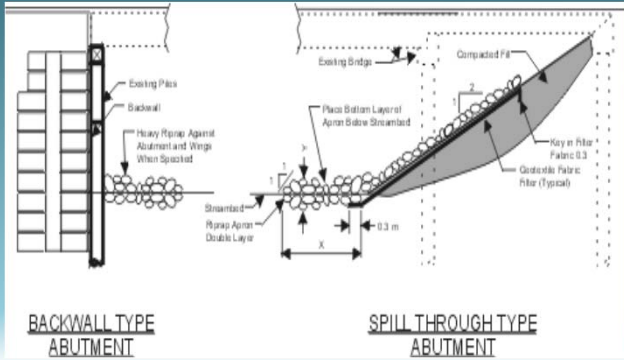


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Bridge Maintenance


Maintenance of Headslopes



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Bridge Maintenance

Substructure Maintenance (Cont'd)

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

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Bridge Maintenance

Drift upstream of the bridge.





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Bridge Maintenance


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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Bridge Maintenance

Spurs to prevent erosion on outside bend.





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Bridge Maintenance

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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Bridge Maintenance

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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Bridge Maintenance

Beaver dam under a timber bridge.





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Bridge Maintenance

Repair Materials


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

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Bridge Maintenance

Repair Materials (Cont'd)

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



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Bridge Maintenance

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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Bridge Maintenance

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	



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Bridge Maintenance

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>



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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>