


Bridge Maintenance

BRIDGE MAINTENANCE




Technical Standards Branch
Class B Bridge Inspection Course




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.




Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance

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.



Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


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




Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance


Types of Maintenance

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



4

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

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





5

Technical Standards Branch
Class B Bridge Inspection Course




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



6

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

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





7

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

Applying concrete sealers to bridge curbs and medians.



8



Technical Standards Branch
Class B Bridge Inspection Course

Bridge Maintenance

Routine or Minor Maintenance

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

9



Technical Standards Branch
Class B Bridge Inspection Course

Bridge Maintenance

Routine or Minor Maintenance

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

10



Technical Standards Branch
Class B Bridge Inspection Course

Bridge Maintenance

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


11

Technical Standards Branch
Class B Bridge Inspection Course


Bridge Maintenance

Rehabilitation or Major Maintenance

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



Technical Standards Branch
Class B Bridge Inspection Course




12


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/CORNELLS		2017		Caps and piles		
REPAIR/REPLACE TIMBER CAPS		2017		As required after coring		
REPAIR ABUTMENT SCOUR/PROSPION		2017		All bankslope = 30 m ² pit. Pile		
PLACE ADDITIONAL RIP RAP		2017		All bankslope 30 m ² SL Bank		
REMOVE DRIFT ACCUMULATION						
INSTALL STRUTS						



Technical Standards Branch
Class B Bridge Inspection Course




13


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				
PATCH DECK		2017		Approx. 1.5 m ² P.D. Repair		
SEAL DECK						
OVERLAY DECK						
REPAIR/REPLACE DECK JOINTS		2017		Tin cap at sub. pier pile		
STRAIGHTEN/REPLACE MEMBERS		2017				
WASHERS		2017				
CORR. TIMBER CAPS/CORNELLS		2017		Caps and piles		
REPAIR/REPLACE TIMBER CAPS						
REPAIR ABUTMENT SCOUR/PROSPION		2017		20m ² C.I. at RR bankslope		
PLACE ADDITIONAL RIP RAP		2017		At RR		
REMOVE DRIFT ACCUMULATION						
INSTALL STRUTS						



Technical Standards Branch
Class B Bridge Inspection Course




14


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




Technical Standards Branch
Class B Bridge Inspection Course




15

Bridge Maintenance


Approach bump and potholes



16



Technical Standards Branch
Class B Bridge Inspection Course




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

17




Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


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



18



Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


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

19



Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Gravel abrasion/worn edges on precast girders.



20

Technical Standards Branch
Class B Bridge Inspection Course

Bridge Maintenance

Missing and broken stripdeck




21



Technical Standards Branch
Class B Bridge Inspection Course

Bridge Maintenance

Worn/rotten timber strip deck.




22



Technical Standards Branch
Class B Bridge Inspection Course

Bridge Maintenance

Rotten timber sub-deck.




23

Technical Standards Branch
Class B Bridge Inspection Course

Bridge Maintenance


Superstructure Maintenance (Cont'd)

- Deck
 - subdeck rotten / “punkny” 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




24


Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance


Punch-out in deck of precast girder.






25


Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance


Bottom of punch-out in precast girder.





26


Technical Standards Branch
Class B Bridge Inspection Course



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



27



Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Superstructure Maintenance

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

28  Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Ponding water on bridge.





29  Technical Standards Branch
Class B Bridge Inspection Course 

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

30  Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Holes in curb from low cover and plow abrasion.



31  Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Partial depth repair to curb and post anchorage



32




Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


Rotten wheelguard & sub-standard rail.



33



Technical Standards Branch
Class B Bridge Inspection Course




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

34




Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


Missing section of rail and posts



35



Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Rotted timber rail




36

 Technical Standards Branch
Class B Bridge Inspection Course





Bridge Maintenance

Damaged curb and post anchorage



37

 Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Damaged posts and rails.



38

 Technical Standards Branch
Class B Bridge Inspection Course





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)


39

 Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance


Bending crack on timber stringer.



40

Alberta
Transportation


Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance


Rotten timber stringer.



41

Alberta
Transportation

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

Spalled girder legs.



42

Alberta
Transportation

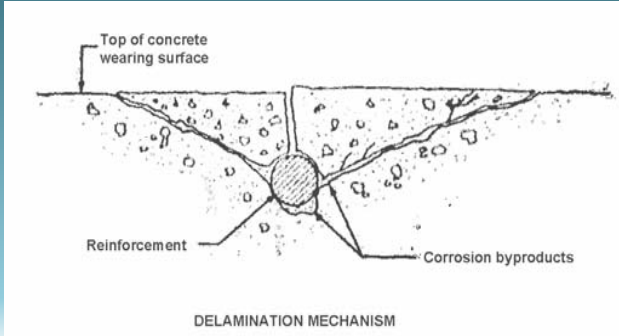
Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

Concrete spalling mechanism by rebar corrosion.




DELAMINATION MECHANISM

43

Alberta
Transportation


Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance


Bridge Maintenance

Corrosion cracking on pre-stressed girder underside



44

 Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Girder being repaired with strand and stirrups exposed but still bonded




45

 Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Repaired pre-stressed girder




46

 Technical Standards Branch
Class B Bridge Inspection Course





Bridge Maintenance

Non-functional bolted connectors.



47

 Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

SM-SC prestressed girder cracks.





Technical Standards Branch
Class B Bridge Inspection Course



48

Bridge Maintenance

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






Technical Standards Branch
Class B Bridge Inspection Course




49

Superstructure Inspection and Rating



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.



Technical Standards Branch
Class B Bridge Inspection Course



50

Bridge Maintenance

BIM Bulletin 6 – 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 from a minimum of once every 24 months. This greater risk 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.

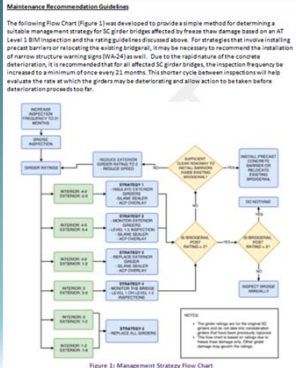




Figure 3: Management Strategy Flow Chart



Technical Standards Branch
Class B Bridge Inspection Course



51

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

52

Vertical misalignment - pier heave



53

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

54

Substructure Maintenance (Cont'd)

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

55

Bridge Maintenance

Rotten cap on abutment (bulging & crushing).



56

Alberta
Transportation

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Pier cap crushing over piles.



57


Alberta
Transportation

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance


Consequence of pier cap failure.



58


Alberta
Transportation

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance


Collapsed girder where cap has failed.



59


Alberta
Transportation

Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


Bottom view of collapsed girder and failed pier cap.



60



Technical Standards Branch
Class B Bridge Inspection Course




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

61



Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance

Bridge Maintenance


Substructure Maintenance (Cont'd)

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

62



Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

Settled abutment pile.



63



Technical Standards Branch
Class B Bridge Inspection Course




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



64


Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

Void under abutment seat.





65


Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance

Bridge Maintenance


Erosion under abutment seat by improper drainage of headlopes.





66

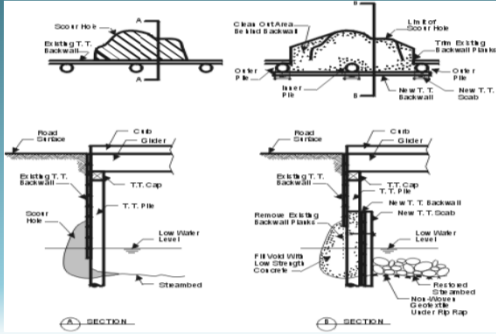
Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance

Bridge Maintenance


Substructure Maintenance (Cont'd)





67

Technical Standards Branch
Class B Bridge Inspection Course



Bridge Inspection and Maintenance

Bridge Maintenance

Breastwall added to repair erosion





 Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Substructure Maintenance (Cont'd)

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

 69 Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Leaning abutment wingwall.





 70 Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Substructure Maintenance (Cont'd)


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

 71 Technical Standards Branch
Class B Bridge Inspection Course 

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



72

Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance

Bridge Maintenance


Substructure Maintenance (Cont'd)

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



73

Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance

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



74

Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance

Bridge Maintenance


Substructure Maintenance (Cont'd)

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



75

Technical Standards Branch
Class B Bridge Inspection Course




Bridge Inspection and Maintenance

Bridge Maintenance


Headslope erosion, water coming through girder joints.



76




Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


Headslope erosion due to flood. Trough drains still intact.



77



Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Eroded abutment and approach road.



78

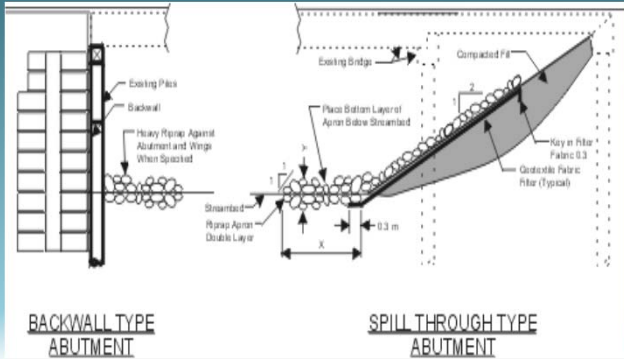


Technical Standards Branch
Class B Bridge Inspection Course




Bridge Maintenance


Maintenance of Headslopes



79





Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance

Substructure Maintenance (Cont'd)

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

80  Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Drift upstream of the bridge.





81  Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance


Channel Maintenance



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

82  Technical Standards Branch
Class B Bridge Inspection Course 

Bridge Maintenance

Spurs to prevent erosion on outside bend.




83  Technical Standards Branch
Class B Bridge Inspection Course 


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



Technical Standards Branch
Class B Bridge Inspection Course




84


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



Technical Standards Branch
Class B Bridge Inspection Course



85

Bridge Maintenance

Beaver dam under a timber bridge.





Technical Standards Branch
Class B Bridge Inspection Course




86


Bridge Maintenance

Repair Materials

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



Technical Standards Branch
Class B Bridge Inspection Course




87

Bridge Maintenance


Repair Materials (Cont'd)

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



88

Technical Standards Branch
Class B Bridge Inspection Course



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>



89


Technical Standards Branch
Class B Bridge Inspection Course



Bridge Maintenance


Concrete Sealers

<ul style="list-style-type: none"> • Type 1a • Type 1b • Type 1c • Type 2a • Type 2b • Type 3 	<ul style="list-style-type: none"> - relatively dry decks - outdoor exposure decks - outdoor exposure decks - one component coating - two component coating - pigmental coating - http://www.transportation.alberta.ca/689.htm 	<ul style="list-style-type: none"> RMC \leq55% RMC \leq70% RMC $<$80% RMC \leq70% RMC \leq70% RMC \leq70%
---	--	--



90


Technical Standards Branch
Class B Bridge Inspection Course



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>



91

Technical Standards Branch
Class B Bridge Inspection Course



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>