Welcome

Class B Bridge Inspection Course
Twin Atria, Edmonton, AB
August 29 – September 2, 2016

Course Instructors

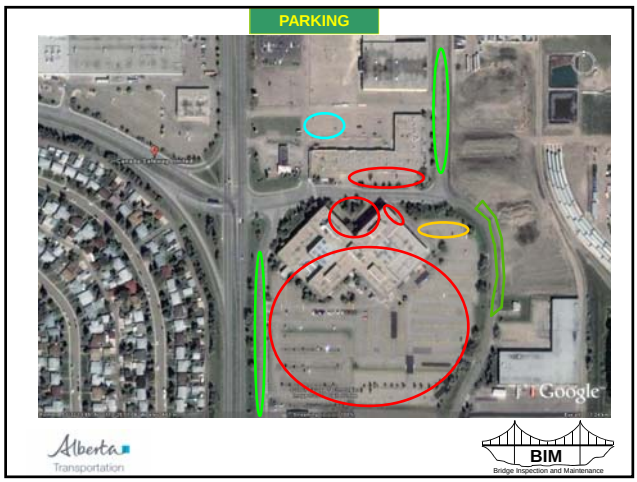
- Trainers
  - Randy Bredo
  - Garry Roberts
- Guest Lecturers
  - AT staff - Caroline Watt, Matt Spratlin, Dave Besuyen, Bryan Wai.
  - Ted Belke, Reg Quinton, Abdul Waheed
- Refer to Course Schedule

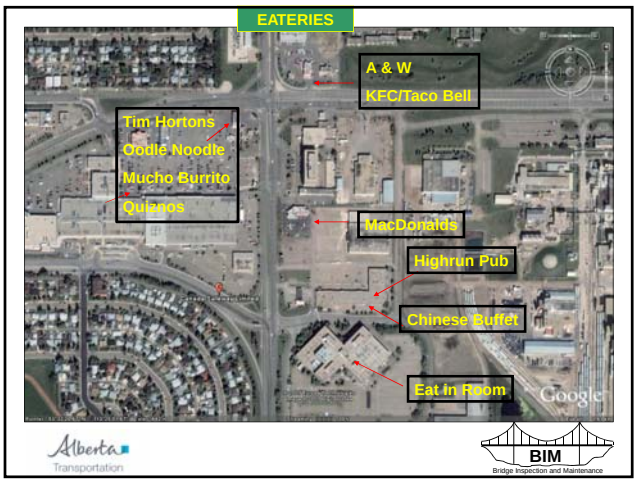
General Information

- Emergency Protocol
- Washrooms
- Room Access
  - Opens at 7:30 am
  - Locked at 5:00 pm
  - Open at lunch
  - Computers
- Smoking
  - At designated locations only - minimum 30 ft from building entrances

General Information (cont'd)

- Registration and Payment
- Note Taking & Course Materials
- Course Evaluation must be completed





Self Introduction

- Name
- Organization
- Present or Proposed Involvement with Bridges
- Fill out Name Tag/Placeholder

BIM Inspector Training

****Alberta Transportation Requires All BIM course participants to self register for TIMS/BIS application for certification tracking purposes****

https://extranet.inftra.gov.ab.ca/inftra_login.html

https://extranet.inftra.gov.ab.ca/Self_Registration_Guide_to_Access_TIMS.pdf

Course Schedule

- Monday – Friday
  - Start Time 8:00 am
  - Finish Time 4:15 - 4:45 pm
- Field Trip on Wednesday
  - Hard Hat, Traffic Vest, Hip Waders, Boots
  - Clip board, flashlight, hammer, tape measure
  - Transportation provided. Bring lunch.
- Preparation Requirements
- Questions allowed at anytime

Quizzes

- Four Closed Book Exams:
  - Tuesday morning;
  - Thursday morning;
  - Friday morning; and
  - Friday afternoon
- Pass mark is 70%
- Marks posted daily – any objections to posted marks contact the instructor

Courtesies

- Turn cell phone OFF/vibrate
  – no text messaging.

- No talking during exams – leave room and talk in hall once exam is completed.

Course Objectives

- Introduction to AT's BIM system
- Learn bridge inspection terminology
- Learn inspection protocol and principles
- Introduction to bridge maintenance

INTRODUCTION TO THE BRIDGE INSPECTION AND MAINTENANCE SYSTEM (BIM)

BIM System Definition

A comprehensive management system with the ability to process inspection and component information to support:

- Inspection management
- Maintenance programming
- Strategic planning
  - » Rehabilitation programs
  - » Replacement programs
  - » Budget development

BIM System Functions

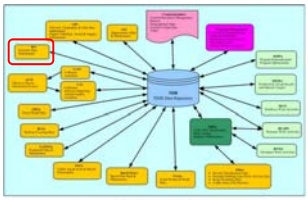
- Ensures appropriate levels of safety and service.
- Maximizes life and utility of bridge structures.
- Assists service life prediction of bridge elements or structure types.
- Identifies need for continued monitoring.
- Provides a electronic system for managing inspection information and collecting and verifying inventory data.
- Provides data for setting priorities.

BIM System Functions (cont'd)

- Assists the allocation of resources.
- Provides information to develop maintenance costs (.i.e. materials, quantities).
- Facilitates information exchange with others.
- Provides a framework for training and evaluation of inspectors.
- Provides information for evaluating design, construction and maintenance standards.

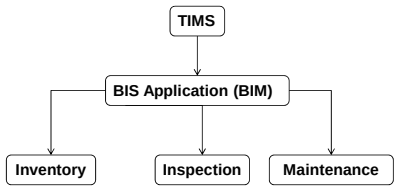
BIM System Management

Alberta Transportation uses a single Web Based knowledge system designed manage infrastructure assets known as the **Transportation Infrastructure Management System (TIMS)**.



TIMS Applications

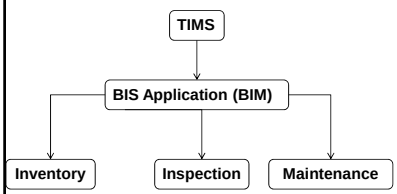
BIM System Management

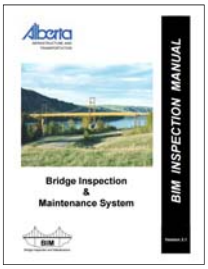


TIMS - BIS Application

Standard Bridge: BF 2397
Culvert: BF 77444

Bridge Information System (BIS)

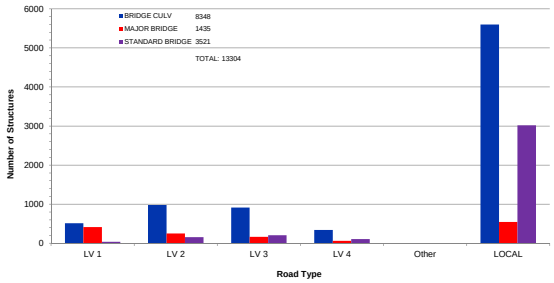




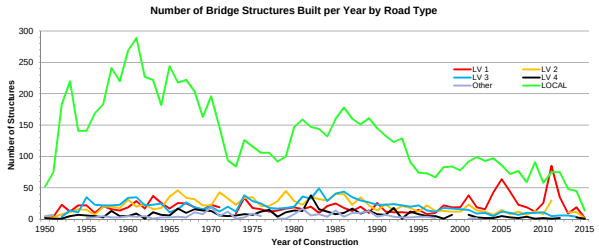
Bridge Structure Categories

- Standard Bridges
  - A bridge constructed from standard components according to standard plans.
- Culverts
  - A bridge sized culvert is one with an equivalent diameter of 1500 mm or larger.
- Major Bridges
  - All bridges which are not standard
- Sign Structures
  - Overhead sign structures

BIM - Bridge Structure Statistics



Bridge Structures Statistics



BIM System – Critical Considerations

- The accuracy of the information contained within the BIM system directly impacts the effectiveness of the system.
  - Consistency of inspection standards
  - Inspection accuracy
  - Inventory accuracy
  - Maintenance accuracy

The bridge inspector must adhere to the highest standard at all times.

Inspection Policies & Procedures

Requirements for Certification and Re-Certification

Inspector's Role and Responsibilities

- Identify safety related deficiencies.
- Take appropriate action.
- Perform a thorough inspection.
- Accurately determine the condition of the bridge components.
- Rate the bridge elements in accordance with established criteria (BIM Manual).
- Identify deficiencies and recommend appropriate and timely maintenance.

Inspector's Role and Responsibilities

- Properly document required items on the appropriate inspection form.
- Provide additional documentation to back up ratings and maintenance recommendations.
- Verify, update or collect necessary inventory information.

Inspector's Skills

- Able to recognize safety related deficiencies.
- Be decisive in taking appropriate action.
- Able to accurately determine the condition of bridge components.
- Understand the rating system.
- Know the appropriate ratings for the full range of conditions encountered.
- Able to recognize maintenance requirements and make appropriate maintenance recommendations.
- Have written communication skills to produce a proper inspection report.

Classes of Inspectors

Bridge Inspectors are classified as Class A or Class B and are certified to carry out inspections of bridge structures on public roads as follows:

Class A

Qualified to perform a Level 1 inspection on all major bridges, standard bridges and culverts (all structure types).

Class B

Qualified to perform a Level 1 inspection on standard bridges and culverts only.

Class B Certification Requirements

- High School Diploma or equivalent education and experience is required

Certification process is **5** Stages: (updated Feb. 17, 2016)

Stage 1:

Successful completion of Alberta Transportation Class B BIM Training Course (5 day course – 70% average score required).

Stage 2:

Successful completion of AT BIM Field Training Course (3 day "Boot Camp"). Field Trainer recommendation is required).

Class B Certification Requirements

Stage 3: Successful completion of mentorship program.

- Mentor is Class A - or Class B with minimum 9 years of certification, and approved by AT.
- Inspect 5 different structure types with mentor
- Mentor selects training sites - variety of types – Minimum 75% of sites with max. Structural Condition Rating of 45%. Must be accessible.
- Complete min. 25 training sites under mentor if previously completed AT Field Training – OR –
- Complete min. 35 training sites under mentor if previously completed AT approved equivalent Field Training course.
- Completed within 2 years-otherwise +10/year.

Class B Certification Requirements

- "Letter of Recommendation" from mentor
- Provide pdf copies of training inspections with mentor comments and Summary Spreadsheet

Stage 4:

- Certification exam (min. 75% score required)

Stage 5:

- Test inspections at 3 sites selected by AT – completed in 1 day and using blank forms.
- Sites are previously benchmarked by AT representative and reviewed for acceptability by AT

(Stage 4 and 5 can be done in reverse order).

Class B Certification Requirements

- If failure of any stage of process then:

➢ One chance to redo that stage.
➢ Two failures of any stage requires process to be re-started at Stage 1.

- Certification after all 5 stages have been successfully completed and with approval from Director of Bridge Engineering.
- Certification is valid until next certification renewal date – normally 3 years

Class B Re-Certification Process

- Requires active involvement in BIM and acceptable performance
- In order to be re-certified, inspectors must meet one of the following criteria:

1) Performed minimum average rate of 2 BIM inspections per month during previous 3 year period – or –
2) Performed a minimum average rate of 1 BIM inspection per month during previous 3 year period and have been active in management, design, or construction of bridges – or –
3) Acted as reviewer for min. avg. rate 2.5 inspections/month OR Department reviewer for a min. avg. rate of 5 inspections/month during previous 3 year period, and active in management, design, construction.

Class B Re-Certification Process

- Inspector status is reviewed by AT every 3 years
- Decision on re-certification is made by AT
- Assistance from Regional bridge staff as required
- Inspectors meeting requirements will be re-certified and notified by AT
- Inspectors not meeting requirements will be asked if they intend to maintain certification. If so, a 3 member AT panel will review inspector's status and make recommendation to Director of Bridge Engineering.
- Panel may develop plan for inspector – typically writing re-certification exam and 5 test sites

Levels of Inspection

- Most bridge structures can be visually inspected by a qualified inspector on a routine basis. (Level 1)

- Some structures or their components will require a specialized inspection (Level 1.5 or 2) in order to:

  – accurately determine their condition
  – gather additional information
  – access components that are not fully accessible during routine Level 1 inspections

Levels of Inspection

Level 1 Inspection

- A general inspection
- Primarily visual
- Requires completion of the Level 1 BIM inspection report
- Use of basic tools and equipment

Level 1.5 Inspection

- Level 1 inspection but within arms reach of all bridge elements using manlift or snooper

Levels of Inspection

Level 2 Inspection

- In-depth inspection.
- Completion of the appropriate Level 2 inspection report.
- Use of specialized knowledge, equipment or procedures

- All levels of inspections must be performed by a certified inspector.
- Level 1 inspections must be done at the minimum frequency specified by policy.
- Level 1.5 and Level 2 inspections are performed on a prescribed cycle or an as required basis.

Inspection Frequency

A Level 1 inspection must be performed on all bridge structures on a cycle not exceeding:

- All structures located on roadways designated as Level 1 or Level 2 in accordance with the Provincial Highway Service Classification – every 21 months.
- All structures located on roadways designated as Level 3 or Level 4 in accordance with the Provincial Highway Service Classification – every 39 months.
- Major bridges on local roads - 39 months.
- Standard bridges and culverts on local roads - 57 months.
- All new structures – as part of final construction completion.
- After significant maintenance or rehabilitation.
- Frequencies are intended to provide the benefit of inspecting during different seasonal conditions.

Inspection Frequency

- In special circumstances (e.g. park roads with summer access only) Department may modify frequency.
- A shorter cycle may be appropriate depending on:
  - age of the structure.
  - traffic characteristics.
  - known deficiencies.
  - inaccessibility of a component or element.
- If a shorter cycle is necessary make recommendation in "Special Comments For Next Inspection" box.
- Reviewer will flag and notify AT if in agreement
- AT will change inspection cycle if in final agreement
- A date beyond the next standard cycle date will not be accepted by the system.
- Refer to BIM Advisory Bulletin #2 – January 8, 2015 for more information (included in Supplemental Binder)

http://www.transportation.alberta.ca/4827.htm

Training of Inspectors

- Technical Standards Branch manages the delivery of the BIM Bridge Inspection Course and the BIM Field Training Course (boot camp)
- Regions responsible for field training of Department Staff
- Non Department staff are responsible to arrange for additional field training after completing 3 day BIM Field Training Course by engaging appropriate mentor (Stage 3 Mentorship program described earlier)

Responsibility for Inspection
Technical Standards Branch

- Develop and manage the BIM System.
- Develop and monitor standards, policies and procedures.
- Perform audit inspections with assistance from Regions as required
- Provide technical support to Regions.
- Maintain and oversee updating of inventory databases.

Responsibility for Inspection
Regions

- Manage inspection programs for Provincial Roads and major bridges on Local Roads through BIM inspection consultant.
- Carry out ad hoc inspections.
- Arrange for specialized inspections by others.
- Review and accept Inventory updates
- Review and accept inspection reports
- Initiate appropriate action where deficiencies are identified.
- Provide technical support to Local Road Authorities as resources permit.

Responsibility for Inspection
Local Road Authorities

- Manage BIM inspection program for Standard bridges and Culverts on local roads.
- Control and manage the bridge structures in their jurisdictions.
- Print forms and complete scheduled Level 1 inspections on standard bridges and culverts (in-house or consultant delivery).
- Monitor all bridge structures as required.
- Report hazardous or structural element concerns (rated 2 or less) to Bridge Manager.
- Perform maintenance.

Responsibility for Inspection
All Inspectors

Inspectors must follow established guidelines defining reporting procedures to ensure that:

- Proper action is initiated when safety related concerns are identified.
- Information is reported in a systematic and organized manner.
- Proper expertise is applied to inspection and maintenance.
- Follow-up is done for maintenance recommendations.

Responsibility for Inspection
All Inspectors

- Use the appropriate BIM report for inspections.
- Carry blank forms for possible structure changes
- Assign ratings according to BIM system
- Provide ratings that are consistent with explanations and supporting documentation
- Gather sufficient information and data to initiate structure change when encountered
- Verify or revise inventory data on the inspection form
- Provide missing inventory data.

Responsibility for Inspection
All Inspectors

- Condition ratings of 4 or less the inspector must
  - provide an explanation of condition.
- Condition ratings of 3 or less the inspector must
  - make appropriate recommendation for maintenance or monitoring .
  - supplement with photos - also sketches, measurements if needed.
  - consider decreasing the next inspection date.
- Hazardous conditions or structural load carrying elements rated 2 or less must be reported immediately to the Bridge Manager (and LRA if on local road).
- Rating of 1 on an element critical to the safe operation of the bridge, take immediate steps to close or restrict traffic on the structure and provide appropriate notification.
- Report any deficient signage to the appropriate road authority as soon as possible.

Responsibility for Inspection
All Inspectors

- Send completed inspection forms with all supporting documentation to Department's BIM consultant for review and entry of inventory updates and inspection data into BIS
- Inspection reports will be returned to the inspector if requirements are not met
- Inspector must revise report and resubmit to the BIM consultant
- Inspector should contact the BIM consultant or the Bridge Manager if there are concerns or questions about the review process

Refer to the following link

Certification Process

- Following is the link to the Certification and Re-Certification Process for bridge inspectors:

http://www.transportation.alberta.ca/Content/docType30/Production/Final_BIM_Certification_Process_Dec%2016%202014.pdf

Questions??

BIM INSPECTION FORMS

There are 2 Types of Bridge Inspectors – Class B and Class A.

- Class B inspectors can only inspect Standard Bridges and Culverts
- Class A Inspectors can inspect Major Bridges, Standard Bridges and Culverts

Definition of a Standard Bridge - Bridges that are built with a Standard Drawing

Definition of a Major Bridge – Bridges that are not built with Standard Drawings

For a listing of all current and archived drawings refer to:
http://www.transportation.alberta.ca/4738.htm

Inspection Form Types

- Each form has a unique form identification
- 10 different inspection report forms for bridges with a single span type
- 3 different inspection report forms for culverts
- Custom forms generated to suit bridges with multiple form types are unlimited.

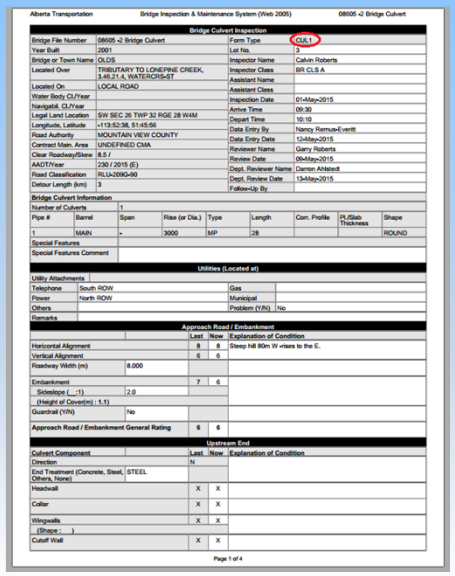
FORM TYPE	DESCRIPTION	SPAN TYPE
TH	Through Trusses	TH
PT	Pony Truss	PT
SG	Rolled Beams Riveted Plate Girders Welded Girders Steel Rigid Frames	RB RC RG WG FR
SS	Other Trusses & Arches	SS SSB SSA SSS SSF SSC
DT	Deck Trusses	DT
TT	All Timber Bridges	TT UT XT TP
PCS	Standard Precast Bridges	HH HC VH PG GR PE PA PS MM HCO PGO HHO PX PES PEF VS SM SMO SC SCC SMO VSO SCM SL SLC
PSR	Regular Prestress Bridge	RD FC VF PM VM PB DBT PQ PO PMO OM LF FM RM PJ NU CBT DBC CBC FCO PJO
CON	All Cast in Place Concrete Bridge Concrete Tee Girder Bridges Concrete Flat Slab Bridges	CA CB CF CV CX CC CXP CT CS
CUL1 CULM CULE	Single Culverts Multiple Culverts Culverts extended with different material and/or size	RP SP FP MP WP CP BP AP BPR RPB CPA CPE SPE PCB RPA RPE RPP MPB SCA SCR SSP CPP SPP SRA MPE
SIGN	Sign Structures	Z
THTT	Through Trusses with Timber Approaches	
THPCS	Through Trusses with Standard Precast Approaches	
THPSR	Through Trusses with Regular Prestress Approaches	
THSG	Through Trusses with Steel Girder Approaches	
THPT	Through Trusses with Pony Truss Approaches	
PTTT	Pony Trusses with Timber Approaches	
PTPCS	Pony Trusses with Standard Precast Approaches	
SGTT	Steel Beams with Timber Approaches	
SGPCS	Steel Beams with Standard Precast Approaches	
PSRPCS	Regular Prestress with Standard Precast Approaches	
SSSG	Special Steel with Steel Girder Approaches	
DTSG	Deck Truss with Steel Girder Approaches	

Table 1.1 - BIM Report Index Page 1-5

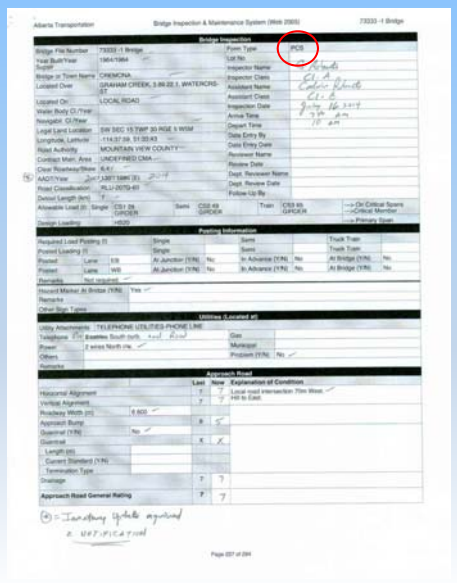
Form Verification

- How do you know what the form ID is?
  - Look on form itself.
- How do you know what span type it is?
  - Look on form itself.
- What if the form ID or span type do not make sense?
  - Look at resource material to match up the actual in field structure with drawings.
    - If still in doubt ask a senior inspector or AT representative.

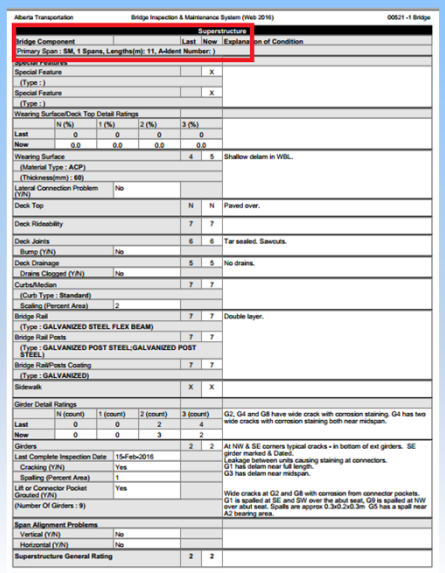
Inspection Forms



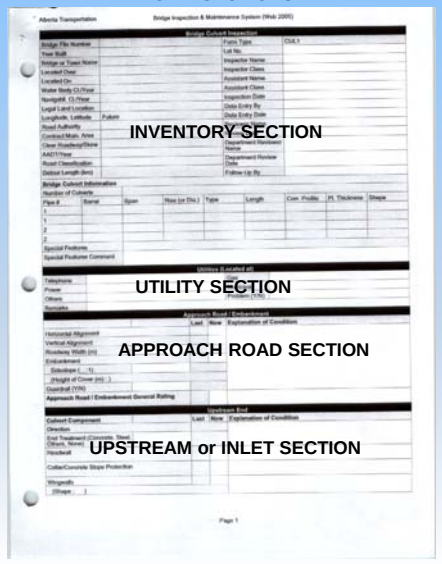
Inspection Forms



Inspection Forms



FORM SECTIONS

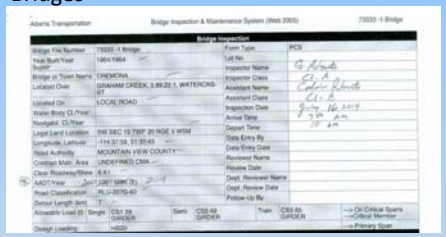


Sections of Standard Bridge & Culvert Forms

Form Section	Bridge	Culvert
Inventory	Similar	Similar
Signing	Bridges Only	N/A
Utility	Identical	Identical
Approach	Similar	Similar
Superstrucutre	Bridges Only	N/A
Inlet	N/A	Same as Outlet
Barrel	N/A	Culverts Only
Outlet	N/A	Same as Inlet
Substructure	Bridges Only	N/A
Channel or	Similar	Similar
Grade Separation	Identical	Identical
Maintenance	Similar	Similar
AT Management	Identical	Identical

Inventory (Similar)

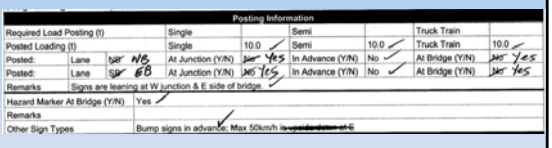
- Bridges



- Culverts

Signing (Bridges Only)

- Bridges Only



Utility Section (Identical)

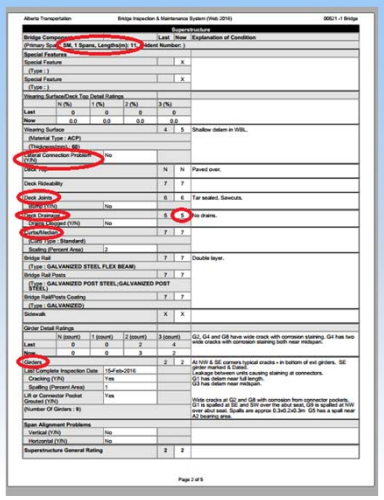
Utilities (Located at)			
Utility Attachments	TELEPHONE UTILITIES-PHONE LINE		
Telephone	South curb and ROW.	Gas	
Power	North ROW.	Municipal	
Others		Problem (Y/N)	No
Remarks			

Differences between Precast Girder and TT Stringer Superstructures

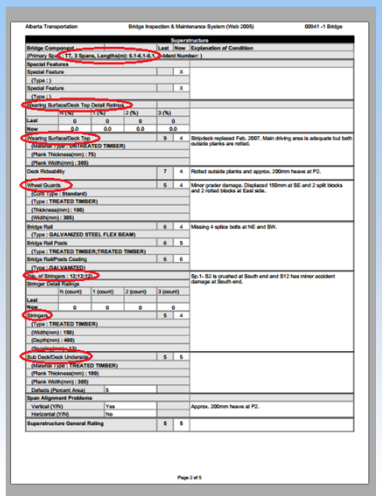
- PCS has separate rating boxes for both Deck Top and Wear Surface. Combined on TT form
- Adds “Plank Width” to TT Form
- Adds “Lateral Connection Problem Y/N” to PCS Form
- Joints added to PCS Form
- Deck Drainage rated on PCS form only (rated “X” for TT decks)
- Curb component PCS vs Wheelguard component TT Form
- Girders on PCS vs Timber Stringers on TT Form

The remainder of the form is the same.

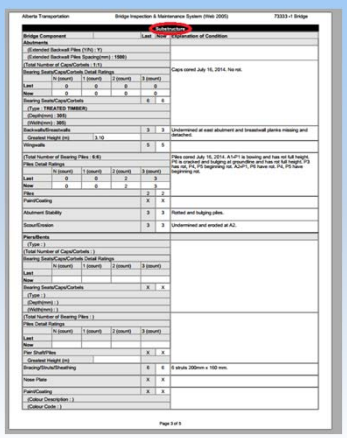
Superstructure (Bridges Only) Precast Girders



Superstructure (Bridges Only) Treated Timber Stringers



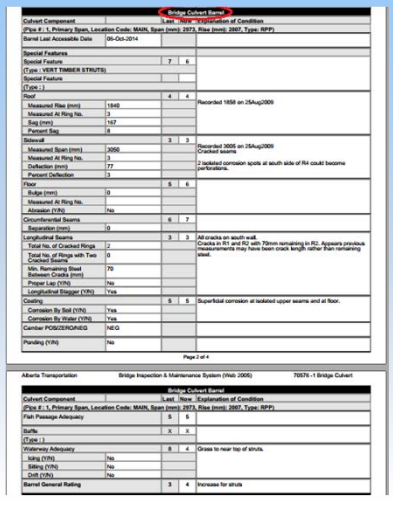
Substructure (Bridges Only)



Culvert Inlet (U/S) and Outlet (D/S) (Identical)

Downstream End				
Culvert Component		**Last**	**Now**	**Explanation of Condition**
Direction		E		
End Treatment (Concrete, Steel, Others, None)	STEEL			
Headwall		X	X	
Collar		X	X	
Wingwalls		X	X	
(Shape :)				
Cutoff Wall		X	X	
Bevel End		5	6	
Heaving (mm)	70			
Invert Above/Below Stream Bed	BELOW			
Above/Below (mm)	200			
Scour Protection		6	6	
(Type : **RIP RAP**)				
(Avg. Rock Size(mm) : **200**)				
Scour/Erosion		6	6	Scour hole 10m D/S. not affecting pipe
Beavers (Y/N)	No			
Downstream End General Rating		**5**	**6**	

Culvert Barrel



Culvert Channel Section

Structure Usage				
		Last	**Now**	**Explanation of Condition**
Channel (U/S and D/S)				
Alignment		5	5	
Bank Stability		5	5	
HWM (m below Top of Culvert)				(High water 1.2m above streambed @ outlet.) No visible HWM. Drift on floor of R1-R4
Drift (Y/N)	Yes			
Channel Bottom Degrading/Aggrading	DEGRADING			At D/S only
Beavers (Y/N)	Yes			Beavers at both U/S and D/S
(Fish Compensation Measure 1 : **NONE**)				
(Fish Compensation Measure 2 : **NONE**)				
Channel General Rating		**5**	**5**	

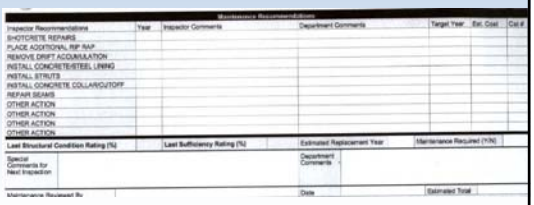
Bridge Channel Section

Structure Usage				
		Last	Now	Explanation of Condition
Channel				
(U/S Direction : **N**)				R x R crossing 50m D/S.
(D/S Direction : **S**)				
Alignment		7	7	
Bank Stability		5	4	Vertical slumping bank at SW
HWM (m below Top of Curb)	2.5			(April 12/09) No visible HWM.
Drift (Y/N)	Yes			Drift at west abutment
Slope Protection		5	5	
(Type : **NATURAL; NATURAL**)				
Guidebank/Spurs		X	X	
Adequacy of Opening		7	7	
(Fish Compensation Measure 1 : **NONE**)				
(Fish Compensation Measure 2 : **NONE**)				
Channel General Rating		**5**	**5**	

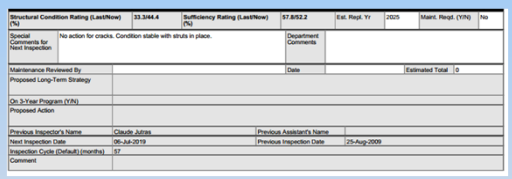
Maintenance (Similar)

- Bridges

- Culverts



AT Management Section (Identical)



Inspection Form Types

- Culvert form types:
  - CUL1 Form
    - single culverts of all types
    - single culvert extended with same size and material type
    - one barrel section
    - therefore - 1 inlet, 1 barrel and 1 outlet
  - CULM Form
    - multiple pipes or cells
    - two cell concrete box extended with steel
    - two or more barrel sections
    - therefore - multiple inlets, multiple barrels & multiple outlets
  - CULE Form
    - single culvert extended with different material or pipe size
    - two or more barrel sections
    - therefore – 1 inlet, multiple barrels and 1 outlet
  - Custom Forms to suit number & types of barrel sections.

Form Features

- Tailored to the span type or types of the particular structure.
- Contain full descriptions and full comments, no codes are required.
- Shows inventory data needed for a proper inspection.
- Provides the design and allowable loads and critical member.
- Allows for condition rating of elements and explanation.

Form Features

- Allows for general rating of each major category.
- Provides a list of typical maintenance items.
- Provides for special comments or instructions for the next inspection.
- Provides for programming, scheduling, cost estimation, authorization and tracking of maintenance.
- Repeats previous inspection data for inspector's information.
- Provides for 2 levels of inspection.

Form Features

- Provides sufficiency rating and structural condition ratings based on inspection data.
- Clearly indicates if a bridge element is not accessible or not applicable.
- A logical sequence to facilitate the inspection process.

Data Fields

- Shaded Fields
  - Element and data labels
  - Inventory Information (confirm, revise, or add if missing)
  - Element descriptions (type, size, etc.)
- Unshaded Fields
  - Element ratings
  - Inspection measurements
  - Explanations of condition

BIM System Fills In Shaded Area Inspector Confirms, Corrects, or Adds

Bridge Inspection	
Bridge File Number	
Year Built	
Bridge or Town Name	
Located Over	
Located On	
Water Body Cl./Year	
Navigabil. Cl./Year	
Legal Land Location	
Longitude, Latitude	Future
Road Authority	
Contract Main. Area	
Clear Roadway/Skew	
AADT/Year	
Road Classification	
Detour Length (km)	

Hi-Lited Section to be Filled in by Inspector

Alberta Transportation — Bridge Inspection & Maintenance System (Web 2005) — 81800 NW-1 Bridge

Bridge Inspection			
Bridge File Number	81800 NW-1 Bridge	Form Type	CON
Year Built/Year Supstr	1993/1993	Lot No.	2
Bridge or Town Name	CALGARY BEDD	Inspector Name	Garry Roberts
Located Over	2:15 R1 42.207;2:15 L1 42.314	Inspector Class	BR CLS A
Located On	772:01 R1 0.886	Assistant Name	Jon Davies
Water Body Cl./Year		Assistant Class	BR CLS B
Navigabil. Cl./Year		Inspection Date	11-Sep-2014
Legal Land Location	SE SEC 15 TWP 25 RGE 1 W5M	Arrive Time	11:20
Longitude, Latitude	-114:02:54, 51:07:34	Depart Time	13:15
Road Authority	Alberta Transportation (AIT)	Data Entry By	Nancy Remus-Everitt
Contract Main. Area	DEERFOOT/STONEY	Data Entry Date	29-Sep-2014
Clear Roadway/Skew	12.2 / 5 deg. (RHF)	Reviewer Name	Ash Morjaria
AADT/Year	22,309 / 2001 (E)	Review Date	18-Sep-2014
Road Classification	RLU-208-100	Dept. Reviewer Name	Tim Davies
Detour Length (km)	999	Dept. Review Date	03-Oct-2014
		Follow-Up By	

- Lot Number
  - 1 = Major maintenance, Assessments, Critical elements rated 3 or less, Level 2, or reduced cycle
  - 2 = Minor or routine maintenance
  - 3 = All structures not managed by AT
  - 4 = No action or Monitoring
- Lot number is assigned by Reviewer
- Certification status of inspector checked by system.

Example of Y/N Field

Floor		7	7
Bulge (mm)	0		
Measured At Ring No.			
Abrasion (Y/N)	No		
Circumferential Seams		8	8
Separation (mm)	60		
Longitudinal Seams		X	X
Total No. of Cracked Rings			
Total No. of Rings with Two Cracked Seams			
Min. Remaining Steel Between Cracks (mm)			
Proper Lap (Y/N)			
Longitudinal Stagger (Y/N)			
Coating		7	7
Corrosion By Soil (Y/N)	No		
Corrosion By Water (Y/N)	No		
Camber POS/ZERO/NEG	ZERO		
Ponding (Y/N)	No		

Page 2 of 4

Alberta Transportation — Bridge Inspection & Maintenance System (Web 2005) — 08605 -2 Bridge Culvert

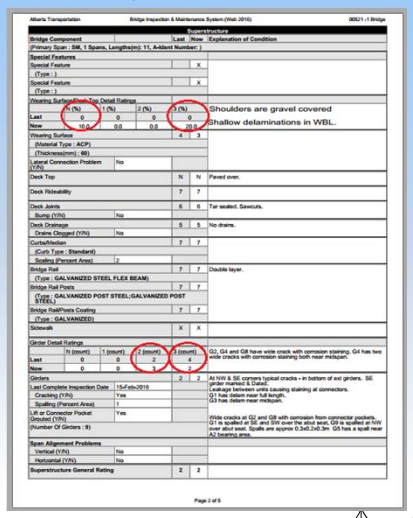
Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
(Pipe # : 1, Primary Span, Location Code: MAIN, Span (mm): , Rise (mm): 3000, Type: MP)				
Fish Passage Adequacy		7	7	
Baffle		X	X	
(Type :)				
Waterway Adequacy		7	7	Approx. 1.1m deep silt at first 3m of pipe.
Icing (Y/N)	No			
Silting (Y/N)	Yes			
Drift (Y/N)	No			
Barrel General Rating		8	8	

Example of Y/N Supporting Comments Required

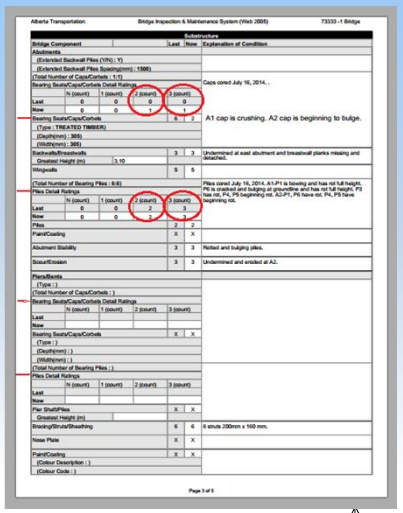
Structure Usage

		Last	Now	Explanation of Condition
Channel (U/S and D/S)				
Alignment		5	5	
Bank Stability		5	5	
HWM (m below Top of Culvert)				(High water 1.2m above streambed @ outlet.) No visible HWM.
Drift (Y/N)	Yes			Drift on floor of R1-R4
Channel Bottom Degrading/Aggrading	DEGRADING			At D/S only
Beavers (Y/N)	Yes			Beavers at both U/S and D/S
(Fish Compensation Measure 1 : **NONE**)				
(Fish Compensation Measure 2 : **NONE**)				
Channel General Rating		5	5	

Example of Filling in Data Fields and Detailed Rating Boxes – Superstructure



Example of Filling in Data Fields and Detailed Rating Boxes – Substructure



Detail Ratings

Superstructure:

- Wearing surface / deck top
- TT stringers and PCS girders

Substructure:

- Timber caps
- Timber piles

- ➢ Provided when ratings are 3, 2, 1, and N
- ➢ Record 0 in Detailed Rating boxes if element is rated 4 or more.
- ➢ Some Detailed Ratings boxes require % of total area (i.e. Wear Surface/Deck Top
- ➢ Some Detailed Ratings boxes require “Count” of total numbers (i.e. Caps, Piles)

STANDARD BRIDGE & CULVERT COMPONENTS

Alberta Bridge Inventory

In Alberta there are about 13,300 bridges.

Types of bridges in Alberta:

- Standard bridges 3521 (26%)
- Bridge size culverts 8348 (63%)
- Major bridges 1435 (11%)

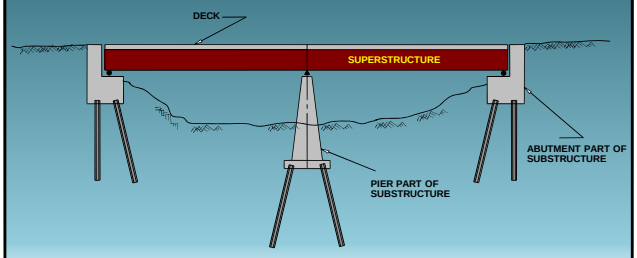
Standard Bridges

Any bridge which is built according to standard drawings (plans) is classified as a standard bridge.

For inspection purposes standard bridges are divided into two basic features:

- Superstructure
- Substructure

Typical Bridge Components



Typical Bridge Components

Superstructure
- It carries the load applied to the deck and transfers it to bridge supports.

Substructure
- It transfers load from the superstructure to the foundation soil or rock.
- It includes all elements below the bearings.

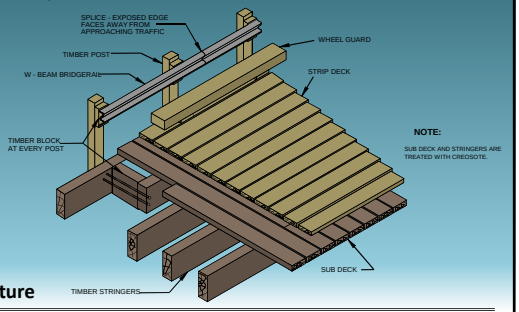
Typical Bridge Components

Deck
- Provides a smooth & safe riding surface
- Transfers load of the deck to other components.
- Three common material used for the deck:
  - Wood
  - Concrete
  - Steel

Superstructure for Standard Bridges

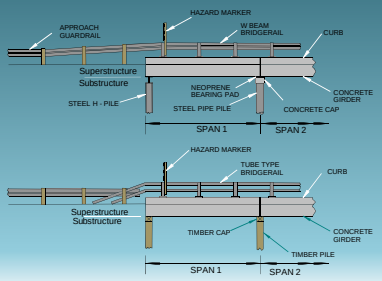
Superstructure comprises of bearings and all elements above bearings, including:
- Bridgerail.
- Hazard markers.
- Timber stringers with timber deck.
- Reinforced concrete girders.
- Prestressed concrete girders.
- Bearings.

Superstructure Elements



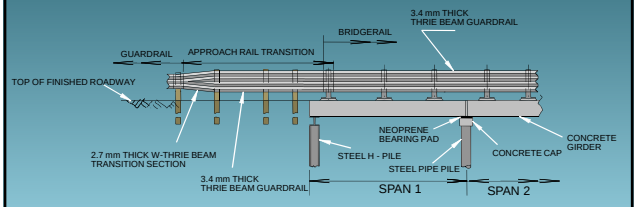
Timber Superstructure

Superstructure Elements



Standard Bridge & Culvert Components

Superstructure Elements



Alberta Transportation
Technical Standards Branch
Class B Bridge Inspection Course
BIM Bridge Inspection and Maintenance

Standard Bridge & Culvert Components

Superstructure Elements

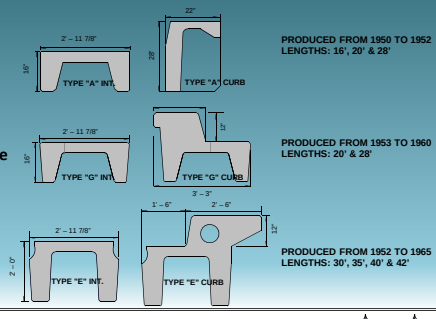
- Reinforced Concrete Girders
  - Concrete is strong in compression and weak in tension.
  - Concrete bending members are reinforced with mild reinforcing steel to produce reinforced concrete girders.
- Prestressed Concrete Girders
  - Girders are reinforced with high strength steel under tension.
  - Girders are designed not to crack.
  - Generally more economical.

Alberta Transportation
Technical Standards Branch
Class B Bridge Inspection Course
BIM Bridge Inspection and Maintenance

Standard Bridge & Culvert Components

Superstructure Elements

Reinforced Concrete Girders

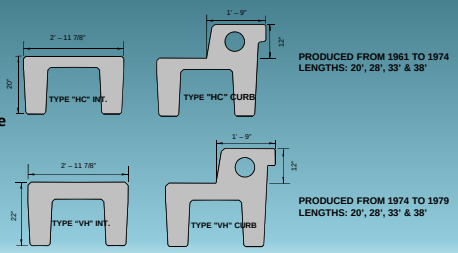


Alberta Transportation
Technical Standards Branch
Class B Bridge Inspection Course
BIM Bridge Inspection and Maintenance

Standard Bridge & Culvert Components

Superstructure Elements

Reinforced Concrete Girders



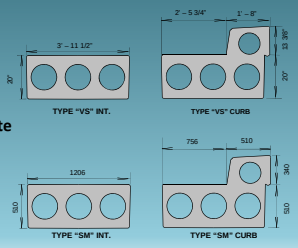
PRODUCED FROM 1961 TO 1974
LENGTHS: 20', 28', 33' & 38'

PRODUCED FROM 1974 TO 1979
LENGTHS: 20', 28', 33' & 38'

Standard Bridge & Culvert Components

Superstructure Elements

Prestressed Concrete Girders



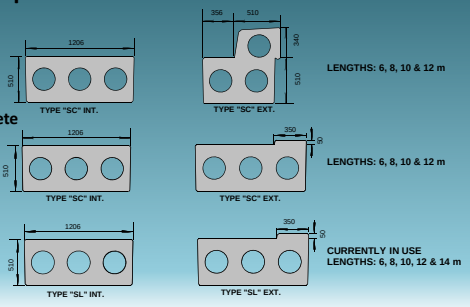
PRODUCED FROM 1974 TO 1979
LENGTHS: 20', 25', 30' & 35'

PRODUCED FROM 1979 TO 1990
LENGTHS: 6, 8, 10 & 11 m

Standard Bridge & Culvert Components

Superstructure Elements

Prestressed Concrete Girders



LENGTHS: 6, 8, 10 & 12 m

LENGTHS: 6, 8, 10 & 12 m

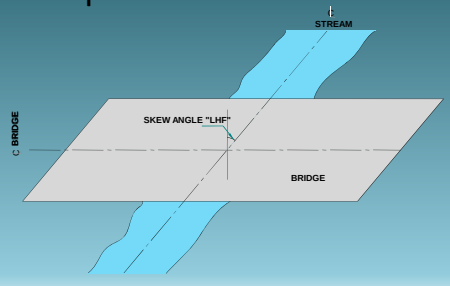
CURRENTLY IN USE
LENGTHS: 6, 8, 10, 12 & 14 m

Standard Bridge & Culvert Components

Superstructure Elements

Superstructure Elements

Superstructure Elements

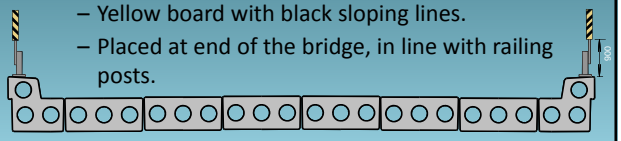


SKEW ANGLE

Superstructure Elements

Hazard Marker

- Warning sign at bridge approaches.
- Yellow board with black sloping lines.
- Placed at end of the bridge, in line with railing posts.



Superstructure Elements

- Bearings
  - Neoprene or rubber pads or strips.
  - Used over steel and concrete caps.
  - Transmit all loads from superstructure to substructure.
  - Permit longitudinal movement of the superstructure.
  - Allow rotation caused by deflection.

Substructure Elements

Substructure comprises of all elements below bearings.

Major components:

- Abutments
- Pier or Pile Bent (H pile pier or Pipe pile pier)

Substructure Elements

Other components:

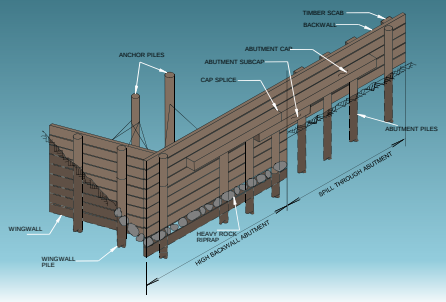
- Caps & Subcaps.
- Piles.
- Sheathing & Bracing.
- Wingwall
- Backwall
- Riprap

Substructure Elements

Substructures can be:

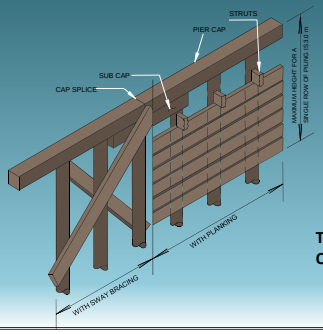
- Timber piles with timber cap
- Timber piles with steel cap
- Steel “H” piles with steel cap
- Steel “H” piles with concrete cap
- Steel pipe piles with concrete cap

Substructure Elements



Standard Bridge & Culvert Components

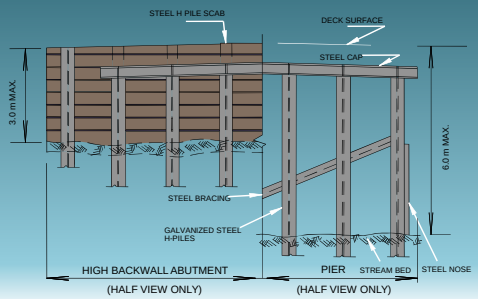
Substructure Elements



Timber Piers (2 Types Of Bracing)

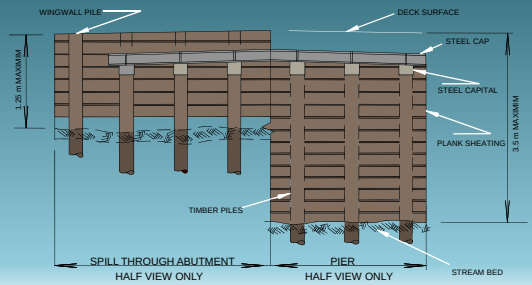
Standard Bridge & Culvert Components

Substructure Elements



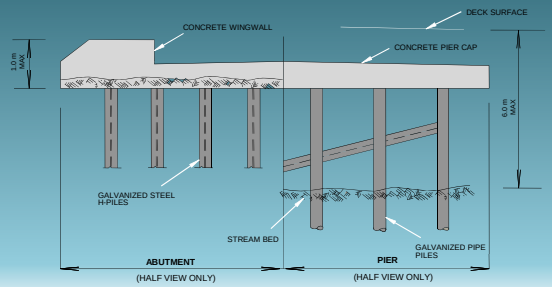
Standard Bridge & Culvert Components

Substructure Elements



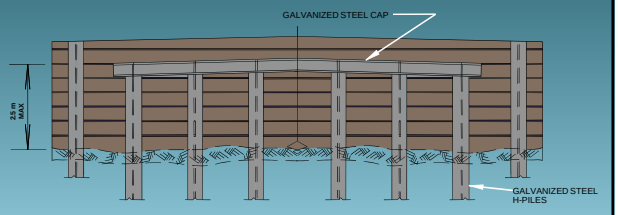
Standard Bridge & Culvert Components

Substructure Elements



Standard Bridge & Culvert Components

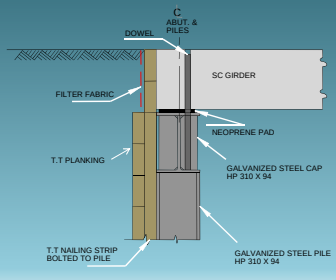
Substructure Elements



SC PRESTRESSED CONCRETE GIRDER BRIDGE WITH STEEL SUBSTRUCTURE HIGH ABUTMENT BACKWALL (ELEVATION)

Standard Bridge & Culvert Components

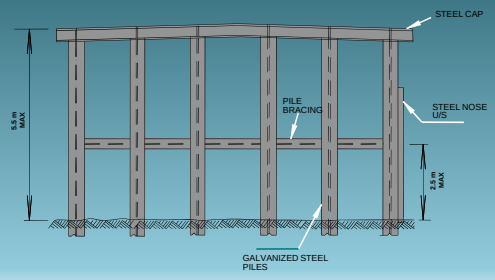
Substructure Elements



SC PRECAST GIRDER BRIDGE WITH STEEL SUBSTRUCTURE (SECTION)

Standard Bridge & Culvert Components

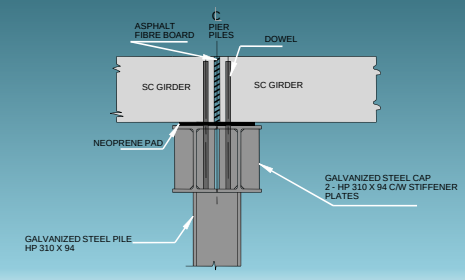
Substructure Elements



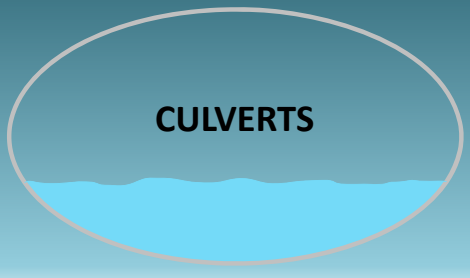
SC PRECAST GIRDER BRIDGE WITH STEEL SUBSTRUCTURE PIER (ELEVATION)

Standard Bridge & Culvert Components

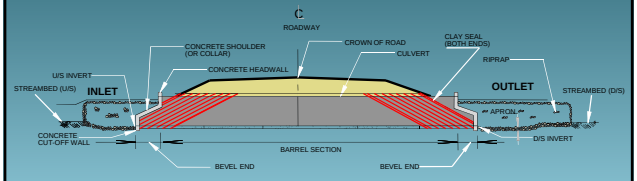
Substructure Elements



SC PRECAST GIRDER BRIDGE WITH STEEL SUBSTRUCTURE PIER (ELEVATION)

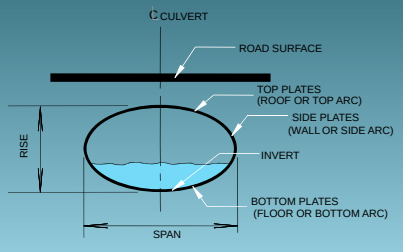


Culvert Components



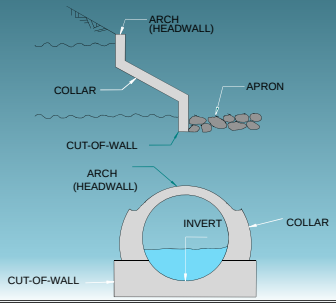
LONGITUDINAL SECTION THROUGH CULVERT

Culvert Components

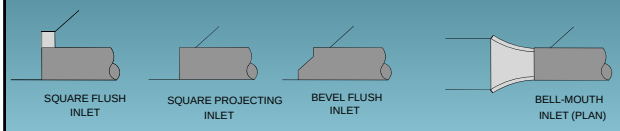


SECTION

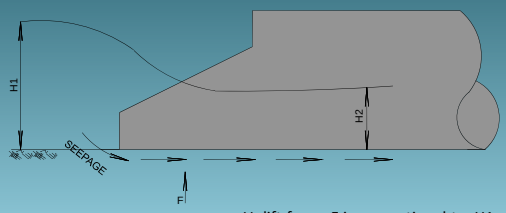
Culvert Components



Typical Inlet Configurations

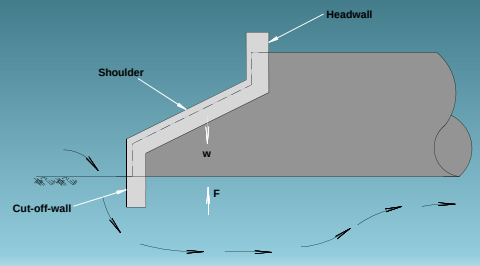


Concrete End Treatment



Uplift force, F is proportional to H1 – H2
Seepage is proportional to H1 – H2

Concrete End Treatment



Concrete End Treatment

Concrete end treatment has five important functions:

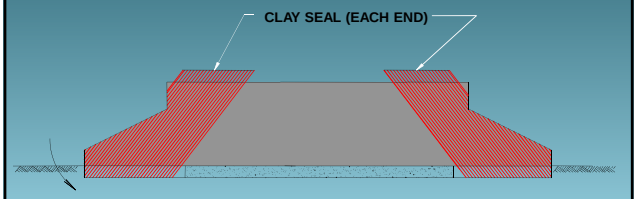
1. Weight provides downward force to resist uplift.
2. Cut-off wall lengthens the seepage path.
3. Shoulder strengthens the bevel edges.
4. Enhances the inlet transition.
5. Aesthetics.

Clay Seals

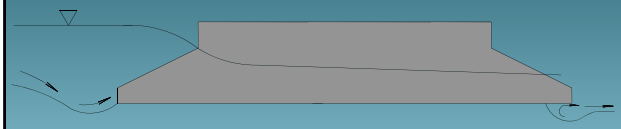
Problems due to seepage:

- Fine material is removed from the granular backfill.
  - Loss of material creates voids.
  - Support length of the backfill is reduced.
  - Culvert can deform.
- Uplift forces are increased.

Clay Seals



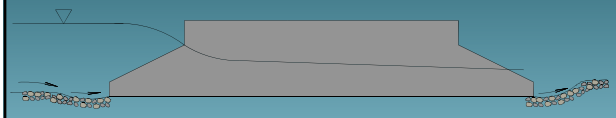
Scour Protection - Aprons



Flowing water causes shear forces on the bed.

- Shear force is proportional to velocity.
- High shear forces will erode bed and bank material.
  - Causes fill stability problems at inlet and outlet.
  - Causes structural deformation.

Scour Protection - Aprons



- Riprap is placed to protect the end of culverts.
- Larger and heavier riprap provides higher shear resistance.
- Cut-off wall helps anchor riprap.

Culvert (SPCSP) Installation

Culvert (SPCSP) Installation

END

BRIDGE MATERIALS

CONCRETE

What is Concrete?

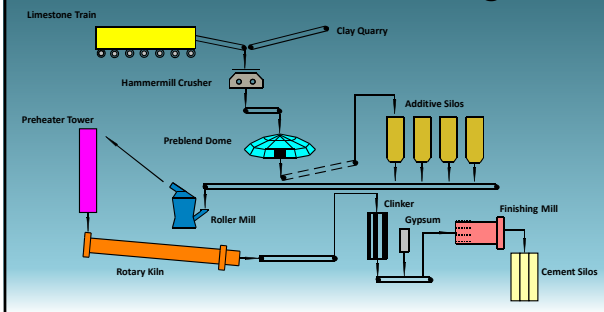
A mixture of various components which chemically react to form a strong construction material

Unit Weight – normal 2400 kg/m^3 or semi 1900 kg/m^3

Component Ratios:

- Cement (10 to 15%)
- Aggregate (75 to 80%)
- Water and Air (remainder)
- Admixtures

Cement Manufacturing



Aggregate

Aggregate qualities for strong and durable concrete:

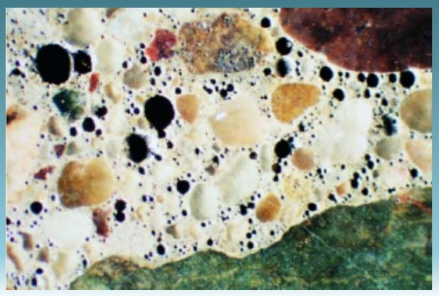
- Abrasion resistance
- Weather resistance
- Chemical stability
- Cleanliness and even gradation

Water

Entrained Air

- Entrained air 5% to 8%
- Improves freeze thaw resistance
- Improves workability
- Reduces segregation and bleeding
- Improves sulfate resistance

Air-Entrained Concrete



Admixtures

Ingredients used to modify certain properties of concrete to have a desired function

Two types of admixtures:

- Mineral admixtures
- Chemical admixtures

Mineral Admixtures

Fly Ash

- Reduces heat of hydration & increases workability
- Increases set time & reduces strength

Silica Fume

- Increase strength & abrasion resistance
- Increases water demand
- Reduces **permeability** & workability

Chemical Admixtures

Water Reducers – reduces water demand

Super Plasticisers – increases slump, workability, strength

Accelerators – decreases set time

Retarders – increases set time

Physical Properties

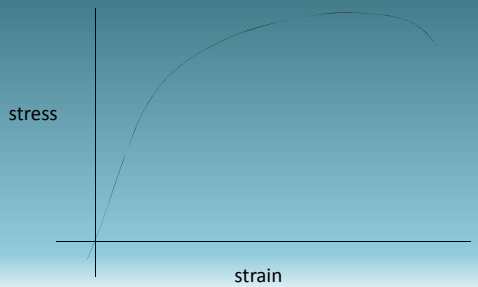
Compressive strength (f'c)	(28 day)
Tensile strength	(10% f'c)
Shear strength	(12-13% f'c)
Flexural strength	(14% f'c)

Physical Properties (Cont'd)

How to increase Compressive Strength

- Increased cement content
- Increased aggregate strength
- Decreased w/c ratio
- Decreased entrapped air
- Increased curing time
- Use of admixtures

Concrete Stress-Strain Diagram



Physical Properties (Cont'd)

Creep
Fire resistance
Durability
Isotropy
Permeability

- Affected by
  - evaporation of bleed water
  - excess water
  - micro-cracking
  - porous aggregates
  - improper mixing, finishing

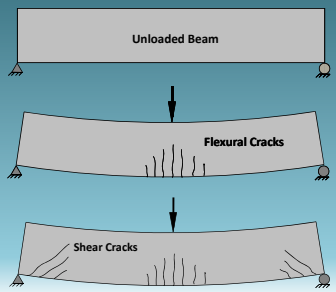
Concrete Damage & Deterioration

1. **CRACKS**

Crack is a linear fracture in concrete

- Working Cracks
- Structural Cracks
  - Flexure cracks
  - Shear cracks

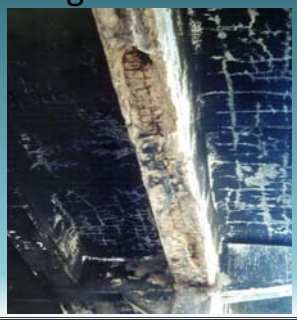
Structural Cracks



Concrete Damage & Deterioration

- Non-Structural Cracks
  - Crazing cracks
  - Temperature cracks
  - Shrinkage cracks
- Crack Size
  - Hairline — less than 0.1 mm
  - Narrow — ≥ 0.1 mm < 0.3 mm
  - Medium — ≥ 0.3 mm < 1.0 mm
  - Wide — ≥ 1.0 mm

Shrinkage Cracks on Deck



Concrete Damage & Deterioration

2. SCALING

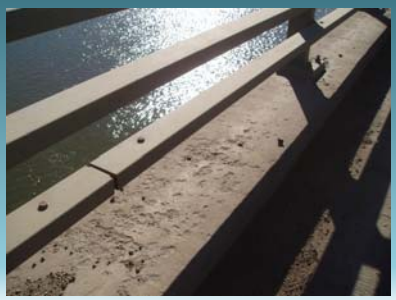
- Scaling is a gradual loss of mortar and aggregate
- Categories of Scaling
  - Light scaling — loss of surface mortar 6 mm deep
  - Medium Scaling — loss of surface mortar 6 to 13 mm deep
  - Heavy scaling — coarse aggregate exposed
  - Severe scaling — loss of coarse aggregate

Bridge Materials

Light Scaling

Bridge Materials

Medium Scaling



Bridge Materials

Heavy Scaling

Bridge Materials

Freeze/Thaw Deterioration of Deck

Concrete Damage & Deterioration

3. POP-OUTS

- Due to porous aggregate

4. ABRASION

- Due to wheel wear

5. SPALLING

- Expansion of corroding rebar and overstressing

Expansive Aggregate Pop-out

Abrasion Damaged Girders

Concrete Damage & Deterioration

6. DELAMINATION

- Bond failure between old and new concrete and expansion of corroding rebar

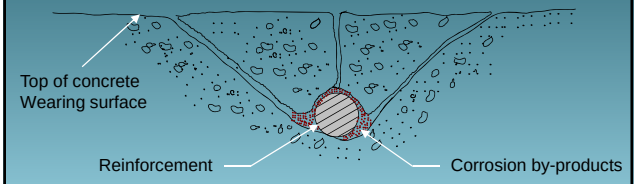
7. STAINING

- Rust stains leaching through cracks

8. ALKALAI AGGREGATE REACTION

9. CARBONATION (EFFLORESCENCE)

Delamination Mechanism



Delamination & Corroded Rebar

Longitudinal Crack & Corroding Rebar

Corrosion Spall

350

Calcium Carbonate Deposits

Concrete - Steel Combination

Reinforced Concrete
- Concrete has high compressive strength and low tensile strength
- Always cracks under tensile load
- Mild steel carries tensile load

Prestressed Concrete
- High strength steel strands
- Concrete is pre-compressed
- Carries load without cracking

STEEL

What is Steel?

Steel is an alloy of iron, carbon and other trace metals

Carbon and trace metal ratios:

– Carbon	0.15 to 0.3%
– Manganese	0.50 to 2.0%
– Phosphorus	0.02 to 0.2%
– Sulphur	0.02 to 0.06%
– Silicon	0.15 to 0.8%

Iron

- Iron in the pure form is a soft, shiny metal like aluminum.
- However, it is never found in this state.
- Iron oxidizes extremely easily.
- In nature it is always found as an oxide.

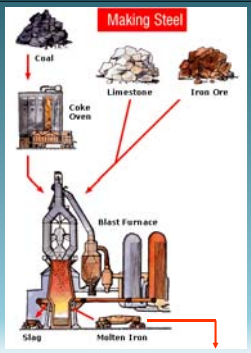
Steel Making Process

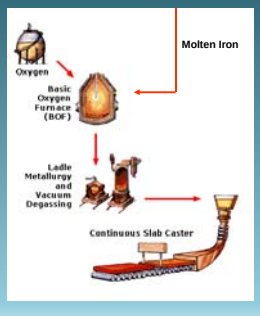
- Iron ore, coke and limestone are major raw materials.
- Raw material is charged into Blast furnace which has a temperature of 1600°C.
- Iron melts and settles at the bottom.
- Solidified iron is called “Pig Iron”

Steel Making Process

- Molten metal from blast furnace and silicon is taken into Basic Oxygen furnace
- Chemical analysis of the molten material is done
- Steel billets are heated to 1200°C for rolling and finished products.

Bridge Materials





Effects of Various Elements

Effects of Carbon in steel:
- Increases strength and hardness
- Reduces ductility, weldability, machinability and toughness

Effects of Phosphorus in steel:
- Increases strength and hardenability
- Reduces ductility and weldability

Effects of Various Elements

Effects of Manganese in steel:
- Increases strength, hardenability and notch toughness
- Reduces weldability
- Reduces ill effects of sulfur

Effects of Sulfur in steel:
- May cause porosity and hot cracking in welding
- Can cause brittleness

Effects of Various Elements

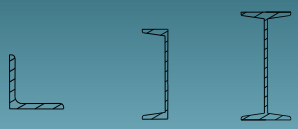
Silicon in steel:
- Increases strength, hardenability and notch toughness
- Reduces weldability
- Deoxidizer in steel making

Copper, Chrome, Nickel:
- Weathering steel (Cor-ten)

Common Steel Shapes

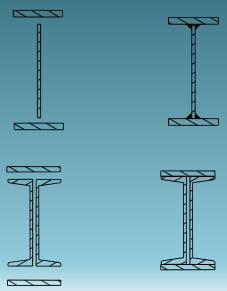
- Wires
- Cables
- Steel Plates
- Steel Bars
- Rolled Beams
- Built-up Shapes

Rolled Sections



Angle Channel Rolled I Beam

Built-up Sections

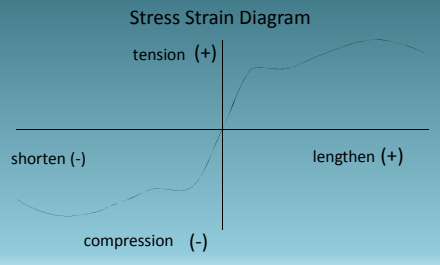


Bridge Materials

Important Physical Properties

- Strength
  - Compression
  - Tension
  - Fatigue
- Ductility
- Notch toughness
- Weldability
- Fire Resistant
- Corrosion Resistant

Tension & Compression



Steel Damage and Deterioration

Corrosion
- Environmental corrosion
- Stray current corrosion
- Stress corrosion

Cracking
- Fatigue
- Impact
- Excessive loading

Note: Any crack in a steel member is serious

Steel Damage and Deterioration

Deformation
- Excessive loading
- Heat damage
- Impact

Corrosion Holes in Girder Web

Stains from Soil Side Corrosion

Crack initiated by Bolt Hole

Collision damaged steel girder.

Fire Damaged Truss.

Fire Damaged Truss.

UNCONTROLLED WELDING IS NOT ALLOWED ON BRIDGE STRUCTURES.

TIMBER

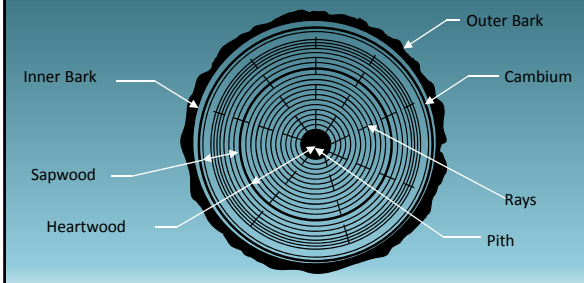
Wood

What is wood?
- A naturally occurring non- homogeneous material.

Composition of timber:
- Carbohydrate fibres
- Water

Classification of timber:
- Hardwood
- Softwood

Cross Section of Tree

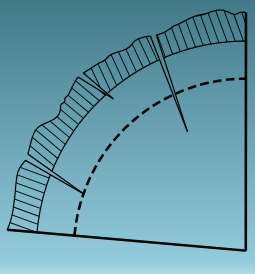


Growth Features

Growth features
- Knots
- Splits, Checks

Moisture content
- Moisture affects dimensional stability
- 19% moisture content is considered seasoned wood

Checks



Physical Properties

- Compression
  - perpendicular to grain
  - parallel to grain
- Tension
- Bending
- Fatigue
- Shrinkage
  - 60% radially
  - 2% longitudinally

Timber Damage & Deterioration

- Abrasion
- Warping
- Checks & Splits
- Cracking
  - Flexural
  - Horizontal Shear
- Fire Damage
- Collision Damage
- Decay

Timber Damage & Deterioration

- Decay is caused by fungi
- To grow fungi need:
  - Oxygen
  - Temperature
  - Food
  - Moisture
- Insects or borers are not a problem in Alberta

Protective Systems

- Water repellents
- Preservatives
  - Creosote
  - Cromated Copper Arsenate (CCA)
  - Ammoniacal Copper Zinc Arsenate (ACZA)
- Paint

Warping due to Drying Shrinkage

Bridge Materials

Horizontal Shear Crack.

Bridge Materials

Checking & Start of Rot

Bridge Materials

Serious Rot in Stringer

Bridge Materials

Fire Damaged Timber

Questions??

CONDITION RATING

Why we need a rating system

- A rating system provides:
  - a numerical representation of the condition of bridge elements and inspection categories.
  - a uniform method for describing the condition and functionality of an element
- The ratings can be used to:
  - flag safety related problems
  - identify elements in poor condition
  - assign priorities to repair, maintenance, etc
  - justify budget proposals
  - asses the health of the system
  - measure rates of deterioration to
    - properly time remedial work
    - identify premature failures
  - monitor performance of new materials or practices
  - Allow for various sorting of the numeric values

Types of ratings

- Condition ratings (elements)
- General ratings (summarizes respective sections)
- Structural Condition Rating (overall rating of the structure's structural condition in %)
- Sufficiency Rating (overall rating of structure sufficiency in %)
- Load rating

Rating System features

- Must rate
  - the individual elements of the structure
    - girders, railing, etc.
  - the major components
    - approach roads, superstructure, substructure, etc.
  - the overall condition of the structure
    - Sufficiency and structural ratings

Rating System features

- Identify and flag safety concerns
- Provide measure of condition
- Identify maintenance requirements

Rating System features

- Logical
- Simple to understand and to use
- Usable in an electronic system
  - numeric
  - easy to input
  - low storage requirement
  - sortable
- Easy to use in the field
  - visual - i.e., rate what you see

Rating System features

- Not based on
  - Maintenance budgets
  - Crew or contractor availability
  - Standards

Rating System features

- Rating is a measure of:
  - Functionality
  - Condition

Functionality

- The ability of an element to perform as originally designed
- Not measured according to today's standards
- Examples:
  - New timber railing
  - Rotten Timber cap

Condition

- The existing condition of the element taking into account any deterioration from the original new condition

Rating system

	Rating	Description
	9	Very Good (New)
	8	
3	7	Good
	6	
2	5	Adequate (fair)
	4	
1	3	Poor
	2	
	1	Immediate action

Rating system

- Based on a 1 to 9 numeric system
- Has special characters to denote
  - elements not applicable to a specific structure (X)
  - elements not sufficiently accessible for an adequate visual inspection (N)
- Measures functionality and condition of component

Rating system

- The element's current condition and functionality is compared to a range of defined values for
  - ratings
  - a condition
  - that rating is intended to mean
- Table 1.2 in Inspection Manual (page 1-9)
- With this course and field training, inspectors are able to rate elements within "1" point.
- Experience and periodic ongoing training after certification ensures consistency

Rating system

- Very Good to Good (9 to 7) range

RATING	DESCRIPTION	COMMENTARY
9	Very good.	• New condition. • No repairs in foreseeable future.
8		• Almost new condition. • No repairs required in foreseeable future.
7	Good.	• Could be upgraded to new condition with very little effort • No repairs necessary at this time.

Rating system

- Adequate (6 to 4) range

RATING	DESCRIPTION	COMMENTARY
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.
4		• Below minimum acceptable condition. • Low priority for repairs.

Rating system

- Poor to Immediate Action (3 to 1) range

RATING	DESCRIPTION	COMMENTARY
3	Poor	• Presence of distress or deterioration. • Not functioning as intended. • Need for replacement, repair, and/or signing.
2		• May require continued observation until work is completed. • 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.

Rating system

- Special Ratings:

RATING	DESCRIPTION	COMMENTARY
N	Not Accessible	• Element cannot be visually inspected.
X	Not Accessible	• Element not applicable to this bridge.

Maintenance Priority

- **4 is low priority for repair.**
  - Repair is added to list of more immediate repairs or if the bridge is to be rehabilitated.
- **3 is medium priority, repair before next inspection.**
  - Next inspection date may be on a shortened inspection cycle due to critical nature of element.
- **2 is high priority, repair within next 3 to 6 months.**
  - Reduce inspection cycle to end of intended repair date.
- **1 is immediate action.**
  - Follow-up is strongly recommended.

Rating Guidelines

- Rate the worst element
- See enough of the element to assign a rating
- Rating must be given for elements partly visible but what is visible is 4 or less.
- Blank ratings are not allowed
- If an element is not applicable but is required:
  - rate element X
  - provide comment in Explanation of Condition
  - provide maintenance recommendation

Rating Guidelines

- If an element is not constructed according to design or standards rate 4 or less
- Intended to flag rare and unusual situations that may be significant to the structure
- Does not apply to minor deviations from standard practice

Temporary Repairs

- Intended to be in place for less than two years
- Do not affect the element rating
- May be difficult to determine if repair is temporary or permanent
- Temporary repair may also be a special feature and require a condition rating
- Examples:
  - flexbeam guardrail strapped over damaged bridgerail
  - pile bent on mudsills

Permanent Repairs

- Intended to be in place more than two years
- Consider the effect of the repair when assigning a rating
- Complete replacement of element may increase rating to 9
- Simple repair may restore element to an acceptable condition and a rating of 5
- Examples:
  - steel cap replacing timber cap
  - shotcrete repair on culvert seam
  - equivalent timber stringer inserted beside broken stringer
  - steel banding of timber piles

Rating actions

- Ratings of 4 or less need an explanation of condition.
- Ratings of 3 or less need:
  - an explanation of condition
  - photographs, sketches and measurements as required
  - an accompanying recommendation for
    - maintenance
    - monitoring
    - other appropriate action.
  - Reduced inspection cycle may be warranted
- Take appropriate immediate action condition ratings of 2 or less for critical elements.
  - report to the Regional Bridge Manager including suggested action
  - report to the responsible road authority official including suggested action
  - erect warning signs
  - close bridge
  - Reduce the inspection cycle
  - Suggest follow-up with authorities if extreme hazard.

Rating actions

- Recommendations for maintenance need
  - a detailed explanation of the recommendation
  - a photo showing damage to be repaired
  - Recommended repair year
  - a list of required maintenance materials showing dimensions and quantities.
    - routine or minor maintenance
    - reasonably obtainable during a Level 1 inspection

General Rating

- Required for all inspection categories
  - approach road
  - superstructure
  - substructure
  - channel or grade separation
- Provided by the inspector after rating the individual elements in the category
- Ratings are done in accordance with same numerical rating system used for condition rating of elements
- Used to calculate
  - Structural Condition Rating
  - Sufficiency Rating

General Rating

- Is a reflection of the critical element ratings in the category

BUT

- Is not the average of the ratings of the individual elements
- Must consider the condition of key elements and their impact on the structural integrity and safety of the bridge
  - load carrying members have greater influence than non load carrying members
- General rating cannot be higher than lowest critical rating
- General rating could be lower than lowest critical rating

General Rating

Examples:

- A timber cap with a rating of 3 would result in a general rating of 3 for the substructure
- Curbs with a rating of 3 do not impact the general rating for the superstructure to the same degree

Structural Condition Rating

- A measure of the structural condition of the entire structure
- Single numerical value
- For bridges:
  - The average of the superstructure and substructure General Condition Ratings as a percent of the "as new" rating

$$\text{Structural Condition Rating} = \frac{(\text{Superstructure Rating} + \text{Substructure Rating})}{18} \text{ X } 100\%$$

  - For Culverts:
  - The Barrel General Condition as a percent of the "as new" rating

$$\text{Structural Condition Rating} = \frac{(\text{Barrel General Condition Rating})}{9} \text{ X } 100\%$$

Sufficiency Rating

- The sufficiency rating is a single numerical value
- It indicates the adequacy of a structure relative to the acceptable standard of a new structure at the same location

Sufficiency Rating - Bridges

- Calculated automatically by the computer from inspection and inventory data then printed on the last page of the form.
- Uses 4 major impact categories
  - Structural Condition
  - Load Carrying Capacity (strength)
  - Operational and Safety
  - Traffic Reduction Factor
- Major categories are further divided into a total of 10 categories.
- Categories weighted in accordance with their relative importance.

Sufficiency Rating Calculation
Bridges (page 12.1)

A. Structural Condition (35%)	Superstructure (20%)
	Substructure (15%)
B. Strength (20%)	Load Rating (20%)
C. Operational & Safety (45%)	Approach Road (12%)
	Bridge Width (10%)
	Vertical Clearance (8%)
	Channel Adequacy (10%)
	Safety Features (5%)
D. Traffic Reduction Factors (15%)	Traffic Count (5%)
	Detour Length (10%)
Sufficiency Rating = A + B + C - D	

Sufficiency Rating - Culverts

- Calculated automatically by the computer from inspection and inventory data then printed on the last page of the form.
- Uses 3 major impact categories
  - Structural Condition
  - Operational Features
  - Reduction Factor
- Major categories are further divided into a total of 10 categories.
- Categories weighted in accordance with their relative importance.

Sufficiency Rating Calculation
Culverts (page 14-1)

A. Structural Condition (55%)	Upstream End (7.5%)
	Barrel Section (40%)
	Downstream End (7.5%)
B. Operational Features (45%)	Approach Road (15%)
	Channel Section (5%)
	Waterway Adequacy (25%)
C. Traffic Reduction Factors (15%)	Traffic Count (5%)
	Detour Length (5%)
	Vertical Clearance (5%)
	Environmental (10%)
Sufficiency Rating = A + B - C	

Sufficiency Rating Descriptions

- Ranges from 0% to 100 %
- 100% represents a bridge that is in excellent condition and provides the best possible level of service.
- 50% represents a bridge that is in adequate condition and provides an acceptable level of service.
- Lower ratings indicate a bridge that is in poor condition and/or provides a below minimum level of service.
- Lower ratings also indicate need for replacement, rehabilitation or maintenance.

Sufficiency Rating Uses

- Provides a rational basis for bridge management.
- Evaluates the present adequacy to serve public needs.
- Identifies structures with deficiencies which can be corrected at minimum cost to provide acceptable levels of service.
- Provides data to evaluate the cost of upgrading a structure to provide an acceptable level of service.

Sufficiency Rating Cautions

- Should not be used as the only basis for bridge management decisions.
- Does not include or identify:
  - cost/benefit analysis
  - social factors
  - economic factors
  - environmental factors
  - alternatives
  - optimal solutions
  - timing constraints
  - budgetary constraints

BRIDGE INVENTORY INFORMATION

Inventory Information

- On inspection forms to assist inspector
- Sources
  - Transportation Infrastructure Management System (TIMS)
  - Inspectors add new data, verify existing or revise as required
  - future pick lists for addition or revision

How Are Bridges Identified?

- **Bridge File Number** (99999) assigned to each bridge site
  - 5 digit number
  - leading zeros, eg. **00987**
  - assigned in sequence
  - example: 75555
- Structure Number (99) assigned to each bridge at site
  - example: **1, 2, 3, etc.**

How Are Bridges Identified? continued

- Visual Identifiers
  - Travel Direction
  - Structure Type
  - blank = Two Way Traffic
  - N = Northbound Structure
  - EC = Eastbound Collector
  - ZNC = Sign Structure on Northbound Collector
  - example: **75555-ZNC-3**
- Year Built
  - First year substructure or barrel built
  - Second year superstructure fabricated

Where is the Bridge?

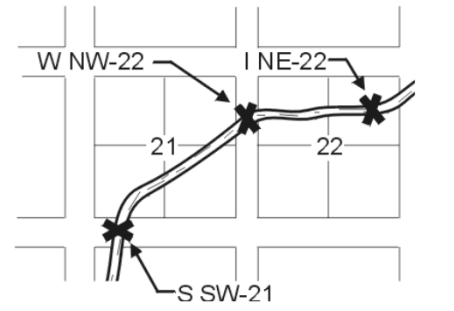
- Bridge Name or Nearest Town
  - bridge official name
  - nearest town on road map
- Located Over
  - Watercourse, Road, Railway, etc.
- Located On
  - Highway or Local Road
  - Includes Control Section (2.03)
- Contract Maintenance Area
  - Highways

Watercourse Designations

- Water Body Class & Year
  - future
  - water class of the watercourse
  - year designated by Environment
- Navigable Waters Class & Year
  - future
  - Navigable Class of Stream
  - Year Classified

Where is the Bridge?

- Legal Land Location
  - ie WNW 22 - 028 - 03 - 5

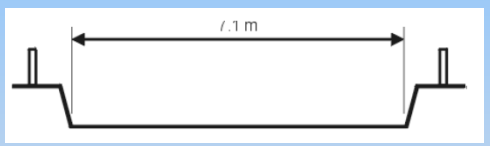


- Prefix is always W, S or I
- Longitude Latitude - Future

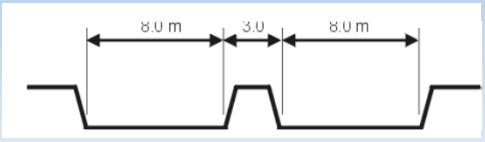
Road Authority

- Alberta Transportation (AT)
- County or Municipal District (C01 or M36)
- Town or Village (T or V)
- City (USA stands for Urban St Albert)
- Municipal Affairs (MA)
- Federal Government Departments (FIA)
- Private (P)

What is Clear Roadway?



- Typical Bridge Clear Roadway = 7.1 m

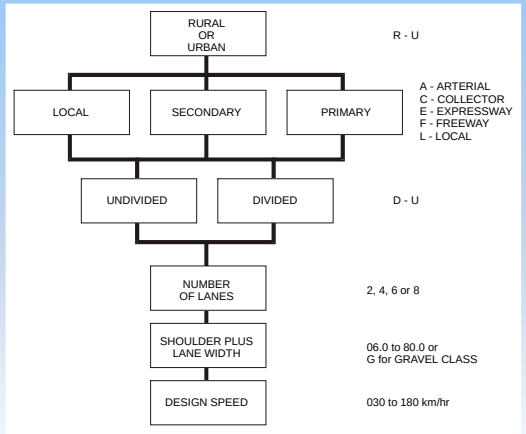


- Bridge with Median Clear Roadway = 16.0 m
- No curbs, measure inside rails

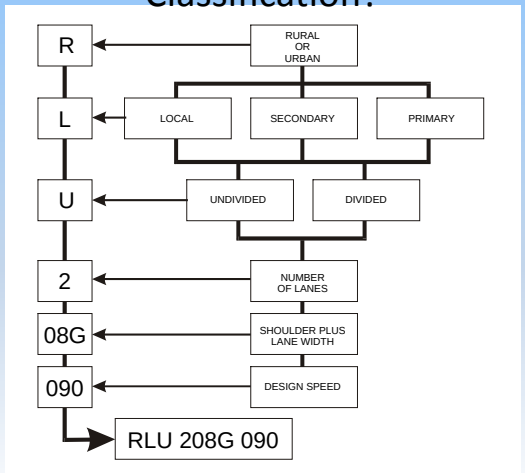
Average Annual Daily Traffic

- Field is three parts ie.150/2005 (E)
- Traffic Volume 150
  - Count adjusted for time of day & month
- Year 2012
  - year count taken
- Type of Traffic Count (E) or (A)
  - "A" is actual from inventory
  - "E" is estimate by inspector

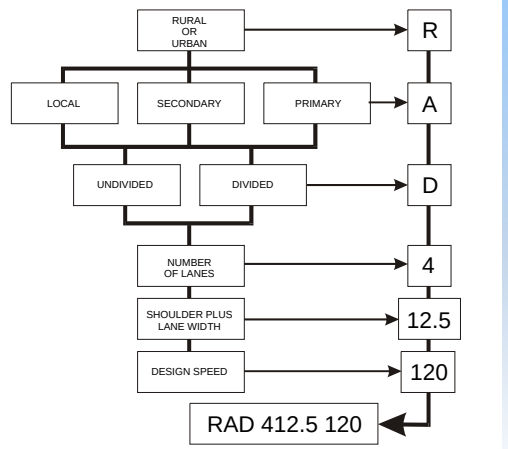
What is the Road Classification?



What is the Road Classification?



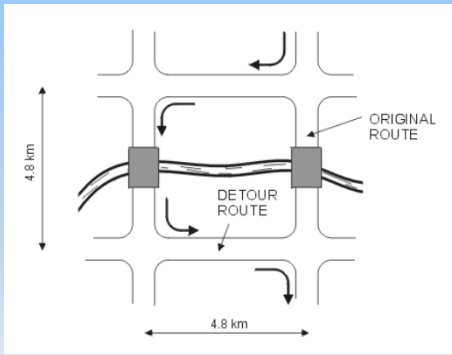
What is the Road Classification?



Standard Road Classifications

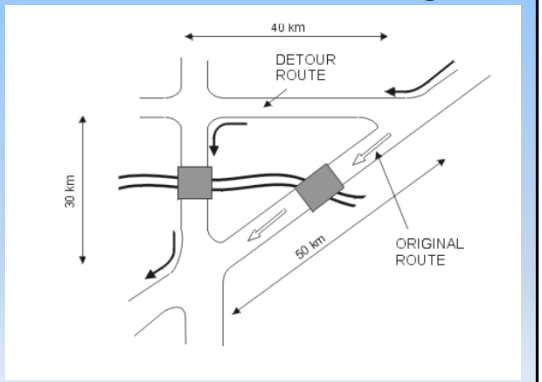
- Local Roads (gravelled)
  - RLU-207G-60
  - RLU-208G-60
  - RLU-208G-90
  - RLU-209G-90
  - RLU-210G-90
- Local Roads (paved)
  - RLU-208-100
  - RLU-208-110
- Provincial Highways
  - RCU-208G-090
  - RCU-209G- 090
  - RCU-208-110
  - RCU-209-110
  - RCU-210-110

What is the Detour Length?



Detour length is extra distance traveled = 9.6 km

What is the Detour Length?

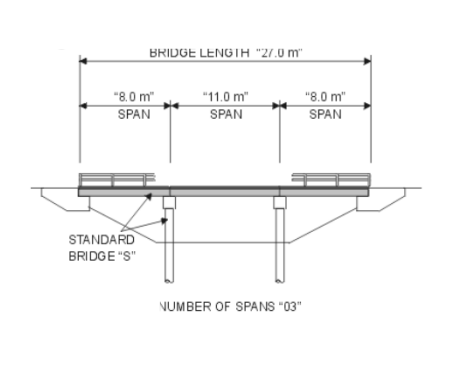


Detour length is the extra distance traveled = 40 km + 30 km - 50 km = 20 km

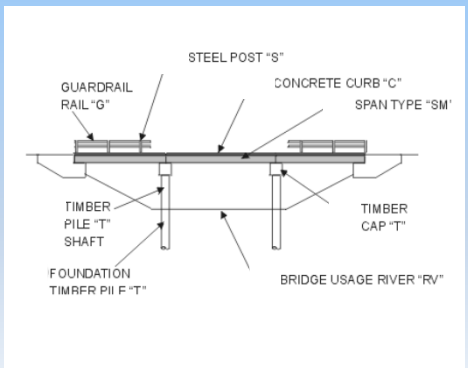
What is Posted Clearance?

- Only on:
  - grade separation
  - pedestrian overpass
  - through truss
- Lowest measured clearance between road and bridge less tolerance
- Calculation
  - Minimum measured clearance = 4.88 m
  - Tolerance 0.10 m
    4.78 m
  - Round down to nearest decimeter = 4.7 m (1/10th of a metre)
  - BIM Required Vert. Clearance Posting = 4.7 m
  - TIMS Data = 4.8 m

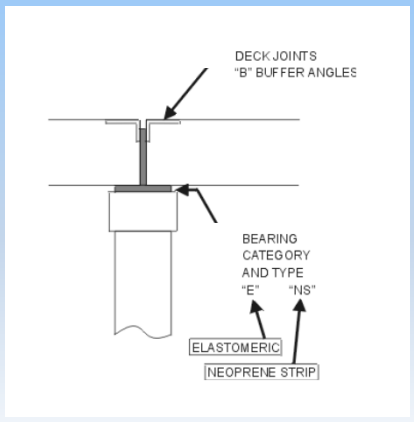
Bridge Details



Bridge Components



Bridge Components



BRIDGE POSTING AND UTILITIES

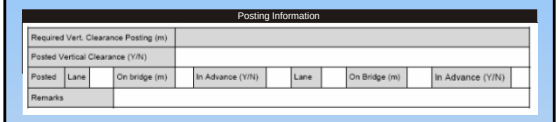
Posting and Utilities Information

- Entered into TIMS BIS application at first inspection
- On subsequent BIM reports
- Inspectors verify information is correct
- Note changes for updating

Responsibility for Posting

- All bridges on local roads are responsibility of Local Road Authority, County, MD, Town
  - passing by-laws
  - installing and maintaining

Vertical Clearance



- On culvert Grade Separations and other various Major bridge forms
- Mounted at midpoint over travel lanes
- Advance warning in each direction
- Legal height 4.15m
- New structures are 5.35m

Vertical Clearance

- Inspection and Coding
  - look for signs in advance and on bridge
  - legible and visible
  - clearance values consistent
  - signs missing circle “N”
  - note direction and location if missing and notify responsible authority
  - look for new pavement or gravel
  - notify Bridge Manager if measurement required

Vertical Clearance Posting is Important!

Posted Loading

Required Load Posting (tonnes)			Single		Semi		Truck Train	
Posted Loading (tonnes)			Single		Semi		Truck Train	
Posted	Lane		At Junction (Y/N)		Advance (Y/N)		At Bridge (Y/N	
Posted	Lane		At Junction (Y/N)		Advance (Y/N)		At Bridge (Y/N	
Remarks:								

- Bridges less than legal load are posted
- Local Road Legal
  - CS 1 28 tonnes
  - CS 2 49 tonnes
  - CS 3 54 tonnes
- Provincial Highways
  - CS 1 28 tonnes
  - CS 2 49 tonnes
  - CS 3 63.5 tonnes

Posted Loading

Allowable Load (t):	Single	CS1 37 GIRDER		Semi	CS2 53 GIRDER		Train	CS3 73 GIRDER		---> On Critical Spans ---> Critical Member	
Design Loading:		HS20								---> Primary Span	
Posting Information											
Required Load Posting (t)			Single			Semi			Truck Train		
Posted Loading (t)			Single			Semi			Truck Train		
Posted:	Lane	NB	At Junction (Y/N)	No		In Advance (Y/N)	No		At Bridge (Y/N)	No	
Posted:	Lane	SB	At Junction (Y/N)	No		In Advance (Y/N)	No		At Bridge (Y/N)	No	
Remarks:	Not required.										

- Inspection and coding
  - note posting at the junctions of roads leading to bridge, in advance, and at the bridge structure
  - legible and visible
  - loading values on sign consistent with rated load or “Required Load Posting” on report
  - may be posted less than rating due to conditions
  - note missing or incorrect signs, report to responsible authority

Posted Loadings

Hazard Markers

Hazard Marker At Bridge (Y/N)	
Remarks	
Other Sign Types	

- All bridges when bridge clear road less than approach road
- All standard bridges on local roads
- Black stripes down toward road

Hazard Markers

- Inspection and Coding
  - noting orientation and location (in line with bridge railing & 1200mm above deck top/wearing surface)
  - note condition
  - missing “N”
  - problems notify responsible authority

Other Signs

- Narrow Bridge, Speed Limit, Curve, Bump,
  - note condition, legibility
  - record type and location

Utilities

	Utilities (Located at)		
Telephone		Gas	
Power		Municipal	
Others		Problem (Y/N)	
Remarks			

- Utility owner responsible for maintenance and operation
- Note only those on or near bridge
- Check if utility
  - overloads bridge
  - interferes with maintenance or operations
  - hazard to public or bridge
  - unattractive appearance (corrosion)
- Installed with approval of AT Regional staff

Utilities Proper Locations

- Newer concrete bridges
  - ducts in curbs for Telephone and Power
- Reinforced concrete precast
  - clamp on side of curb or clamped to rail
- Pre-stressed concrete precast
  - in outside void of stringer
- Should not interfere with bridge or culvert maintenance

Utilities Improper Attachments

- Drilled into pre-stressed girders
- Explosive fasteners in steel or concrete
- Welding or drilling on steel members
- Oversize holes in timber
- Failure to treat cut timber

Utilities

- Inspection and Coding
  - note location of power, phone, etc. (i.e. East ROW)
  - remark if hazardous, report to owner
  - look for improper installation
  - look for leaks in water, sewer or gas
  - check connections for safety
- Notify owner of bridge (AT or LRA) concerning problems or defects

Culverts

- Vertical clearance only if underpass
- No load posting
- Utilities typically not in culverts
- May have ducts in headwalls
- Record location of power, phone, etc. (i.e. West ROW)

Major Bridges

- Local Road Authorities are responsible for signing of major bridges on Local Roads
- Lack of signs
  - legal liability
  - damage bridges
  - damage / injury to public
- Report missing or incorrect Posted Loading signs to Bridge Manager

Approach Road Inspection and Rating

Introduction

- Approach road is the road leading up to the bridge structure
- For culverts it includes the road fill over the culvert
- Considers
  - Geometric alignment at the bridge site
  - Condition of approach fill
  - Inventory and condition of guardrail on approaches
  - Drainage on approaches to bridge

Approach Road Section - Bridges

		Approach Road		
		Last	Now	Explanation of Condition
Horizontal Alignment				
Vertical Alignment				
Roadway Width (m)				
Approach Bump				
Guardrail (Y/N)				
Guardrail				
Length (m)				
Current Standard (Y/N)				
Termination Type				
Drainage				
Approach Road General Rating				

Road Use

- Roads are used by:
- Old people who may have reduced abilities
- Teenagers who just got licenses
- Immigrants who are still inexperienced
- Inattentive drivers
- Impaired drivers
- Drivers who speed
- Bad drivers
- Drivers who are unfamiliar with the area
- Autos that have bald tires

- Right or wrong, alignment handles them all. Coupled with abuse, success is not always guaranteed.

Approach Road Section - Culverts

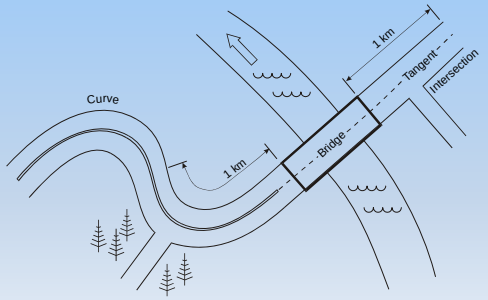
Approach Road / Embankment				
		Last	Now	Explanation of Condition
Horizontal Alignment				
Vertical Alignment				
Roadway Width (m)				
Embankment				
Sideslope (_:1)				
(Height of Cover)m) :)				
Guardrail (Y/N)				
Approach Road / Embankment General Rating				

Alignment

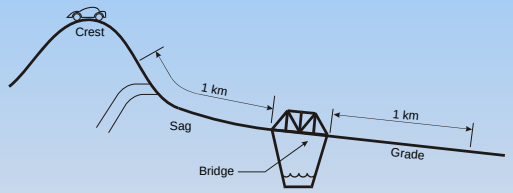
Approach Road / Embankment				
		Last	Now	Explanation of Condition
Horizontal Alignment				
Vertical Alignment				

- Separate rating to be provided for horizontal and vertical alignments
- Defects in alignment must be categorized in either the horizontal or vertical components
- Inspector should consider road alignments are used during adverse weather or road conditions – e.g. fog, heavy rain, snow, ungravelled surfaces, icy roads

Length of Approach



Length of Approach



Alignment

- Design speed is the posted legal speed for road plus 10 kph
- Evaluate by driving at the legal speed limit - if safe to do so and if conditions permit.
- Observe sight distances
- Note if bridge is superelevated
- Note presence of speed limit or other signs
  - Sharp curve
  - Bus stop ahead
    - indicates sight distance problem
  - Intersection ahead
    - indicates sight distance problem

Horizontal Alignment Defects

- Horizontal defects result in a reduction in speed to drive the road safely. They include:
  - Reduced visibility – trees, buildings, embankments
  - Sharp corners
  - Intersecting roads
  - Bridge is at beginning of curve
  - Bridge is offset from straight alignment
  - Note if passing can still be done safely

Horizontal Alignment Ratings

- Note presence of intersecting roads and record location on form (Field accesses do not affect rating).
  - Rate 7 or less depending on visibility, traffic volume and traffic type.
  - Rate may be 8 or 9 if no intersections for 1km
- If horizontal defect is cause of reduced speed, then rate:
  - 6 or more if driven safely at legal speed limit
  - 5 if can be driven safely and posted not more than 20 km/hr below legal speed limit
  - 4 or less if posted more than 20 km/hr below the legal speed limit
  - 4 or less if sharp or blind curves
  - 5 if Land Access bridge and appropriate warning signs are in place.

Vertical Alignment Defects

- Vertical alignment defects result in a reduction in speed to drive the road safely. They include:
  - Reduced visibility – crests in road
  - Steep grades (take into consideration road surface e.g. loose gravel)
  - Adequate sight distance for stopping or passing
  - Intersecting roads

Vertical Alignment Rating

- Vertical alignment with a straight grade of 1% or less - rate 9
- If road can be driven safely at legal speed limit rate 6 or more
- If road can be safely driven and posted not more than 20 km/hr below legal rate 5
- Rate 4 or less if:
  - posted more than 20 km/hr below posted speed
  - sight distance is less than required
  - Steep grades, blind crest curves
- Rate 2 if combined effect of horizontal and vertical alignment is hazardous (e.g. very steep hill combined with sharp hair-pin curve)
- Rate 5 if Land Access bridge

Alignment

- For land access structures:
  - Road services land only, not residential access
  - Local road standards do not apply
  - Consider suitability for traffic
- If adequate for intended use and appropriate warning signs are in place, the Horizontal and Vertical alignment ratings can be rated 5

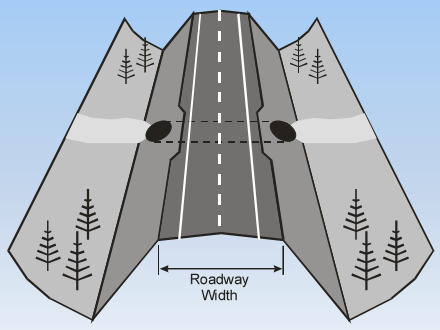
.

Roadway Width

		Approach Road / Embankment		
		Last	Now	Explanation of Condition
Horizontal Alignment				
Vertical Alignment				
Roadway Width (m)				

- This is the width of the traveled lanes and shoulders
- Do not include median width if present
- If curbs on the approach road, measure between faces
- Measure at a representative cross-section
- Record to the nearest 0.1m
- Provide explanation if different on each side of structure

Roadway Width



Approach Bump

		Approach Road		
		Last	Now	Explanation of Condition
Horizontal Alignment				
Vertical Alignment				
Roadway Width (m)				
Approach Bump				

- Bridges only
- Refers to the smoothness of the transition onto the structure
- Severe bump
  - Can be hazard to traffic
  - Increases impact on structure

Approach Bump

- May be a symptom of
  - Settlement of the approach fill
  - Instability of the fill (slumping)
  - Undermining of fill by water
  - Settlement of or damage to approach slab
- Drive over at legal speed if safe – or at safest speed that conditions allow
- Observe traffic crossing structure
- If no defects and smooth transition rate 9
- If bump is noticeable but tolerable - rate 5
- If speed must be reduced - rate 4 or less
- If hazardardous to traffic - rate 2 or less

Guardrail

		Approach Road		
		Last	Now	Explanation of Condition
Horizontal Alignment				
Vertical Alignment				
Roadway Width (m)				
Approach Bump				
Guardrail (Y/N)				
Guardrail				
Length (m)				
Current Standard (Y/N)				
Termination Type				

- Refers to the guardrail or other traffic barrier along the edges of the approach road
- Purpose:
  - Prevent traffic from leaving the roadway at the structure
  - Prevent traffic from impacting structure

Guardrail - Culverts

- Rating is not required
- Record the presence of guardrail by **Yes** or **No**
- Provide comment if guardrail is on one shoulder only
- Guardrail that is too short or is otherwise ineffective – provide comment and maintenance recommendation
- Provide comment and maintenance recommendation if missing and is required for safety
- Note defects (e.g. - broken posts, damaged rails) and provide comment and maintenance recommendation

- ***No*** indicates no guardrail

Guardrails - Bridges

- Record the presence of guardrail by **Yes** or **No**
- Record the minimum length to the nearest meter
  - Explain if different lengths exist
- Maximum is 99 m
- Record the type of termination
  - Common type is Turned Down, wing, Attenuator
- Based on current Standard Drawings record if the guardrail meets current standards (Yes/No)
  - Explain if No
  - Acceptable explanation is “Not thriebeam”
- Link to current Standard Drawings:
- http://www.transportation.alberta.ca/4855.htm

Guardrails - Bridges

- Inspect up to 45m from bridge
- Inspect all components of guardrail
  - Posts
  - Rail
  - Connections
  - Splices
  - Termination
- Rate according to condition only - not standard
- Minor damage but still functional – rate 5
- Missing bolts or improper laps - 4 or less
- Damaged - requires replacement – rate 3 or less
- Damaged – potential hazard – rate 2 or less
- Rate “X” if no guardrail exists
  - If required, recommend action and explain

Drainage

- Applies to bridges only
- Refers to the ability of the approaches to handle drainage
  - Must not allow water to drain onto structure
  - Must not allow damage to fills or headslopes
  - Must not pond on approaches
- Includes drain troughs on approaches
- Water may originate from
  - Precipitation onto approaches
  - Runoff from roadway
  - Runoff from structure

Drainage

- Look for:
  - Ponding of water on approaches or ends of structure
  - Erosion of fills, sideslope or ditches
  - Voids under approach slabs or abutments
  - Undermining of drain troughs
  - Damage or deterioration of drain troughs

Drainage

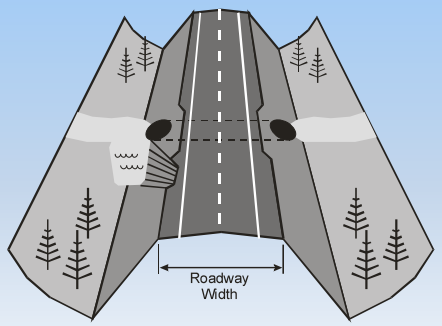
- Good drainage away from bridge – rate 5 or more
- Drainage onto bridge gutters - rate 4 or less
- Drainage onto bridge driving lanes-rate 3 or less
- Drainage eroding headslope or sideslope – rate
- 4 or less
- Erosion from approach road ditch drainage – rate 4 or less
- Drainage causing a hazard - rate 2 or less (e.g. ponding or icing into travel lanes)

Embankment

Approach Road / Embankment				
		Last	Now	Explanation of Condition
Horizontal Alignment				
Vertical Alignment				
Roadway Width (m)				
Embankment				
Sideslope (_:1)				

- Applies to culverts only
- Rates the stability of the road embankment at the culvert and the effects on:
  - traffic
  - structural and functional integrity of the culvert
- Evaluates:
  - roadway surface
  - sideslopes
  - transitions at ends of culvert

Embankment



Embankment

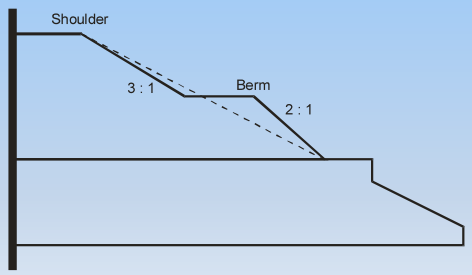
Refers to Culvert Approach Roads

- Look for:
  - cracks or other evidence of instability
  - signs of erosion such as gullying on sideslopes
  - scour at toes of sideslopes or end transitions
- Embankments with no instability or scour/erosion - rate 9
- Embankments with erosion problems - rate 4 or less
- Unstable embankments causing damage to the culvert - rate 3 or less
- Unstable embankments affecting roadway - rate 3 or less

Sideslopes

- Estimate or measure the slope of the sideslope (h:v)
- Record steeper of upstream or downstream sideslope
- If berms or different slopes on the same side, record steepest slope
  - Do not record average slope
- Explain if sideslopes are irregular
  - varying slopes
  - benches or berms
  - different slopes on each sideslope

Sideslopes

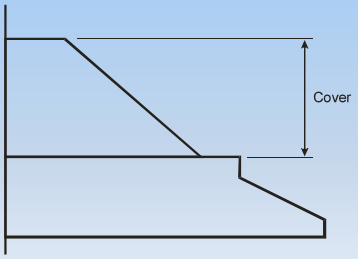


Height of Cover

		Last	Now	Explanation of Condition
	Approach Road / Embankment			
Horizontal Alignment				
Vertical Alignment				
Roadway Width (m)				
Embankment				
Sideslope (_:1)				
(Height of Cover)m) :)				
Guardrail (Y/N)				
Approach Road / Embankment General Rating				

- The vertical distance between the centreline roadway surface and the crown of the culvert
- If different - measure at both ends and record <u>average</u>
- Need to be accurate for low covers
  - Live load effects are greater
- Record to the nearest 0.1m

Height of Cover



General Rating

Refer to 1.10. 1 and 6.8 (Bridges)
Refer to 1.10.6 and 13.4.6 (Culverts)

- Governing Elements
  - Horizontal alignment
  - Vertical alignment
  - Safety Concerns (severe approach bump)
  - Potential hazards (Drainage causing ponding/icing
  - Embankment rating of 3 or less (Culverts)
  - Guardrail that is damaged resulting in a hazard (i.e.
- Missing approach rails that create a hazardous situation may govern the Gen. Rating (rate 2)

Questions??

BRIDGE LOADING AND RATING

LOADS

Types of Loads

Bridges are subjected to many different types of loads.

There are three important types of bridge loads:

- Dead load
- Live load
- Other loads

Dead Load

Dead load consists of the self-weight of the bridge.

The load is usually stationary and permanent.

Typical dead loads are:

- Beams and girders
- Concrete deck
- Asphalt wearing surface
- Curbs
- Railing

Live Load

Live loads are usually temporary and are applied in a short duration of time.

The loads are usually moving.

Typical types of live loads are:

- Truck load
- Dynamic load allowance (impact)
- Pedestrian load
- Longitudinal live load

Other Loads

The bridge is subjected to other loads beside dead and live load.

Other typical bridge loads are:

- Wind load
- Earth pressure
- Ice pressure
- Temperature effects
- Collision loads

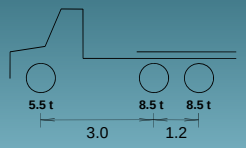
Rating Bridges

- Many older bridges were designed to carry smaller and lighter trucks.
- Are these older bridges capable of carrying today's heavier and longer legal truck configurations?
- Bridges are rated to determine the load carrying capacity of the bridge.
- Generally only the superstructure is load rated.
- The ratings normally assume that the bridge is in good structural condition.

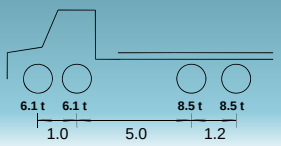
Real Truck Configurations

- There are many truck configurations that can legally travel on Alberta roads.
- The truck configurations are grouped into three categories:
  - Single unit trucks
  - Tractor semi-trailers
  - Truck trains
- Within each of the categories there are many different weights and axle configurations.

Typical Legal Single Unit Trucks

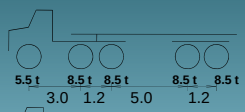


22.5 tonnes

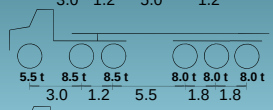


29.2 tonnes

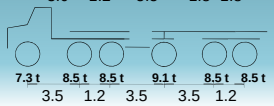
Typical Legal Single Unit Trucks



39.5 tonnes



46.5 tonnes

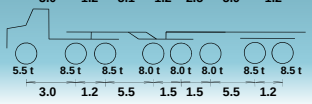


50.4 tonnes

Typical Legal Truck Trains

56.5 tonnes

60.5 tonnes

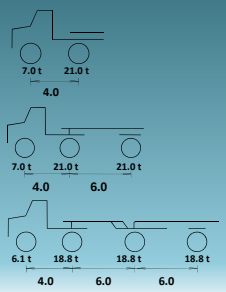


63.5 tonnes

Rating Truck Models

- Each one of the trucks produces unique forces and stresses in the bridge.
- It is not practical to load rate the bridge for each one of the real truck configurations.
- A model truck is used to represent each one of the truck configuration categories.
- CS1 Rating Truck Model - Single unit trucks
- CS2 Rating Truck Model - Tractor semi-trailer
- CS3 Rating Truck Model - Truck trains

Rating Truck Models



CS1 Rating Truck Model

28 tonnes

CS2 Rating Truck Model

49 tonnes

CS3 Rating Truck Model

63.5 tonnes for Primary & Secondary Highways
54 tonnes for Local Roads

Load Rating a Bridge

Step 1
- calculate load carrying capacity of critical member

Step 2
- calculate Dead Load this member is required to carry

Step 3
- member capacity less Dead Load, etc. is Live Load that the member can carry

Rating Equation

Rating Equation $$LLRF = \frac{R - D}{L(1 + I)}$$

Where:
- LLRF = live load rating factor (fraction of the rating truck the bridge can safely carry)
- R = load the bridge can safely carry
- D = dead load of the bridge
- L = live load due to the rating truck model
- I =impact factor

Rating Equation (Cont'd)

Live load rating factor (LLRF) is calculated for each rating truck model.

A LLRF of 1.0 or greater indicates that the bridge is capable of safely carrying the current legal load for the particular truck category.

Legal Loads

Highway Type	CS1 Truck Single Unit	CS2 Truck Semi-Trailer	CS3 Truck Truck-Trains
Primary	28	49	63.5
Secondary	28	49	63.5
Local	28	49	54

Note: Loads are expressed in tonnes

Bridge Load Evaluation Manual"

For further information refer to Alberta Transportation "Bridge Load Evaluation Manual" at:

http://www.transportation.alberta.ca/4824.htm

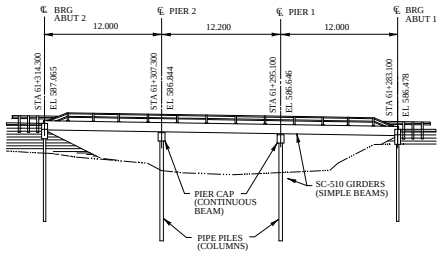
Basic Structural Considerations

Introduction

- Bridge members must be able to carry the loads applied to them.
- This presentation considers:
  - how loads are applied to members
  - how bridge members are stressed by loads
  - how bridge materials resist stress

Beams

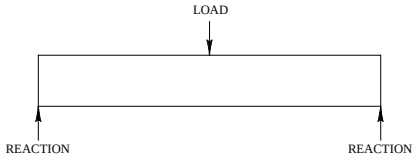
- Different member types carry load in different ways.
- Beams are members which are loaded perpendicular to their length.
- They are also referred to as stringers and girders.



ELEVATION

Simple Beams

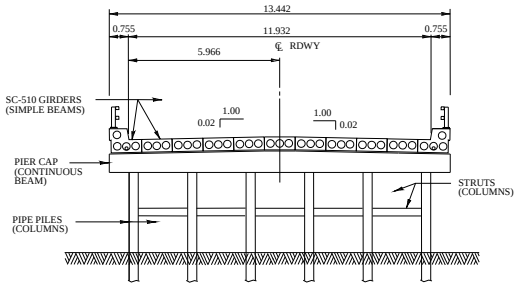
- Shown below is a Free Body Diagram of a simple beam.



- In this diagram arrows are used to show the forces (loads and reactions) acting on the beam.
- These arrows are drawn at the points the forces are applied and in the directions they act.
- Reactions are the forces that support a member.
- They are exerted by other members or by the ground.

Continuous Beams

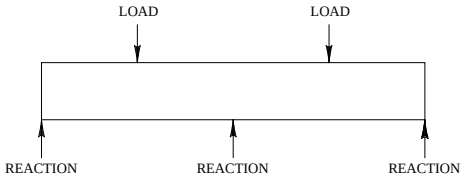
- A continuous beam is a beam that is supported at intermediate points along its length.



TYPICAL CROSS-SECTION

Continuous Beams

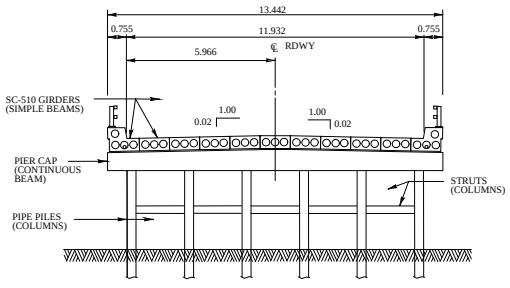
- Shown below is a Free Body Diagram of a continuous beam.



- The addition of intermediate supports allows a beam to carry more load.

Columns and Hangers

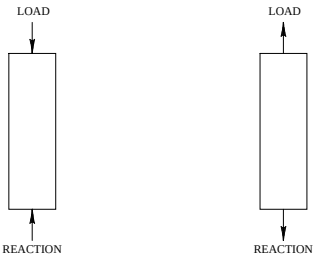
- Columns and hangers are members which are loaded parallel to their length.
- Columns are loaded in compression; hangers in tension.



TYPICAL CROSS-SECTION

Columns and Hangers

- Shown below are Free Body Diagrams for a column and a hanger.



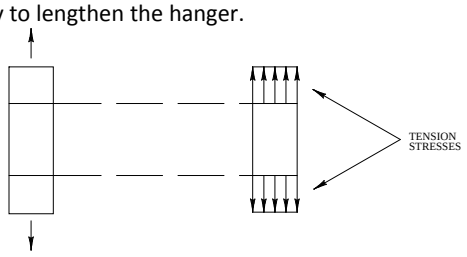
Column Hanger

Stresses

- Loads cause stresses in a member.
- Stresses are the internal forces that the member experiences at its different locations.
- Stress has units of Force/Area e.g. kips per square inch (ksi), Newtons per square millimetre (MPa).
- The following types of stress occur in bridge members:
  - tension stress
  - compression stress
  - bending stress
  - shear stress

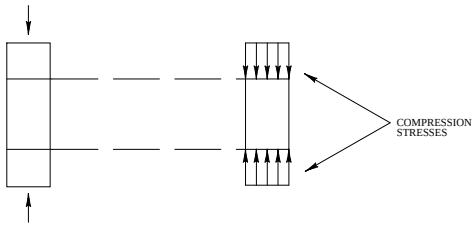
Hangers - Tension Stress

- Below is a Free Body Diagram of a hanger as well as of a piece cut out from the hanger.
- What stresses must be present at the cuts to keep the pieces of the hanger from separating?
- The stresses are the same at each location and try to lengthen the hanger.



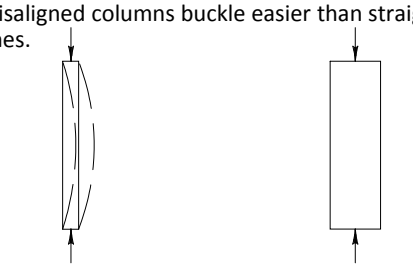
Columns - Compression Stress

- Below is a Free Body Diagram of a column as well as of a piece cut out from the column.
- What stresses must be present at the cuts to keep the pieces of the column apart?
- The stresses are the same at each location and try to shorten the column.



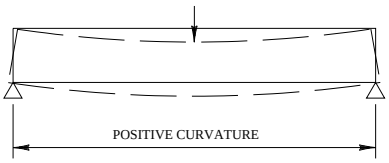
Columns - Buckling

- Compression stresses can also cause buckling of a column.
- Slender columns buckle easier than stocky ones.
- Misaligned columns buckle easier than straight ones.



Simple Beams - Curvature

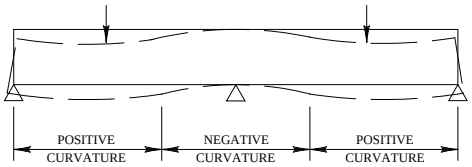
- Bending stresses caused curvature of the beam.
- The larger the curvature; the larger the bending stresses.
- The curvature causes sections of the beam to rotate.
- Simple beams go into positive curvature.



SIMPLE BEAM CURVATURE

Continuous Beams - Curvature

- Continuous beams go into both positive and negative curvature.

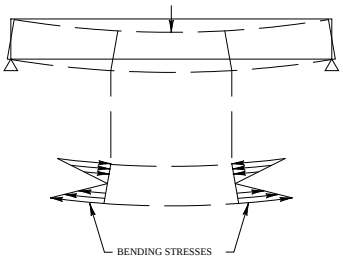


CONTINUOUS BEAM CURVATURE

- Curvature is generally positive away from intermediate supports with maximum positive curvatures occurring beneath the loads.
- Curvature is generally negative near intermediate supports with maximum negative curvatures occurring at intermediate supports.

Simple Beams - Bending Stress

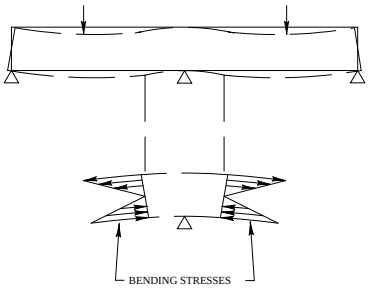
- Below is a Free Body Diagram showing a section of beam in positive curvature.



- The top of the beam is being pushed together (compression) while the bottom of the beam is being pulled apart (tension).
- The mid-height of the beam does not change length and is not stressed.

Continuous Beams - Bending Stress

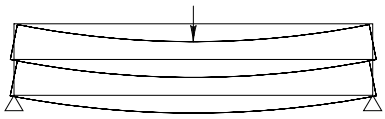
- Below is a Free Body Diagram showing a section of beam in negative curvature.



- The top of the beam is being pulled apart (tension) while the bottom of the beam is being pushed together (compression).
- The mid-height of the beam does not change length and is not stressed.

Beams - Horizontal Shear Stress

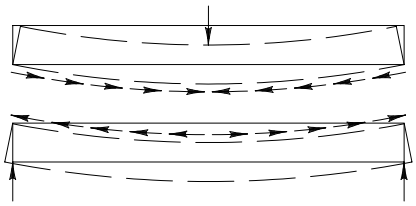
- Horizontal shear stress is caused by beam curvature.
- Below are two beams in bending, one on top of the other.
- The bottom of the top beam lengthens while the top of the bottom beam shortens causing the beams to slide past each other.



- If the two beams become one beam sliding can no longer occur.

Beams - Horizontal Shear Stress

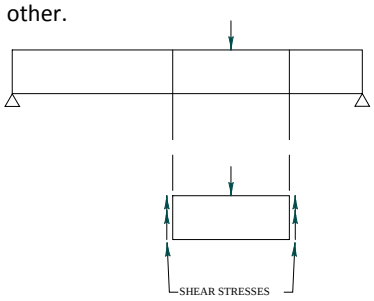
- Below are two Free Body Diagrams showing the horizontal shear stresses required to prevent sliding along a longitudinal cut of a beam in positive curvature.



HORIZONTAL SHEAR STRESSES

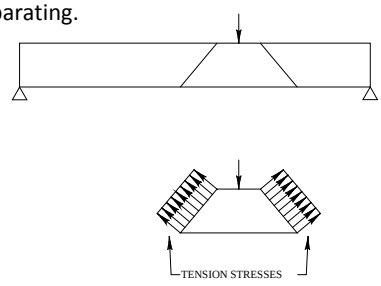
Beams - Vertical Shear Stress

- Below is a Free Body Diagram of a piece of beam.
- Shear stress must be present at the vertical cuts to keep the pieces of the beam from sliding past each other.



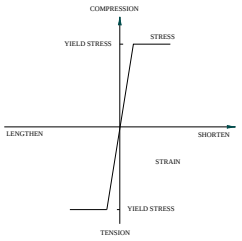
Beams - Vertical Shear Stress

- Below is a Free Body Diagram of a different piece of the same beam.
- Tension stresses must be present at the inclined cuts to keep the pieces of the beam from separating.



Stress In Steel

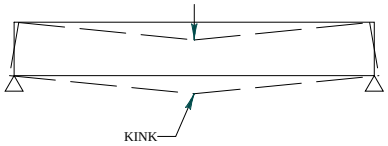
- Different bridge materials respond to stress in different ways.
- Shown below is a stress-strain diagram for steel.
- Strain is a measure of the stretching or shortening of a member under stress.



- Steel is strong in both tension and compression.
- Steel that has reached its yield stress lengthens or shortens under constant stress.

Stress In Steel

- An important property to remember when inspecting bridges is that a steel bending member that has reached its yield stress will develop a kink or sag.
- A beam that has developed a kink and sagged is shown below.

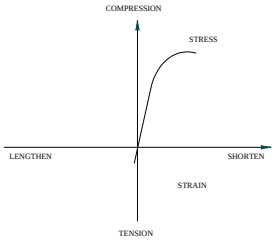


Stress In Steel

- Steel members are normally made up of slender components (flanges and webs).
- Therefore steel compression members (including parts of beams in compression) are susceptible to buckling.
- Misalignment of a member in compression lowers the load at which it buckles.

Stress In Concrete

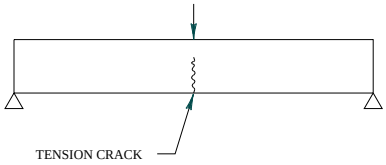
- Shown below is a stress-strain diagram for concrete.



- Concrete is strong in compression and weak in tension.

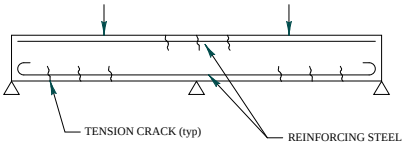
Stress In Concrete

- An unreinforced concrete beam will fail in tension under a small load.



Stress In Concrete

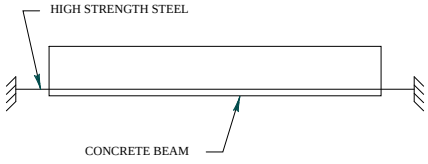
- Reinforcing steel placed on the tension side of a beam increases its strength.



- Cracking of the concrete may still occur but the reinforcing steel acting in tension prevents failure.
- Cracks caused by bending stresses occur in the middle of the span near the bottom of the beam or at intermediate supports near the top of the beam.
- These vertical cracks are normal unless they have opened up indicating that the reinforcing steel has yielded.

Stress In Concrete

- High strength steel is sometimes used to control concrete cracking caused by bending stresses.
- The high strength steel is stretched and the concrete beam cast around it.



- When the concrete has gained adequate strength the high strength steel is cut.

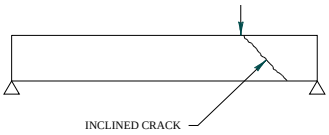
Stress In Concrete

- Shown below is a concrete beam after the high strength steel has been cut.

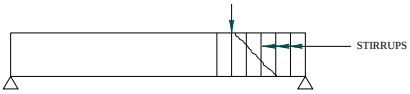
- The cutting of the high strength steel results in the steel and also the bottom of the beam shortening and going into compression counteracting the tension caused by the loads and delaying cracking.

Stress In Concrete

- Shear in an unreinforced concrete beam can cause an inclined crack to form resulting in sudden failure.



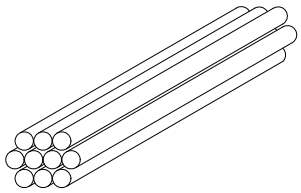
- Stirrups placed across the inclined tension crack increase the shear strength above the concrete cracking strength thus giving warning of failure.



- It is important to report inclined cracking in a beam as the opening up of an inclined crack can result in sudden failure of the beam.

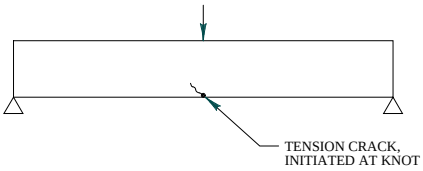
Stress In Timber

- Timber is a "natural" material and has different strength properties in different directions.
- Its internal structure can be thought of as a bundle of straws running in the direction of the grain.



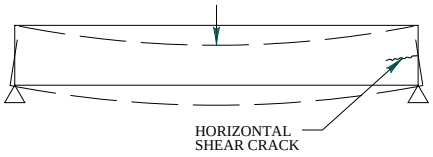
Stress In Timber

- Timber is strong in tension and compression in the direction of the grain.
- Failure due to bending stresses often occurs at a defect such as a knot.



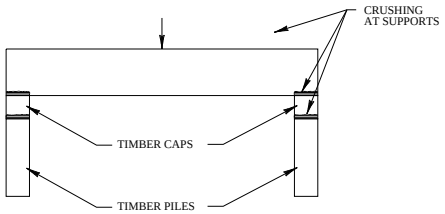
Stress In Timber

- Timber is weak in shear along the grain just as straws in a bundle easily slide past each other.
- Horizontal cracks caused by horizontal shear stresses can occur at the ends of a timber beam.



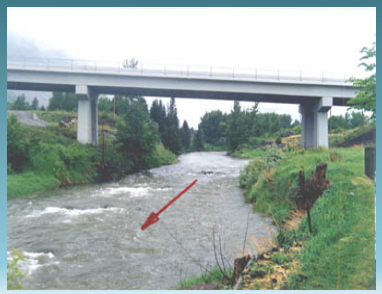
Stress In Timber

- Timber is weak in compression across the grain just as straws are weak against crushing.



- Crushing can occur where timber caps support beams and also where timber caps are supported by piles.

Hydrotechnical Considerations

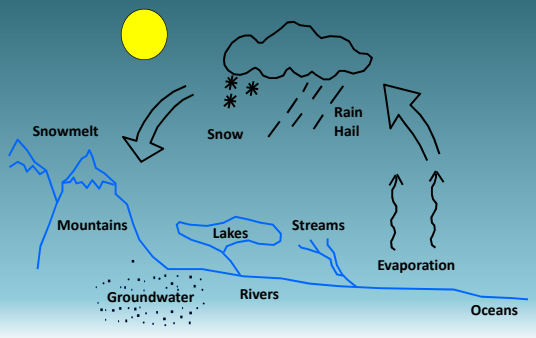


Overview

- Hydrotechnical Design
- River Issues
  - Lateral Stability
  - Vertical Stability
  - Blockage - ice, drift
- River Protection Works

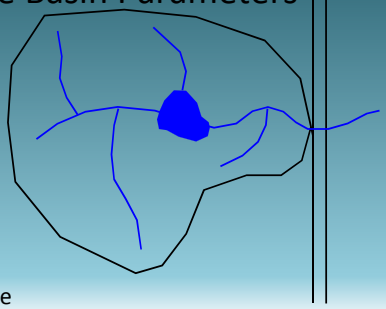
Hydrotechnical Design

The Hydrologic Cycle

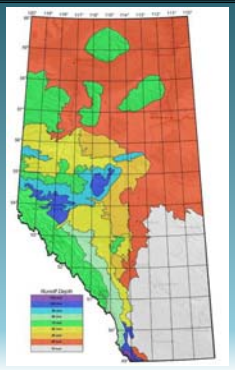


Drainage Basin Parameters

- Area
- Shape
- Slope
- Storage
- Density
- Vegetation
- Soil Type
- Initial Moisture



Runoff Response Variation Across Alberta



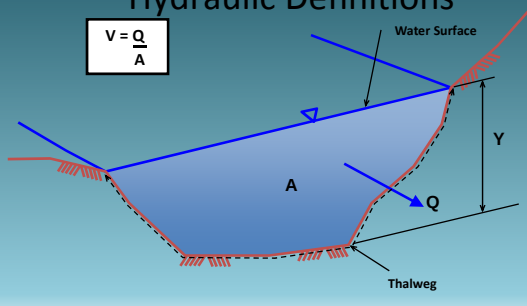
Hydrotechnical Design Guidelines

Channel Capacity
- channel size result of long-term runoff
- channel size affects routing of runoff
- typical channel
- activate overbank storage

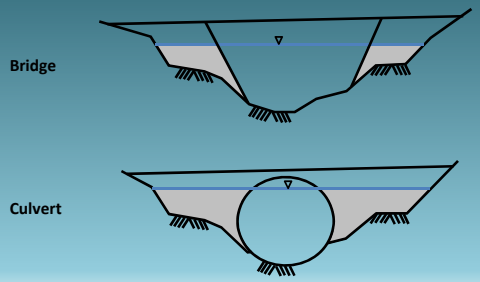
Historic Highwater Data
- HWM – AIT, AENV, WSC, site, airphoto, news
- Location, description

Runoff Potential
- Limit on supply of runoff
- Unit discharge

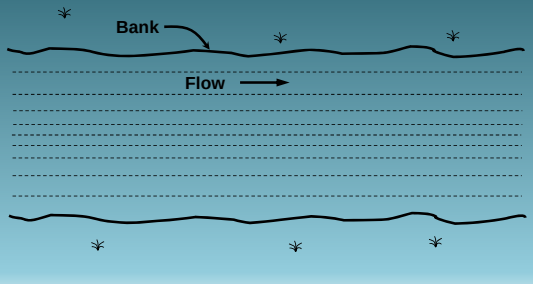
Hydraulic Definitions



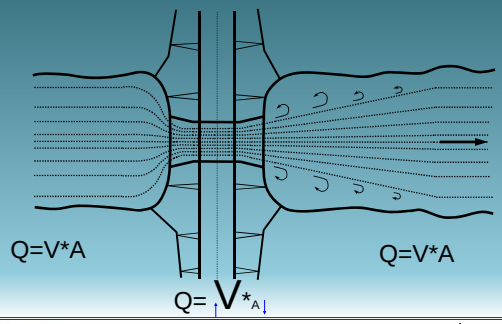
Flow Constriction - Stream Crossing



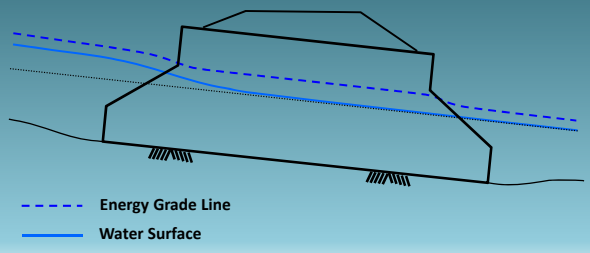
Flowlines - Before Constriction



Flowlines - After Constriction



Flow Profile - After Constriction



Hydrotechnical Considerations

File 00278 - Battle River

Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

BIM Bridge Inspection and Maintenance

Hydrotechnical Considerations

File 00278 - Battle River

Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

BIM Bridge Inspection and Maintenance

Hydrotechnical Considerations

File 00278 - Battle River

Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

BIM Bridge Inspection and Maintenance

Hydrotechnical Considerations

File 75194 - Simonette River

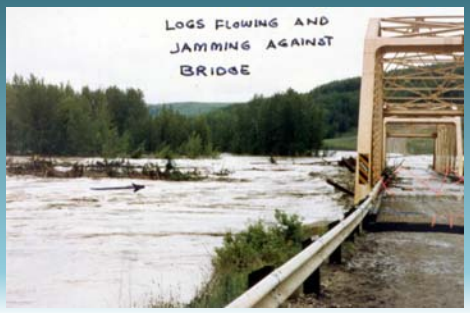
Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

BIM Bridge Inspection and Maintenance

File 75194 - Simonette River

File 75194 - Simonette River



File 75194 - Simonette River

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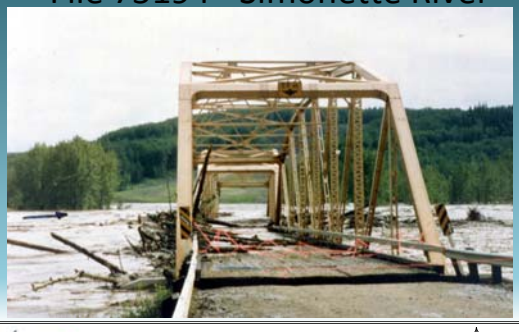


File 75194 - Simonette River

File 75194 - Simonette River

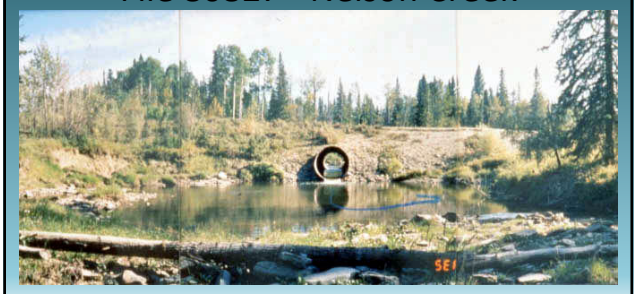
File 75194 - Simonette River

File 07107 - Iron Creek

BF76474 – Smoky River at Grande Cache

File 80827 - Nelson Creek

File 80827 - Nelson Creek



File 79475 - Bald Mountain Creek

Hydrotechnical Considerations

File 79475 - Bald Mountain Creek

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File 01324 - Pigeon Creek

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File 01324 - Pigeon Creek

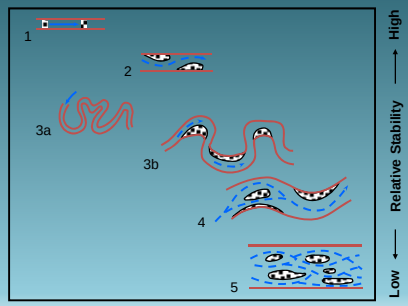
File 78230 - Brewster Creek

File 81653 - Watercourse

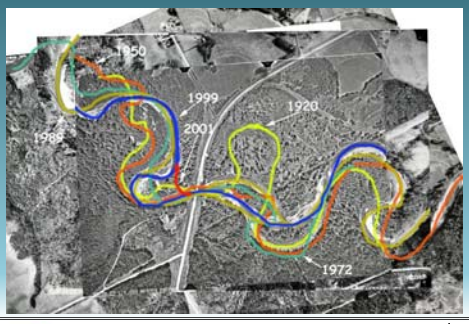
River Issues

Lateral Stream Stability

Stability of Stream Types



BF9259 – Freeman River



BF8036 – Redwillow River

BF13078 – Little Red Deer River

File 81113 - Marten Creek

File 75904 - Island Creek

File 75904 - Island Creek

Hydrotechnical Considerations

File 75904 - Island Creek

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File 73204 - Whitehorse Creek

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File 73204 - Whitehorse Creek

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File 73204 - Whitehorse Creek

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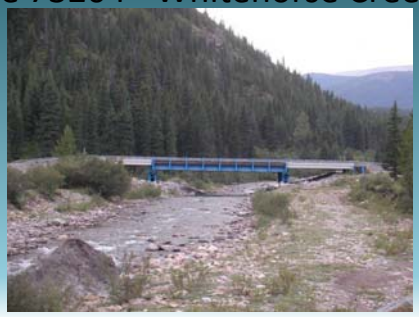
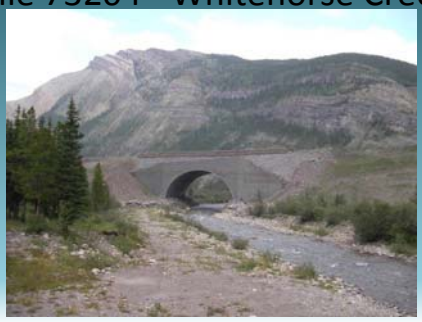
File 73204 - Whitehorse Creek



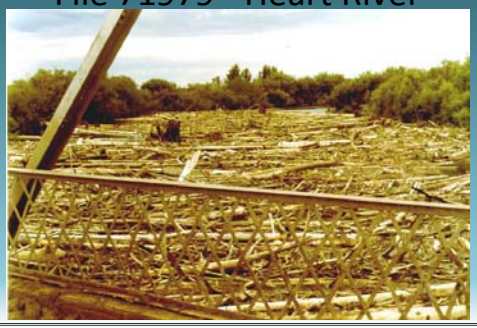
File 73204 - Whitehorse Creek



Blockage - Drift, ice …

File 78889 - Whitecourt Creek

File 71979 - Heart River

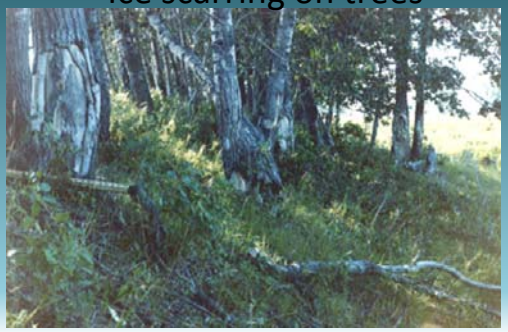


File 72964 – Howard Ck

Drift accumulation can increase velocities around piers

BF 6754 Bow River at Cluny

Ice scarring on trees

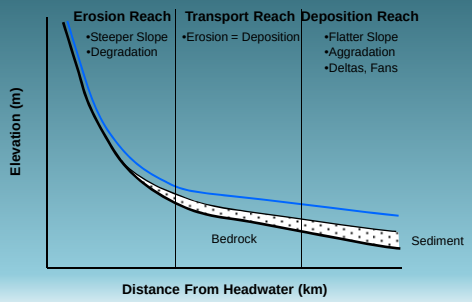


Ice impact damage and abrasion on piers

Other debris?

Vertical Stream Stability

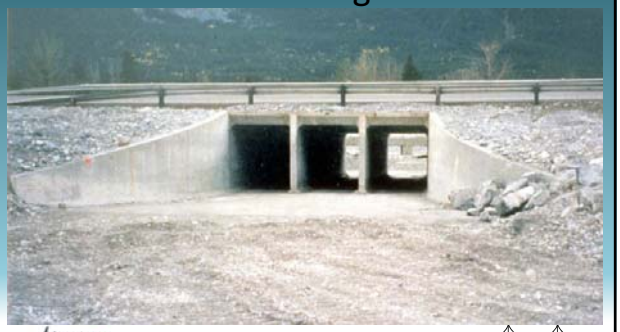
Typical Stream Profile



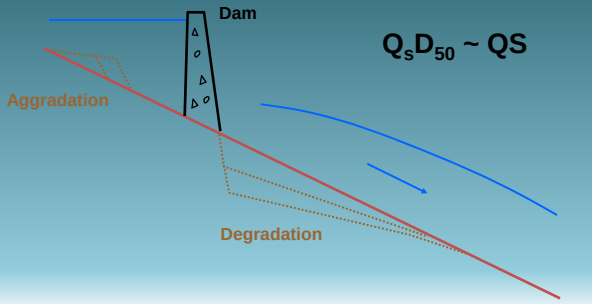
File 76995 - Malcolm Creek

File 76617 - Cougar Creek

File 76617 - Cougar Creek



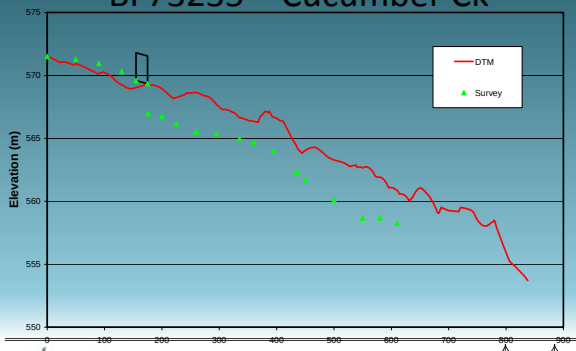
River Response



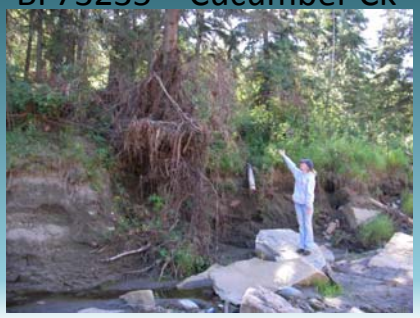
BF74852 – Bear River

BF74852 – Bear River

BF73235 – Cucumber Ck

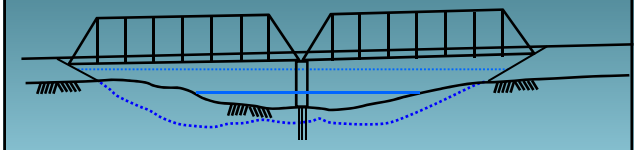


BF73235 – Cucumber Ck



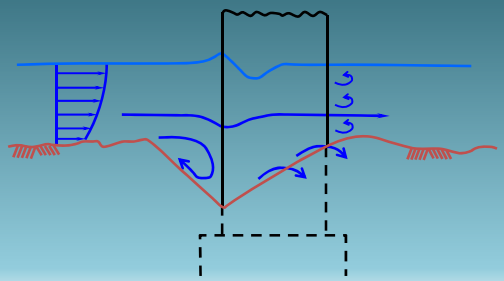
BF73235 – Cucumber Ck

General Scour

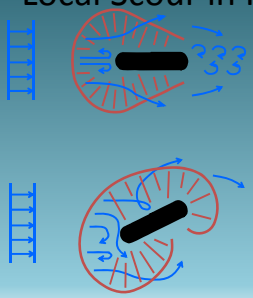


BF74710 – Berland River

Local Scour Profile

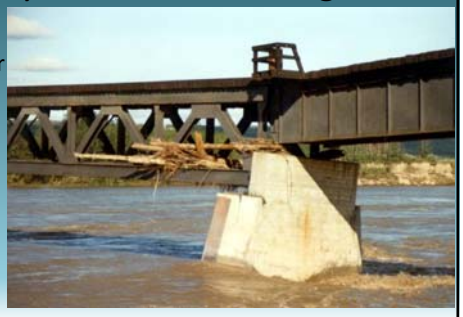


Local Scour in Plan View

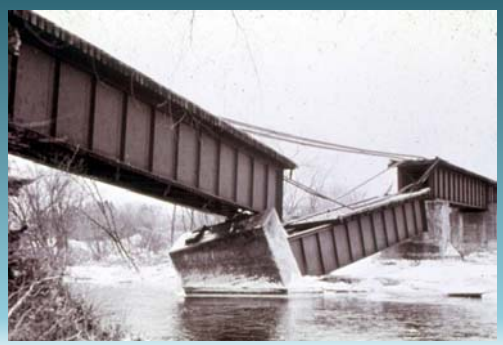


Smoky River CanFor Bridge

Failure of a pier on spread footing due to general scour

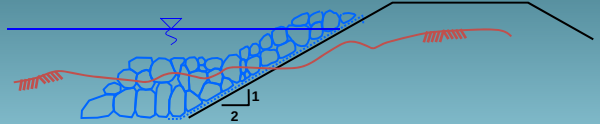


BF 78104 McLeod River near Peers - alignment problem

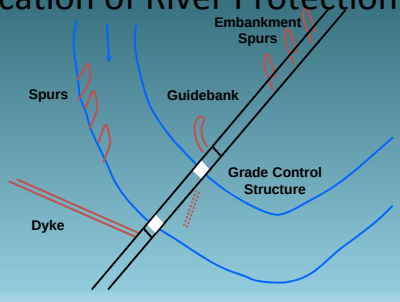


River Protection Works

Typical Rock Riprap Section



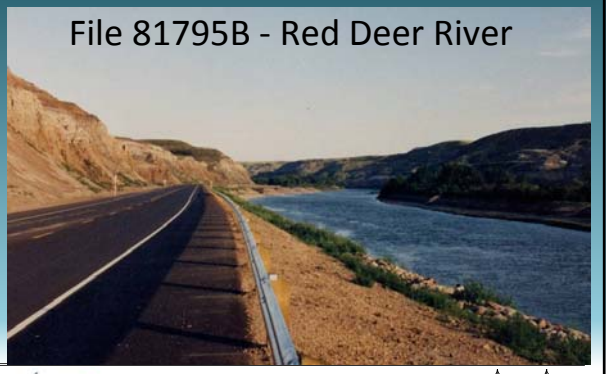
Location of River Protection Works



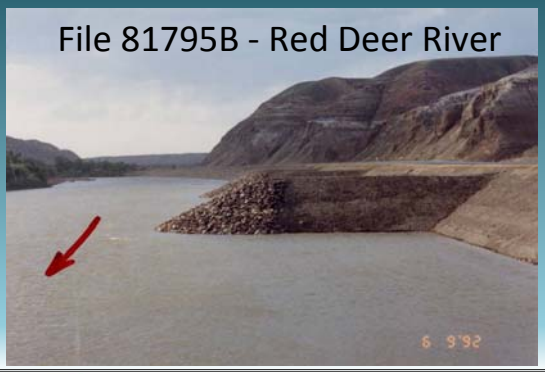
File 81795B - Red Deer River (1992)

File 81795B - Red Deer River

File 81795B - Red Deer River

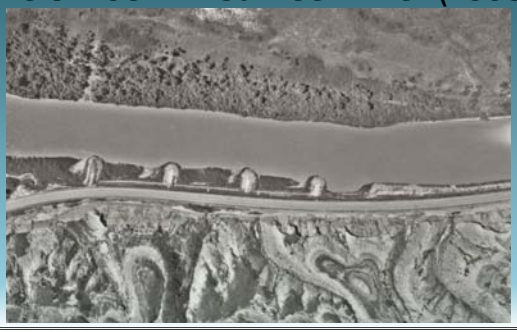


File 81795B - Red Deer River



File 81795B - Red Deer River

File 81795B - Red Deer River (1999)



File 81778B - Wapiti River

Hydrotechnical Considerations

File 81778B - Wapiti River

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Hydrotechnical Considerations

File 81793B - Swan River

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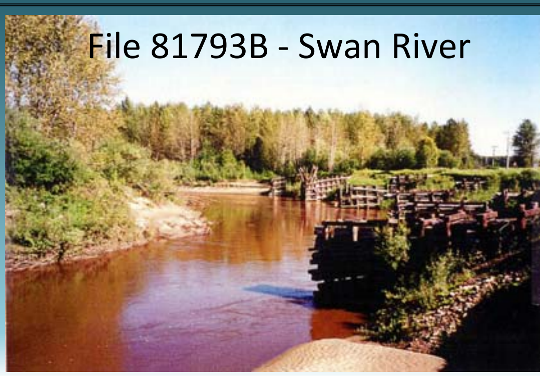
Hydrotechnical Considerations

File 81793B - Swan River



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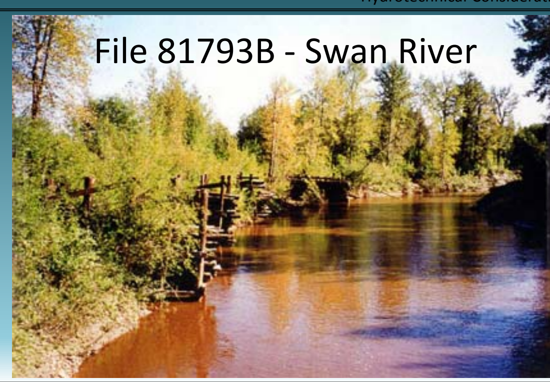
File 81793B - Swan River



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…Questions?

Superstructure Inspection and Rating

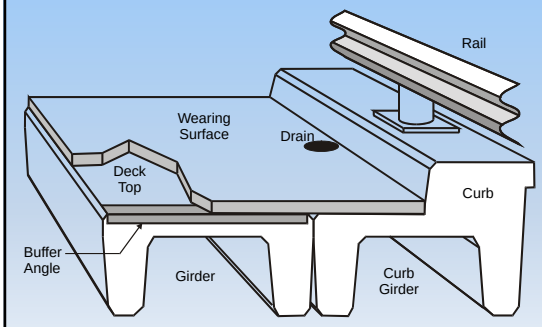
Introduction

- That portion of the bridge above the caps
- Purpose
  - Carry traffic
  - Transfer loads to substructure
- Types for Standard Bridges
  - Timber
  - Concrete
- Component materials
  - Timber
  - Concrete
  - Steel

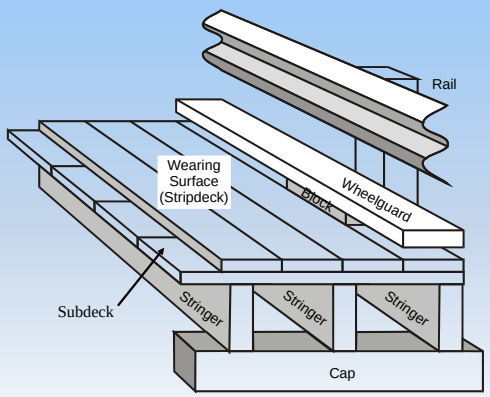
Introduction

- Components in Superstructure
  - Bearings
  - Stringers or girders
  - Deck or subdeck
  - Deck wearing surface
  - Curbs or wheelguards
  - Sidewalks
  - Bridgerail
  - Drains
  - Deck joints

Standard Girder Bridge



Timber Bridge



Introduction

- Two form types (included in Supplemental Manual);
  - TT - timber bridges
  - PCS - Standard plain reinforced & pre-stressed concrete girder bridges
- Both are tailored for components in each type of bridge

Material Defects - Timber

- Structural Failure/Degradation
  - due to loads placed on structural members
    - overloads, collisions, poor grain pattern
  - look for cracks, splits, breaks in structural members
    - stringers, timber posts, rails, etc.
- Decay
  - caused by fungi
  - needs moisture, oxygen and conducive temperature
  - pressure treatment prevents growth
  - look for discoloration (white stains coming from cracks, dampness of wood, ring shrinkage at end grain, hollow sounds, change in geometry
  - look in areas likely to retain moisture
    - bearing or contact areas, buried timber
  - look in areas where treatment is broken/cut
    - bolts, drifts, dowels, cuts, cap ends

Timber Defects – Rot

Timber Defects – Cracked Stringer

Material Defects - Timber

- Volume Change
  - caused by cycles of wetting and drying creating stress in wood
  - look for checks, cracks, warps, twists, etc.
- Mechanical Wear
  - caused by abrasion from traffic, snowplows, ice, debris
  - look in area subject to wear/abrasion - deck surface, wheelguard
- Fire
  - easily recognized
  - reduces the load capacity by reducing their effective size
  - removes the pressure treated zone on the exterior exposing the timber to fungal attack

Timber Defects – Abrasion

Timber Defects – Fire Damage

Material Defects - Concrete

- Structural Cracks
  - caused by stresses higher than design
  - Flexural – generally not serious unless wide or growing in width
  - Shear - most serious - can lead to failure
  - Anchorage depending on cause
- Shrinkage Cracks
  - caused by rapid drying during hydration
  - usually not serious by themselves but let moisture and salt into the concrete
- Settlement Cracks
  - caused by settlement of the falsework
- Map Cracks
  - chemical reaction of the aggregate and paste
  - usually shallow, from over-finishing
  - can cause scaling

Material Defects - Concrete

- Corrosion Cracks
  - caused by corrosion of steel in the concrete creating delaminations or spalls.
  - Maintenance or rehab problem
  - varying widths, locations and orientations
- Chipping
  - caused by external mechanical (backhoe)
- Scaling
  - caused by freeze/thaw action
  - related to poor concrete or workmanship
- Spalling
  - caused by corrosion of rebar
- Popouts
  - caused by expansive aggregates
- Punchouts
  - External mechanical that causes tension failure on opposing side

Superstructure Inspection and Rating

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Superstructure Inspection and Rating

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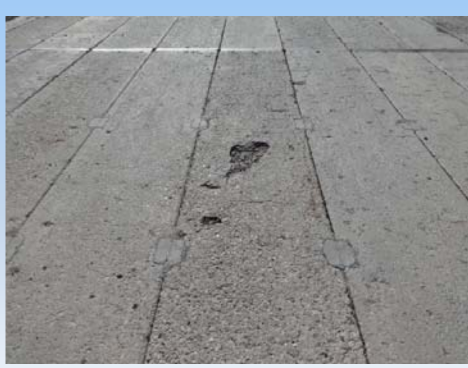
Superstructure Inspection and Rating



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Material Defects - Concrete

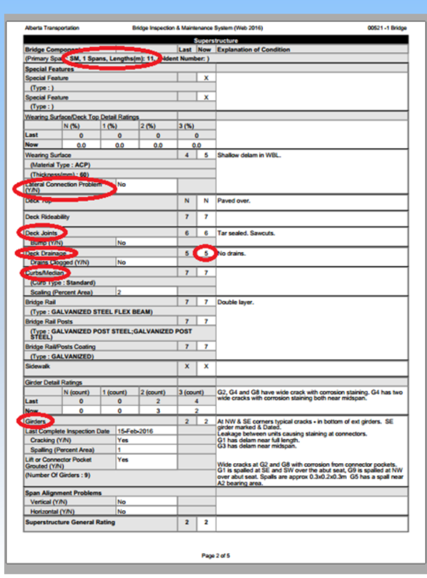
- Efflorescence
  - white salt stains
  - may be associated with cracks which allow water to get into concrete
- Exudation
  - gel-like substance deposited on surface
  - may be associated with cracks which allow water to get into concrete
- Chemical Attack
  - caused by sulfates in the soil reacting with the concrete
  - increases the volume of the concrete causing cracks

Material Defects - Steel

- Corrosion
  - caused by the presence of oxygen and moisture
  - reduces section of steel member
  - can significantly reduce the load carrying capacity
  - increases the risk of fatigue failure
  - look in areas prone to retention of moisture or exposure to salt
    - splash areas, under leaky joints or drains, dirt and debris accumulation
- Cracks
  - caused by fatigue, overload or collision
  - initially may be too small to be seen by eye
  - can progress rapidly
  - look in high stress or fatigue susceptible areas
    - welds, holes, notches, collision locations, connections, bearing locations

Material Defects - Steel

- Deformation
  - caused by fire, collision, overload or thermal stresses
  - May be local buckling of part of member I.e. web or flange
  - entire member may be bent, twisted or buckled
  - look in high stress areas
    - collision locations, bearing locations

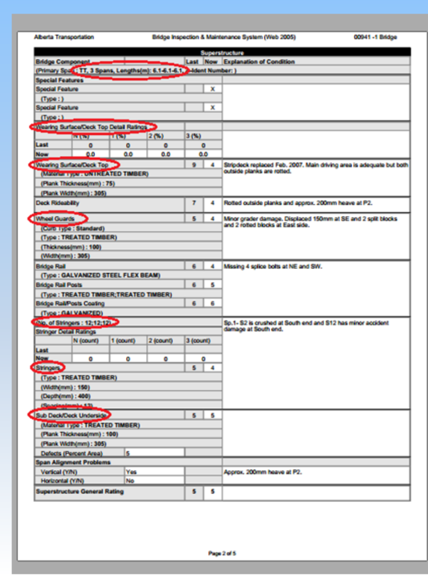


Alberta Transportation   Bridge Inspection & Maintenance System (Web 2016)   00521 -1 Bridge

Superstructure

Bridge Component		Last	Now	Explanation of Condition
(Primary Span : SM, 1 Spans, Lengths(m): 11, Ident Number:)				
Special Features				
Special Feature			X	
(Type :)				
Special Feature			X	
(Type :)				
Wearing Surface/Deck Top Detail Ratings				
	N (%) / 1 (%) / 2 (%) / 3 (%)			
Last	0 / 0 / 0 / 0			
Now	0.0 / 0.0 / 0.0 / 0.0			
Wearing Surface		4	5	Shallow delam in WBL.
(Material Type : ACP)				
(Thickness(mm) : 60)				
Lateral Connection Problem (Y/N)	No			
Deck Top		N	N	Paved over.
Deck Rideability		7	7	
Deck Joints		6	6	Tar sealed. Sawcuts.
Bump (Y/N)	No			
Deck Drainage		5	5	No drains.
Drains Clogged (Y/N)	No			
Curbs/Median		7	7	
(Curb Type : Standard)				
Scaling (Percent Area)	2			
Bridge Rail		7	7	Double layer.
(Type : GALVANIZED STEEL FLEX BEAM)				
Bridge Rail Posts		7	7	
(Type : GALVANIZED POST STEEL;GALVANIZED POST STEEL)				
Bridge Rail/Posts Coating		7	7	
(Type : GALVANIZED)				
Sidewalk		X	X	
Girder Detail Ratings				
	N (count) / 1 (count) / 2 (count) / 3 (count)			G2, G4 and G8 have wide crack with corrosion staining. G4 has two wide cracks with corrosion staining both near midspan.
Last	0 / 0 / 2 / 4			
Now	0 / 0 / 3 / 2			
Girders		2	2	At NW & SE corners typical cracks - in bottom of ext girders. SE girder marked & Dated. Leakage between units causing staining at connectors. G1 has delam near full length. G3 has delam near midspan. Wide cracks at G2 and G8 with corrosion from connector pockets. G1 is spalled at SE and SW over the abut seat, G9 is spalled at NW over abut seat. Spalls are approx 0.3x0.2x0.3m G5 has a spall near A2 bearing area.
Last Complete Inspection Date	15-Feb-2016			
Cracking (Y/N)	Yes			
Spalling (Percent Area)	1			
Lift or Connector Pocket Grouted (Y/N)	Yes			
(Number Of Girders : 9)				
Span Alignment Problems				
Vertical (Y/N)	No			
Horizontal (Y/N)	No			
Superstructure General Rating		2	2	

Page 2 of 5



Alberta Transportation   Bridge Inspection & Maintenance System (Web 2005)   00941 -1 Bridge

Superstructure

Bridge Component		Last	Now	Explanation of Condition
(Primary Span : TT, 3 Spans, Lengths(m): 6.1-6.1-6.1, Ident Number:)				
Special Features				
Special Feature			X	
(Type :)				
Special Feature			X	
(Type :)				
Wearing Surface/Deck Top Detail Ratings				
	N (%) / 1 (%) / 2 (%) / 3 (%)			
Last	0 / 0 / 0 / 0			
Now	0.0 / 0.0 / 0.0 / 0.0			
Wearing Surface/Deck Top		9	4	Stripdeck replaced Feb. 2007. Main driving area is adequate but both outside planks are rotted.
(Material Type : UNTREATED TIMBER)				
(Plank Thickness(mm) : 75)				
(Plank Width(mm) : 305)				
Deck Rideability		7	4	Rotted outside planks and approx. 200mm heave at P2.
Wheel Guards		5	4	Minor grader damage. Displaced 150mm at SE and 2 split blocks and 2 rotted blocks at East side.
(Curb Type : Standard)				
(Type : TREATED TIMBER)				
(Thickness(mm) : 100)				
(Width(mm) : 305)				
Bridge Rail		6	4	Missing 4 splice bolts at NE and SW.
(Type : GALVANIZED STEEL FLEX BEAM)				
Bridge Rail Posts		6	5	
(Type : TREATED TIMBER;TREATED TIMBER)				
Bridge Rail/Posts Coating		6	6	
(Type : GALVANIZED)				
(No. of Stringers : 12;12;12)				Sp.1- S2 is crushed at South end and S12 has minor accident damage at South end.
Stringer Detail Ratings				
	N (count) / 1 (count) / 2 (count) / 3 (count)			
Last				
Now	0 / 0 / 0 / 0			
Stringers		5	4	
(Type : TREATED TIMBER)				
(Width(mm) : 150)				
(Depth(mm) : 400)				
(Spacing(mm) : 12)				
Sub Deck/Deck Underside		5	5	
(Material Type : TREATED TIMBER)				
(Plank Thickness(mm) : 100)				
(Plank Width(mm) : 305)				
Defects (Percent Area)	5			
Span Alignment Problems				
Vertical (Y/N)	Yes			Approx. 200mm heave at P2.
Horizontal (Y/N)	No			
Superstructure General Rating		5	5	

Page 2 of 5

Special Features

Superstructure				
Bridge Component		Last	Now	Explanation of Condition
(Primary Span : PCS)				
Special Features				
Special Feature				
(Type :)				
Special Feature				
(Type :)				

- Bridge elements unique to a particular bridge
- Which cannot be rated under another element or area of the form
- May be permanent or temporary
- Lights & WSC station are utilities
- Examples include:
  - strengthening systems, girder clips
  - temporary bents

Special Features

- Record Type(s) – up to 2
- Use Explanation of Condition for additional information
  - description
  - location
  - dimensions
- Check damage or defects common to the materials and type of component
- Provide suitable rating
- Refer to Section 7.3 in BIM Manual

Special Features

Wearing Surface

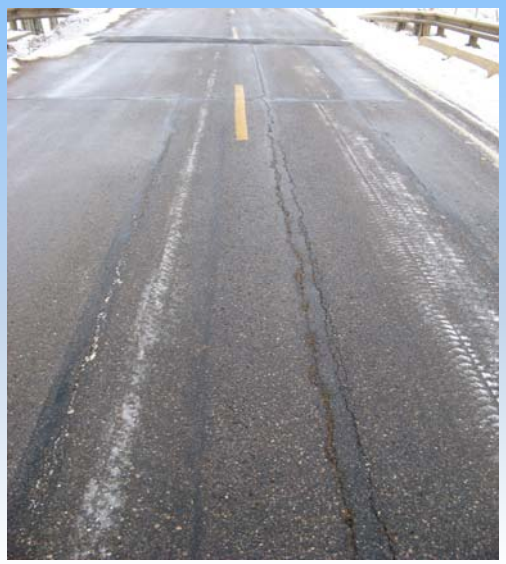
Wearing Surface/Deck Top Detail Ratings					
	N (%)	1 (%)	2 (%)	3 (%)	
Last					
Now					
Wearing Surface					
(Material Type :)					
(Thickness (mm) :)					
(Plank Width (mm) :)					

- TT forms

Wearing Surface/Deck Top Detail Ratings					
	N (%)	1 (%)	2 (%)	3 (%)	
Last					
Now					
Wearing Surface					
(Material Type :)					
(Thickness (mm) :)					
Lateral Connection Problem (Y/N)					
Deck Top					

PCS (precast or pre-stressed standard)

- PCS forms



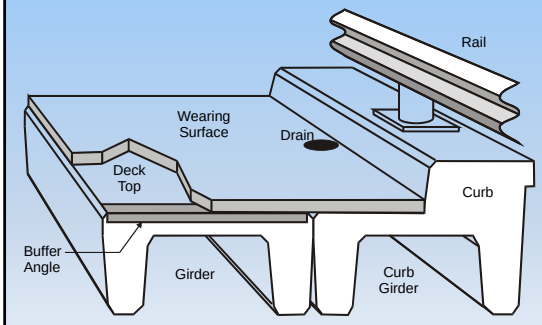
Wearing Surface

- Bonded or fastened to the bridge deck
- In direct contact with the wheels of the vehicles
- List of types in Section 7.4.2 of the BIM manual
- Loose or frozen gravel is not a wearing surface
- Purpose
  - Protect the deck
  - Provide a smooth riding surface
  - Provide skid resistance

Wearing Surface

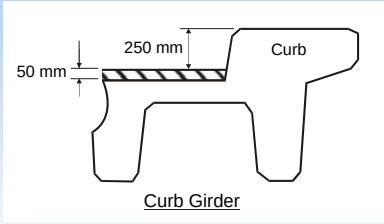
- TT form combines wearing surface and deck top
  - If no wearing surface rating is for deck top only
- Verify the wearing surface material type on the report
  - Type is “NONE” if no wearing surface
- Record or verify the average thickness in mm
- Record the width and thickness of timber planks
- Indicate Y/N whether there is a lateral connection problem between the girders
  - HC - bolted connectors; PA - bolted legs; PE - grout keys; PG - none.

Standard Girders with Wear Surface



Wearing Surface - Thickness

- Measure at curb
  - Most standards curbs 300mm high
  - Refer to plans if in doubt
- Take readings at ends and midspan, and average
- Wearing surface may be thicker at centreline than at curb



Curb Girder

Wearing Surface

- Drive over the deck at fastest safe speed
- Observe traffic to assist in rating
- Look for material defects
- For asphalt pavement wearing surfaces look for:
  - cracks (alligator, lane joint, shrinkage and slippage)
  - distortion (ruts, depressions and corrugations)
  - disintegration (potholes and ravelling)
  - segregation
- Check for delaminations in concrete and asphalt wearing surfaces and record amount in percentage of deck area

Wearing Surface

- If surface is without defects and provides a smooth riding surface with proper skid resistance - rate 9
- Asphalt longitudinal cracks rate 7 or less,
- If speed has to be reduced due to cracks, potholes, etc, - rate 4 or less
- If wearing surface does not cover entire deck and creates a wheel trap - rate 4 or less
- Asphalt raveling rate 4 or less
- Rutting, pot holes or debonding rate 4 or less
- Hazardous rate 2
- Do not rate down due to excessive thickness (100 mm or more)
  - Lower curb rating if height insufficient
  - Request load rating evaluation
  - Recommend reducing thickness

Wearing Surface

- Record % of surface area with defects and rated 1, 2 or 3 in Detail Rating boxes
- Record % of surface area rated N
- Wearing surface rated are 4 or above, detail ratings are “0”

Superstructure Inspection and Rating

Wearing Surface

Superstructure

Bridge Component		Last	Now	Explanation of Condition
(Primary Span HH, 3 Spans, Lengths(m): 8.5-8.5-8.5, A-Ident Number:)				
Special Features				
Special Feature			X	
(Type :)				
Special Feature			X	
(Type :)				
Wearing Surface/Deck Top Detail Ratings				

	N (%)	1 (%)	2 (%)	3 (%)
Last	0	0	0	5
Now	0.0	0.0	5.0	25.0

Bridge Component		Last	Now	Explanation of Condition
Wearing Surface		3	2	ACP Cracking between all girders up to 230mm ACP missing on S span along PG girders. Worst on NBL.
(Material Type ACP - CHIP SEAL COAT)				
(Thickness(mm) 60)				
Lateral Connection Problem (Y/N)	No			Not connected.
Deck Top		N	N	Paved over
Deck Rideability		4	3	Due to wide gaps up to 230mm wide along girders and missing sections of ACP.
Deck Joints		N	N	Paved over.
Bump (Y/N)	No			

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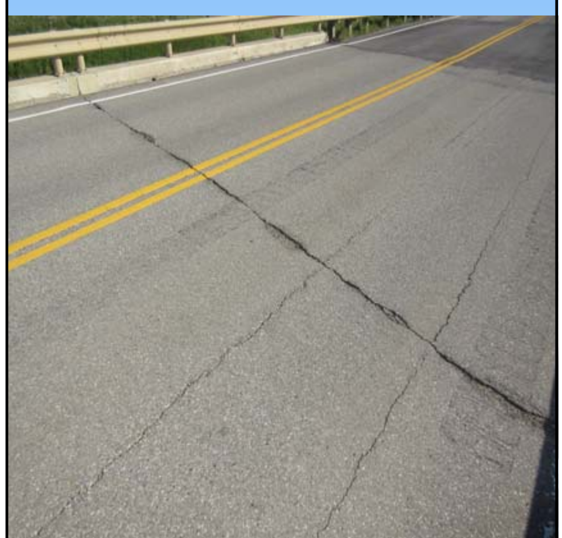

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Deck Top

Bridge Component		Superstructure Last	Now	Explanation of Condition
Deck Top				

- Deck Top is the “structural” part of the deck
- The surface on which the wearing surface is bonded
- If no wearing surface, the deck top is in direct contact with traffic
- Types:
  - Cast-in-place concrete
  - Precast concrete girders

Deck Top

- Purpose:
  - Carry traffic
  - Transfer traffic loads to main structural members
  - Provide smooth riding surface
  - Provide skid resistance
- Rated with wearing surface on TT forms

Deck Top

- Listen for unusual noises and look for deflections under traffic
- Look for material defects
  - Concrete - cracks, scaling, spalling, popouts, abrasion from traffic
  - Timber - missing and loose planks, cracks, splits, rot, wear from traffic
- Look for unfilled lift and connector pockets on precast girders
- Rating of wearing surface does not affect the deck top rating

Deck Top

- Deck smooth, no defects, rate 9
- Good condition with hairline cracks, rate 7
- If speed reduced due to cracks, potholes, etc., rate 4 or less
- Record % area rated 3, 2, 1 and N in Detail Rating boxes
- Deck top rating 4 or more record 0 in Detailed Rating boxes
- Rate 3 or less for severe scaling/spalling/debonded
- Hazardous conditions rate 2

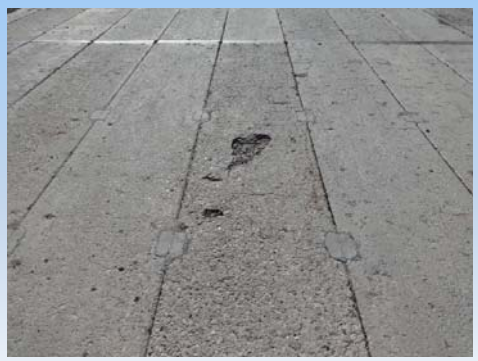
Deck Top

Superstructure					
Bridge Component			Last	Now	Explanation of Condition
(Primary Span PG, 1 Spans, Lengths(m): 6.1, A-Ident Number:)					
Special Features					
Special Feature				X	
(Type :)					
Special Feature				X	
(Type :)					
Wearing Surface/Deck Top Detail Ratings					
	N (%)	1 (%)	2 (%)	3 (%)	
Last	0	0	0	0	
Now	20.0	0.0	0.0	0.0	
Wearing Surface				5	X Remanants of chipseal at W half of deck.
(Material Type :) None					
(Thickness(mm) :)					No connection.
Lateral Connection Problem (Y/N) No					
Deck Top				5	5

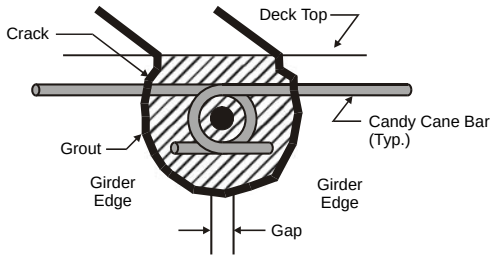
Lateral Connection Problem Y/N

Wearing Surface/Deck Top Detail Ratings				
	N (%)	1 (%)	2 (%)	3 (%)
Last				
Now				
Wearing Surface				
(Material Type :)				
(Thickness (mm) :)				
Lateral Connection Problem (Y/N)				
Deck Top				

PCS (precast or pre-stressed standard)



PE Girder Lateral Connection



Deck Rideability

- A measure of the riding comfort at the legal speed
- Influenced by the condition of the wearing surface or deck top and joints (rated separately)
- Drive over at legal speeds and assess ride quality
- Listen for unusual noise from traffic
- Observe traffic for signs of poor rideability such as slowing down or bouncing
- Smooth, no speed reduction rate 7 or more
- If speed has to be reduced due to cracks, potholes, etc. - rate 4 or less
- Slipperiness reduces rating

Deck Joints

	Superstructure		
Bridge Component		Last	Now	Explanation of Condition
Deck Joints				
Bump (Y/N)				

- Purpose
  - Provide a structural termination of individual spans
  - Can be designed to prevent water and salt from leaking down onto substructure
  - Protects ends of precast girders (buffer angles)
  - Can be designed to span gap between spans
  - Provide a smooth transition (reduces bumps)
- On standard bridge all joints are considered fixed.
- Not applicable to standard TT bridges

Deck Joints

- Standard Bridge Types
  - Buffer angles - steel angles cast into top edge at ends of girder
  - Compression seal - a compressible seal held in place by steel angles
  - Strip seal installed at piers of overlays
  - Others - caulked sawcuts, asphaltic plug joint (Koch or Thorma-joint)
- Asphalt fiber board alone is not a joint – rate X
- Unprotected girder ends is not a joint – rate X

Deck Joints

- Observe traffic crossing over joints
  - Listen for unusual noises
  - Watch for movement
- Look for:
  - Vertical alignment
  - Corrosion
  - Deteriorating concrete around anchorages
  - Damage from snow plows
- Indicate whether or not a significant bump by Yes or No
  - If "Yes", explain location and cause

Deck Joints

- Buffer angles should not be rated down because they leak
- Damage from leakage rated in substructure
- Slightly less that adequate but no maintenance required – rate 4 (missing section of buffer angle)
- Joints requiring repair – rate 3
- Joints which are a hazard to traffic - rate 2 or less
- If joint is not visible:
  - Rate "X" if it is known that no joint exists
  - Rate "N" otherwise
  - Provide explanation

Deck Drainage

Bridge Component		Superstructure Last	Now	Explanation of Condition
Deck Drainage				
Drains Clogged (Y/N)				

- Ability of the deck to drain and properly dispose of water from its surface
- Not applicable to bridges with timber decks
- Drainage system includes gutters, inlet boxes, pipes and catch basins

Deck Drainage

- Poor drainage
  - Common cause of deck deterioration
  - May be hazardous due to hydroplaning or icing
  - Caused by inadequate design, construction or maintenance practices (grade, crown, debris, etc)
  - May affect other superstructure components, substructure, headslopes and sideslopes

Deck Drainage

- Indicate whether or not the drains are plugged by **Y**es or **N**o
  - If no drains, note in Explanation of Condition
- Check entire drainage system to determine if water is being directed off the deck in a proper manner
- If there are any deficiencies in the drainage system or significant deterioration of any components - rate 4 or less
- If erosion is being caused on the headslopes or sideslopes by deck drainage - rate 4 or less
- If water is being allowed to pond on the deck and create a hazard for traffic - rate 2 or less
- not a factor on timber decks therefore rate X

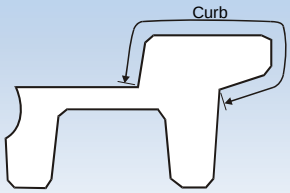
Curbs / Medians

Bridge Component		Superstructure Last	Now	Explanation of Condition
Curb/Median				
Scaling (Percent Area)				

- Raised surface at the edge of the roadway
- Purpose
  - Guide or redirect traffic
  - Divide the bridge according to travel direction
  - Anchor railing posts
- Applies to concrete only - timber or steel called wheelguards

Curbs / Medians

- Curb consists of:
  - the vertical or sloped face along the edge of the roadway
  - the raised horizontal surface
  - the fascia or outside surface down to the deck or girder level



Curb Girder

Curbs / Medians

- Look for:
  - Scaling
  - Other material defects - cracks, spalls
  - Snowplow damage along inside faces
  - Accident damage
  - Holes exposing the voids
  - Water damage in voids and freezing
  - Whether curb lift hook pockets are filled
- Estimate the amount of scaling as a percentage of the total area
  - Record the percentage in the appropriate field
  - Describe the extent and location in the *Explanation of Condition*
  - Scaling is not normally a problem on gravel roads unless using calcium chloride for dust control

Curbs / Medians

- Note any loss of height due to roadway paving or accumulation of dirt or gravel
- Rate according to condition and ability to perform as designed
  - Condition of concrete
  - Ability to withstand and redirect traffic
  - Ability to contain railing anchors in the event of a collision
- Curbs with holes rate 4 or less
- Severe scaling (>25 mm deep) rate 4 or less
- Spalling or broken concrete affecting post anchorage rate 3 or less

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Wheelguard

Superstructure				
Bridge Component		Last	Now	Explanation of Condition

Wheel Guards			
(Curb Type :)			
(Type :)			
(Curb Height (mm) :)			
(Width (mm) :)			

- Curbs made out of timber or steel
- Found on timber decks
- Verify type, height and width
- Record in nominal dimensions (typ. size is 100 x 300 or 150 x 300 but some variations)
- Revise as in inventory area on form
- Add this information if missing
- Record wheelguard block dimensions in comments area if needed

Wheelguard

- Look for:
  - Poor anchorage
  - Material defects
  - Missing or loose bolts
  - Poor connections
  - Mis-alignment
  - Collision damage
  - Snowplow damage
  - Missing sections
- Note any loss of height due to roadway paving or accumulation of dirt or gravel
- Rate according to condition and ability to perform as designed
- Minor splits/cracks rate 5
- Missing/broken sections, blocks, anchors rate 4 or less

Sidewalk

Bridge Component		Superstructure Last	Now	Explanation of Condition
Sidewalk				

- Applicable to PCS bridges
- Designed to accommodate pedestrian traffic
- Not normally part of the load carrying system of the bridge
- If part of the load carrying system, rating & inspection procedures are similar to “Deck Top” and/or Girder”

Sidewalk

Look for:

- Smoothness, adequate traction and debris
- Accessibility for pedestrians to the sidewalk at both ends of the bridge
- Material defects
- Condition of structural members and connections
- Condition of railings (rate under bridge rail)

- Hazards to pedestrian traffic (tripping, slipping, holes, loose boards, etc. rate 2 or less
- Rate according to condition and ability to perform as designed
- Rails systems rated with Bridgerails
- Some defects may be less serious on a sidewalk than on the bridge

Bridge Rail / Posts

Bridge Component		Superstructure Last	Now	Explanation of Condition
Bridge Rail				
(Type :)				
Bridge Rail Posts				
(Type :)				
Bridge Rail/Posts Coating				
(Type :)				

- Considered to be safety features
- Do not contribute to the strength or load carrying capacity of the bridge
- Refer to Section 7.11.2 in the manual for a list of railing and post types
- Verify railing and post types – correct/add in inventory area
- Record coating type on rails and posts
- Record number of layers of flexbeam in comments

Bridge Rail / Posts

- Look for:
  - Material defects
  - Collision damage
  - Horizontal and vertical mis-alignment
  - Loose connections
  - Missing nuts or bolts
  - Inadequate thread engaged on post anchor nuts
  - Broken or spalled post anchors
  - Correct lap direction of flexbeam
    - lapped in direction of traffic
- Includes pedestrian rails found on sidewalks

Bridge Rail / Posts

- Rate according to condition and not the standard of the rail, posts or coating
  - timber rail is substandard but can be rated 9 if in new condition
  - timber posts with wrong orientation
- Rating for rail and posts does not include the condition of the coating – rated separately unless severe corrosion
- If coating on rail and posts is different then record and rate rail coating. Note post coating type and condition in Comment area
- Railing with minor collision damage but still functional and has good connections rate 5
- Timber with signs of rot rate 4 or less
- Rail connections with missing bolts, improper laps nuts rate 4 or less
- Railing with missing sections - rate 2 or less

Bridge Rail / Posts

- Post anchor bolts with insufficient thread rate 4 or less
- Post anchors that are broken or missing anchor nuts and bolts rate 3 or less

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Subdeck

Bridge Component		Superstructure Last	Now	Explanation of Condition
Sub Deck/Deck Underside				
(Material Type :)				
(Plank Thickness (mm) :)				
(Plank Width (mm) :)				
Defects (Percent Area)				

- Applies only to Standard timber bridges
- The “structural” part of the deck
- Strip deck usually installed on top to protect
- If no wearing surface, subdeck is in contact with traffic
- Consists of timber planks nailed to stringers
- Often only visible to inspect at underside and ends
- Verify type and revise or add as needed
  - Record in Inventory area of form.
- Record nominal width and thickness – normally 100 x 300mm

Subdeck/Underside

- Look for:
  - Material defects
  - Loose or broken planks
  - Deflection under traffic
- Estimate the percentage of the area which has defects and record value
  - Decay, staining, split or broken planks
- Minor stains/cracks (concrete) rate 5
- Spalls or severe scaling rate 4
- Rot/Decay in timber rate 4 or less
- Note location in Manual – Section 7.21

Stringers

	Superstructure		
Bridge Component	Last	Now	Explanation of Condition

(No. of Stringers :)				
Stringer Detail Ratings				
	N (count)	1 (count)	2 (count)	3 (count)
Last				
Now				
Stringers				
(Type :)				
(Width (mm) :)				
(Depth (mm) :)				
(Spacing (mm) :)				

- Longitudinal beams resting on the caps and supporting the deck
- The main load carrying members of the superstructure
- Verify number per span or add if missing
- Verify type, size (width and depth), and spacing in nominal dimensions and record in Inventory area of form

Stringers

- Purpose:
  - Support the deck
  - Transfer loads to substructure
  - Critical load carrying members
- Repaired or “sistered” stringers count as one stringer (repair must be with equivalent size stringer)
- Record if stringers are notched including location

Stringer and Girder Numbering

7.13.2. Stringer/Girder Numbering

Girders or stringers are numbered west to east or south to north (see Figure 7.10).

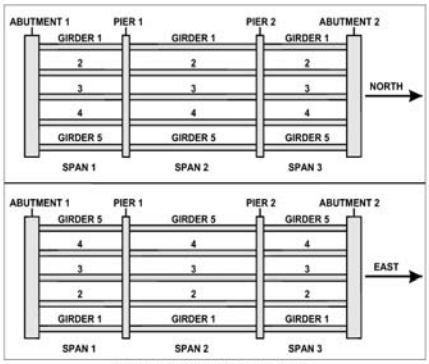
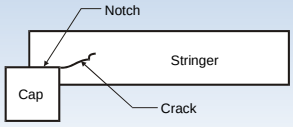


Figure 7.10 - Stringer/Girder Numbering

Stringers

- Look for:
  - Material defects
    - decay, cracks, checks, fire damage, sags, twists
  - Broken or missing stringers
  - Adequate bearing, proper connections and any splitting, crushing or decay in bearing area
  - Collision damage or abrasion from ice or drift
  - Notches at ends of girders



Stringers

- Stringers with notches at the ends - rate 7 or less and note in comments area
- Cracked or broken stringers which have been repaired with additional stringer(s) of equal size may be rated 5 or more
- Stringers with less than 75mm bearing rate 4 or less
- Stringers that are bowed or twisted significantly - rate 4 or less
- Cracked stringers rate 3 or less
- Record number of stringers rated N, 1, 2 & 3 in Detailed Rating boxes
- If all stringers are rated 4 or more, Detail Ratings are recorded as ”0”

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Girders

Superstructure				
Bridge Component		Last	Now	Explanation of Condition

Girder Detail Ratings				
	N (count)	1 (count)	2 (count)	3 (count)
Last				
Now				

Girders		
Last Complete Inspection Date		
Cracking (Y/N)		
Spalling (Percent Area)		
Lift or Connector Pocket Grouted (Y/N)		
(Number Of Girders :)		

- Applies only to concrete girder bridges
- Longitudinal beams resting on the caps
- The main load carrying members of the superstructure
- The deck is integral with the girder
- Detail ratings only on PCS
- Last Complete Inspection Date

Girders

- Purpose:
  - Support the deck
  - Transfer loads to substructure
- Two types in Standard bridges
  - Channel Girders - conventionally reinforced channel girders
  - Standard Prestressed – short girders with pre-tensioned reinforcement

Refer to BIM Reference Manual for types of girders

Table 1.1 from BIM Manual

Alberta INFRASTRUCTURE AND TRANSPORTATION

March 3, 2008

Chapter 1 - Bridge Inspection And Maintenance System

FORM TYPE	DESCRIPTION	SPAN TYPE
TH	Through Trusses	TH
PT	Pony Truss	PT
SG	Rolled Beams Riveted Plate Girders Welded Girders Steel Rigid Frames	RB RC RG WG FR
SS	Other Trusses & Arches	SS SSB SSA SSS SSF SSC
DT	Deck Trusses	DT
TT	All Timber Bridges	TT UT [illegible]
PCS	Standard Precast Bridges	HH HC VH PG GR PE PA PS MM HCO PGO HHO PX PES PEF VS SM SMC SC SCC SMO VSO SCM SL SLC
PSR	Regular Prestress Bridge	RD FC [illegible] PMO OM LF FM RM PJ NU CBT DBC CBC FCO PJO
CON	All Cast in Place Concrete Bridge Concrete Tee Girder Bridges Concrete Flat Slab Bridges	CA CB CF CV CX CC CXP CT CS
CUL1 CULM CULE	Single Culverts Multiple Culverts Culverts extended with different material and/or size	RP SP FP MP WP CP BP AP BPR RPB CPA CPE SPE PCB RPA RPE RPP MPB SCA SCR SSP CPP SPP SRA MPE
SIGN	Sign Structures	Z
THTT THPCS THPSR THSG THPT PTTT PTPCS SGTT SGPCS PSRPCS SSSG DTSG	Through Trusses with Timber Approaches Through Trusses with Standard Precast Approaches Through Trusses with Regular Prestress Approaches Through Trusses with Steel Girder Approaches Through Trusses with Pony Truss Approaches Pony Trusses with Timber Approaches Pony Trusses with Standard Precast Approaches Steel Beams with Timber Approaches Steel Beams with Standard Precast Approaches Regular Prestress with Standard Precast Approaches Special Steel with Steel Girder Approaches Deck Truss with Steel Girder Approaches	

Table 1.1 - BIM Report Index

BIM 1-5

Girders

- Cracks are often the first visible sign of distress or failure
- Types of cracks:
  - Vertical hairline cracks on precast channel girders - common not serious
  - Vertical cracks in the tension zone – flexure – usually not serious unless wide
  - Diagonal cracks near the supports - shear or combination of shear and flexure, can be serious
  - Longitudinal cracks in bottom of legs in precast girders - corrosion of rebar
  - Wide longitudinal cracks in bottom of legs with corrosion may lead to spalling
  - Longitudinal cracks in ends of prestressed girders - stresses from pre-tensioned reinforcement
  - Wide longitudinal cracks with corrosion in girder undersides of prestressed girders may be from strands

Girders

- Look for:
  - Cracks
  - Spalling on bottom of legs
  - Other defects - scaling, staining, etc.
  - Damaged connectors - deteriorating grout, loose or broken bolts, corrosion on bolts or connector channels
  - Spalls at dowel locations
  - Collision damage or abrasion from ice or drift
  - Punchouts in deck
- Look for excessive vibrations or deflections under traffic
  - Observe whether girders with lateral connections deflect independently

Girders

- Indicate cracking by **Y**es or **N**o
  - Applies to all types except shrinkage and hairline or narrow flexural cracks
  - If Yes explain - location, type, size
  - Mark and date cracks
- Record the percentage of spalling on the bottom of the legs
  - Record 0% if none
  - Explain if any
- Indicate Lift or Connector Pockets Grouted
  Yes or **N**o
  - If Yes explain
- Verify total number of girders or record number per span if blank

Girder Rating Guide

- Rating guidelines are provided in Table 7.2 for standard reinforced channel girder
- Provided in Tables 7.3, 7.4 and 7.7 for prestressed girders
- Ratings given are *maximums*
  - Decrease as needed
  - Reflect condition and functionality
- If curb girder *only* affected, can increase ratings by one
- Provide girder count for N, 1, 2 & 3 ratings
- If girder ratings are 4 or above detail ratings are “0”

Rating Guide for Standard Reinforced Concrete Channel Girders

Rating	Spalling or Longitudinal Cracks on Legs	Shear Cracks (not greater than 60° from horiz.)	Other Defects
No effect			• Narrow flexural cracks.
6			• End diaphragm spall. • Narrow map cracks.
5	• Medium crack within anchorage zone with sound concrete (must be accessible and confirmed by inspector) • Wide crack or spall outside anchorage zone	• Narrow (reduce by one if wide longitudinal crack or spall within anchorage zone)	• Top slab transverse crack
4	• Medium crack within anchorage zone with unsound concrete or concrete soundness not confirmed by inspector • Wide crack within anchorage zone with sound concrete (must be accessible and confirmed by inspector) • Moderate loss of section on main bars or stirrup bends (up to 10%)		• Medium or wide map cracking or any map cracking with staining • Medium flexural cracks • Small punchouts, 150 mm or less in diameter • Narrow concrete grout key cracks
3	• Wide crack within anchorage zone with unsound concrete or concrete soundness not confirmed by inspector • Spall within anchorage zone with top half of main reinforcing steel embedded in sound concrete	• Medium (reduce by one if wide longitudinal crack or spall within anchorage zone)	• Other punchouts • Medium or wide concrete grout key cracks • Failed girder connections
2	• Spall within anchorage zone with unsound concrete extending above top half of main reinforcing steel • Severe loss of section on main bars or stirrup bends (greater than 20%)	• Wide or growing (reduce by one if wide longitudinal crack or spall within anchorage zone)	• Wide flexural cracks • End diaphragm spall extending into legs
1			

Table 7.2 - Rating Guide - Standard Reinforced Concrete Girders

Rating Guide for Standard Reinforced Concrete Channel Girders

Table 7.2 - Rating Guide – Standard Reinforced Concrete Girders

Notes:

- Reduce as needed to reflect condition and functionality of structure.
- Longitudinal crack rating is eligible for a one rating point increase if girder type has hooked or cranked longitudinal bars (Type PA and PG girders only) OR longitudinal cracking or spalling is limited to a single leg on the girder. These rating point increases are not cumulative.
- If defects listed are limited to curb girder only the ratings can be raised by one to reflect the lower live load carrying function of this unit.
- Reduce rating by one for punchouts if punchout occurs at lift hook pockets, connector pockets, or at midspan of girder.
- Anchorage zone defined as 1.2 m from the end of the girder for all spans less than 10 m.
- Anchorage zone defined as 2.0 m from the end of the girder for all spans 10 m or longer.

Cracks Widths:

- Hairline — less than 0.1 mm
- Narrow — 0.1 mm to less than 0.3 mm
- Medium — 0.3 mm to less than 1.0 mm
- Wide — equal to or greater than 1.0 mm

7-37

Precast Channel Girder Rating Guide

- Crack widths:
  - Hairline < 0.1mm
  - Narrow ≥ 0.1mm and < 0.3mm
  - Medium ≥ 0.3mm and < 1.0mm
  - Wide ≥ 1.0mm
- Use a crack gauge to measure widths
- Anchor Zone is 1.2m when girder less than 10m & 2.0 when 10m or more (channel girders only)
- Increase longitudinal crack rating by 1 for PA and PG girders OR if only one leg (HC girders). Increase is not cumulative
- Reduce by 1 if punchout at pockets, connectors, or mid-span.
- Defect in curb girder only increase by 1

Superstructure Inspection and Rating

Superstructure Inspection and Rating

Superstructure Inspection and Rating

Superstructure Inspection and Rating

Rating Pre-stressed Girders

- Refer to Sections 7.14 to 7.15.2.7 for general information.
- Refer to Section 7.15.4 for specific information.
- Suggest using “3-strike” rule when determining ratings for pre-stressed girders.

1. Start with Table 7.7 – Exception List for common std. girder types (VS, SM, SC, SL).
   - ➢ Note that crack width must be narrow – reduce by 1 if corrosion staining is present.
   - ➢ If defect in field matches description in Table 7.7 then rate accordingly.
2. Refer to Table 7.4 – Exception List for ALL Pre-stressed Girders.
   - ➢ If defect in field matches description in Table 7.4 then rate accordingly.
3. Refer to Table 7.3–strike 3 – rate accordingly

Rating Guide for Prestressed Girders – Table 7.7

Girder Type: VS, SM, SC, RD, RM, PM, VM, SL

Crack	Rating	Description
1.	5	Diagonal crack on bottom of girder, not longer than 0.5 m. Crack length must be continuous and not intermittent or staggered. Crack lengths to be measured from the face of the pier cap or abutment seat and along the length of the crack (with no signs of corrosion staining).
	3	Diagonal crack on bottom of girder, not longer than 0.5 m. Crack length must be continuous and not intermittent or staggered. Crack lengths to be measured from the face of the pier cap or abutment seat and along the length of the crack (with signs of corrosion staining).
2.	5	Longitudinal crack on girder underside.
3.	5	Longitudinal crack at lower curb fascia.
4.	5	Crack in poured connection at fascia over piers (RM, RD, SMC, SCC, SCM, SLC).

Table 7.7 - Exception List- Girder Type: VS, SM, SC, RD, RM, PM, VM, SL

Rating Guide for Prestressed Girders – Table 7.4

Exception List - All Prestressed Girders

Crack	Rating	Description
1	6	• Narrow map cracks
	4	• Medium, wide or any map cracking with staining
2	3	• Vertical crack 50 to 100 mm from end of girders with or without signs of corrosion stains

Rating Guide for Prestressed Concrete Girders – Table 7.3

Rating	Defects
4	• Hairline cracks with no staining except as noted below.
3	• All other cracks except as noted below. • Corrosion stains originating from prestressed strands.
2	• Cracks with signs of corrosion in webs or bottoms of boxes or flanges except as noted below. • Any cracks which are growing.
1	• Any cracks which are opening or closing under traffic or with slippage along the cracks.

Typical Diagonal Crack

Longitudinal Crack – No Corrosion

Superstructure Inspection and Rating

Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

BIM
Bridge Inspection and Maintenance

Superstructure Inspection and Rating

Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

BIM
Bridge Inspection and Maintenance

Superstructure Inspection and Rating

Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

BIM
Bridge Inspection and Maintenance

Superstructure Inspection and Rating

Typical Corrosion Spots

Alberta Transportation

Technical Standards Branch
Class B Bridge Inspection Course

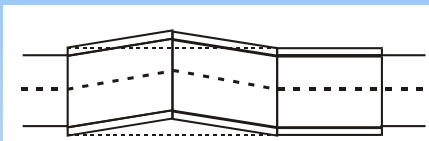
BIM
Bridge Inspection and Maintenance

Span Alignment Problems

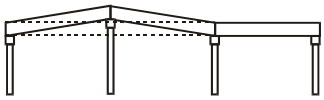
Superstructure				
Bridge Component		Last	Now	Explanation of Condition
Span Alignment Problems				
Vertical (Y/N)				
Horizontal (Y/N)				

- Applies only to
  - the vertical and horizontal alignment of the superstructure
- No rating is required
- Mis-alignments may indicate distress in the superstructure and/or substructure

Span Alignment Problems



Horizontal Misalignment



Vertical Misalignment

Span Alignment Problems

- Look along edges of girders, curbs, railing for signs of sags, bows, movement, buckling, twisting, etc.
- Look for vertical mis-alignment and uneven gaps at deck joints
- Indicate whether there is a vertical and horizontal alignment problem by **Y**es or **N**o
- Provide an explanation of the location, type, possible cause and seriousness

General Rating

- Governed by
  - Structural load carrying members
  - Subdeck or deck underside
  - Stringers
  - Girders
- Span alignment problem if related to serious structural
- Hazardous conditions such as missing rail, conditions potentially harmful to motorists

Questions??

PREPARATION FOR INSPECTION AND INSPECTION SAFETY

Inspection Safety

- Occupational Health & Safety Act
  - high rigging
  - scaffold & swing stages
  - crane safety and rigging
  - confined spaces
  - working over water

Inspection Safety (Continued)

- General Safety Issues
  - use proper equipment
  - park in a safe location
  - avoid unnecessary risk
  - assume all electrical is live
  - do not wear chest waders in fast moving water
  - use caution on ice
  - do not enter confined spaces
  - un-even ground
  - slippery culverts
  - fast flowing water
  - 3-point contact on bridgerails
  - inspect facing traffic – be alert
  - use check-in procedure – test it!!

Inspection Safety (Continued)

- Traffic Safety
  - if possible schedule during low traffic flow
  - inform road authority
  - park vehicles off road
  - wear high visibility vests
  - inspect facing traffic
  - be efficient and follow a routine – don't cross back and forth in traffic un-necessarily
  - be alert – be safe
  - use flag persons and signage if necessary-Level 2

Personal Safety

- Personal Equipment
  - hard hat
  - proper foot wear (non-slip soles)
  - hip waders
  - eye protection
  - warm clothing
  - extra clothing
  - rain gear
  - 1st aid kit
  - bug spray
  - bear spray
  - snake bite kit
  - safety harness – Level 2
  - life jackets – Level 2

Basic Tools for Inspection

- BIM Manual, Reference Manual
- Clip board and extra pencils
- Camera
- Long tape & steel weight
- Pocket tape
- Chipping hammer
- Binoculars
- Crack gauge
- Angle finder
- Flashlight and headlamp c/w extra batteries
- Marking crayons

Basic Tools for Inspection

- Surveyor hand level
- Regular hand level
- Wire brush
- Plumb bob
- String line
- Measuring pole or electronic measuring device
- Personal equipment
- Shovel

Inspection Equipment

- Inspection Equipment – Level 2
  - portable ladders
    - base 1/4 of length from wall
    - do not work on top two rungs
    - base firm and non-slip
    - extension ladders proper overlap
  - scaffold
    - anchor properly
    - design = 4X load
    - inspect daily
  - safety harness – Level 2
    - adjust to fit
    - attach to fixed anchor
    - check prior to use

Preparation for Inspection

- BIM Inspection Forms
  - Order from BIS
  - Carry blank forms
  - Review previous inspections
- Bridge File Maps
  - shows bridge locations
  - GPS co-ordinates
  - plan route
  - set-up designated check-in person or system – test it!
- Bridge Inventory Information
  - use to confirm bridge characteristics
  - Inspection requirements
  - check bridge file number
  - Update inventory during inspection

Substructure Inspection and Rating

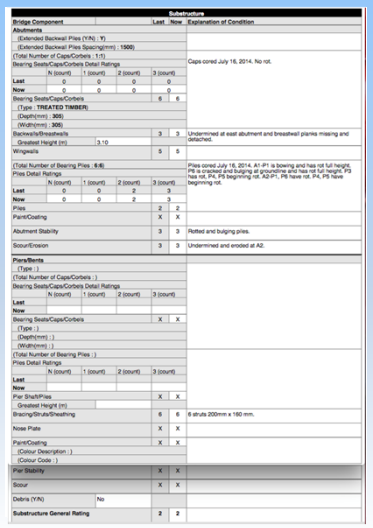
Introduction

- That portion of the bridge located below the bearings
  - Abutments
  - Piers
  - Rated separately
- Purpose is to:
  - Receive the loads from the superstructure
  - Transfer forces to the ground
  - Contain the approach fills
  - Withstand other forces on it
    - Ice
    - Debris/drift
    - earth pressure

Introduction

- Components
  - bearing seats. caps
  - piles
  - backwalls
  - wingwalls
  - bracing and struts
- Component materials
  - timber
  - concrete
  - steel

Introduction

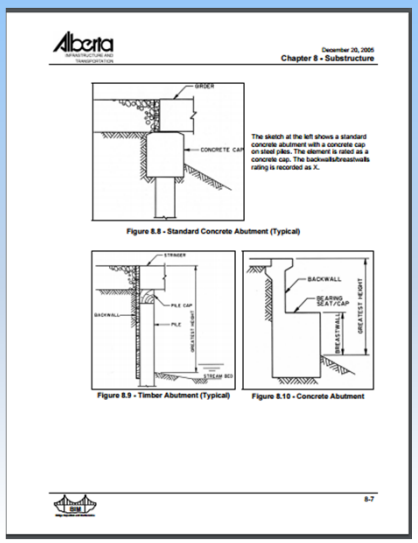


Substructure			
Bridge Component		Last	New	Explanation of Condition
Abutments				
(Extended Backwall Piles (Y/N) : Y)				
(Extended Backwall Piles Spacing(mm) : 1500)				
(Total Number of Caps/Corbels : 1/1)				
Bearing Seats/Caps/Corbels Detail Ratings				Caps cored July 16, 2014. No rot.
	N (count)	1 (count)	2 (count)	3 (count)	
Last	0	0	0	0	
Now	0	0	0	0	
Bearing Seats/Caps/Corbels			6	6	
(Type : TREATED TIMBER)					
(Depth(mm) : 305)					
(Width(mm) : 305)					
Backwalls/Breastwalls			3	3	Undermined at east abutment and breastwall planks missing and detached.
Greatest Height (m)	3.10				
Wingwalls			5	5	
(Total Number of Bearing Piles : 6/6)					Piles cored July 16, 2014. A1-P1 is bowing and has rot full height, P6 is curved and bulging at groundline and has rot full height, P3 has rot, P5 beginning rot, A2-P1, P6 have rot. P4, P5 have beginning rot.
Piles Detail Ratings					
	N (count)	1 (count)	2 (count)	3 (count)	
Last	0	0	2	3	
Now	0	0	2	3	
Piles			2	2	
Paint/Coating			X	X	
Abutment Stability			3	3	Rotted and bulging piles.
Scour/Erosion			3	3	Undermined and eroded at A2.
Piers/Bents					
(Type :)					
(Total Number of Caps/Corbels :)					
Bearing Seats/Caps/Corbels Detail Ratings					
	N (count)	1 (count)	2 (count)	3 (count)	
Last					
Now					
Bearing Seats/Caps/Corbels			X	X	
(Type :)					
(Depth(mm) :)					
(Width(mm) :)					
(Total Number of Bearing Piles :)					
Piles Detail Ratings					
	N (count)	1 (count)	2 (count)	3 (count)	
Last					
Now					
Pier Shaft/Piles			X	X	
Greatest Height (m)					
Bracing/Struts/Sheathing			6	6	6 struts 200mm x 160 mm.
Nose Plate			X	X	
Paint/Coating			X	X	
(Colour Description :)					
(Colour Code :)					
Pier Stability			X	X	
Scour			X	X	
Debris (Y/N)		No			
Substructure General Rating			2	2	

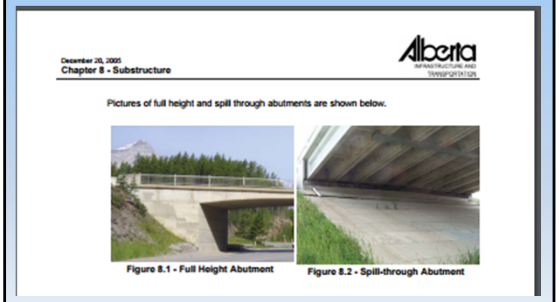
Abutments

- Purpose
  - Support the ends of the girders or stringers
  - Contain the approach fills
- Two types in standard bridges - classified according to their height

Abutments



Full Height & Spill Through Abutments



Abutments

- Full Height Type
  - Solid retaining walls
  - Extend the full height of the bridge
  - Has wingwalls
  - No headslopes
  - Susceptible to lateral displacement from earth pressure
  - Vulnerable to undermining if not protected

Abutments

Full Height Type

Full Height Abutment

Full Height Abutment

Abutments

- Spill Through Type
  - Intersect the headslopes at the cap height
  - No retaining wall (backwalls) below caps
  - Short wings
  - Vulnerable to undermining if headslopes not protected with scour protection
  - Susceptible to slumping if headslopes too steep or scour at toe

Spill Through Abutment

Abutments

- Indicate Extended Backwall Piles "**Y**es" or "**N**o"
- Record Extended Backwall Pile maximum spacing in mm
- Provide Backwall/Breastwall rating–refer to 8.6
- Measure and record greatest height – lowest point to top of deck
- Rate struts on single span bridge in Pier section of form

Extended Backwall Pile

Backwalls/Breastwalls

Backwalls/Breastwalls		3	3
Greatest Height (m)	3.10		

Undermined at east abutment and breastwall planks missing and detached.

- Applies to abutments only
- That part of the abutment sheeting between the wingwalls
- Function is to retain the approach fill
- On standard bridges, backwalls are:
  - horizontal timber planks nailed to the piles
  - vertical driven tongue and groove timber planks nailed to whalers attached to piles
  - Includes extended backwall piles
- Measure and record greatest height – lowest point to top of deck

Backwalls/Breastwalls

- On Standard bridges Breastwalls refer to planks attached to streamside of abutment piles
- Look for:
  - Defects common to timber and steel
  - Sheathing not installed low enough
    - sheeting to be set 300 mm below ground level or scour protection
  - Loss of fill material below the backwall or breastwall
  - Loose, missing, or bowing planks

Backwalls/Breastwalls Ratings

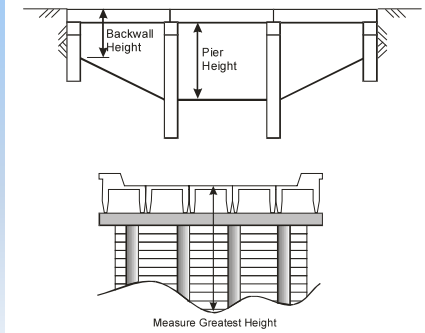
- Rate according to condition and ability to perform as designed (retaining wall)
- Sheeting bowing out from earth pressure rate 5 providing it is functioning (retaining fill).
- Loss of material under sheathing - rate 4 or less
- Excessive gaps between the planks allowing infiltration rate 4 or less
- Decay, broken or missing planks - rate 4 or less

Backwalls/Breastwalls Loss of Fill Rated 4

Repair with Breastwall

Vertical Driven Backwall Sheathing

Backwall & Pier Height



Wingwalls

- Applies to abutments only
- Primary function is to retain fill
- Consist of horizontal or vertical driven sheathing attached to piles
- Wing piles are included in inspection and rating
- Stability and Scour/Erosion are rated separately
- Look for:
  - Material defects
  - Sheeting not installed low enough - sheeting to be set below the ground level or scour protection installed at the bottom
  - Loss of fill material below the wingwall
  - Excessive gaps between the planks allowing infiltration
  - Sheeting or piles bowing out from earth pressure
  - Missing or broken planks or piles
  - Missing or damaged tin tops on timber wing piles
    - installed to prevent water from entering cut end and rotting interior of pile
  - Proper attachment to backwall - loose or missing wing cleat
  - Broken or loose anchor tie to pile

Wingwall Ratings

- Requires repairs for aesthetics but is still functional - rate 5 or more
- Requires repairs to be functional - rate 4 or less
  - Loss of fill material – rate 4 or less (also rate under Scour)
  - Sheathing or piles bowing out from earth pressure rate 5 or less depending on functionality
  - Missing or broken planks rate 5 or less depending on functionality
  - Broken or rotted piles rate 4 or less
  - Missing or damaged tin tops on wing piles rate 4

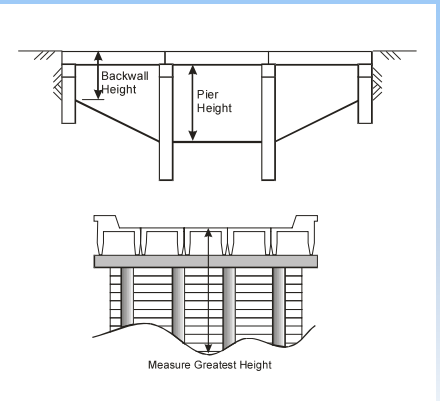
Wingwall – Separation from Backwall

Wingwall – Broken Pile

Piers

- Intermediate supports between the abutments on multi-span bridges
- Record pier type
  - On Standard bridges piers are usually “Pile Bents”
  - Pile bent is a single row of piles
  - Pile Bent is recorded as “Pier Column”
- Measure and record greatest height – lowest point to top of pier cap
- Material Type:
  - Timber
  - Steel
  - Concrete (major bridges)

Backwall & Pier Height



Timber Pier Bent (Column) with Sway Bracing

Timber Pier Bent (Column) with Sheathing

Teepee Pier Bent (Column) with Sheathing, Capitols, Steel Caps

Galvanized Steel Pier Bent (Column) with Bracing

Bearing Seats/Caps/Corbels

8.5. ABUTMENT AND PIER BEARING SEATS / CAPS / CORBELS

Bridge Component				Last	Now	Explanation of Condition
Abutments or Piers/Bent						
(Total Number of Caps or Corbels)						
Bearing Seats/Caps/Corbels Detail Rating						
	N (count)	1 (count)	2 (count)	3 (count)		
Last						
Now						
Bearing Seats/Caps/Corbels						
(Type:)						
(Depth (mm) :)						
(Width (mm) :)						

- Applies to abutments and piers
- Corbels used on major bridges only
- Purpose
  - Receive the loads from the superstructure
  - Transfer loads to the piles
- High stress concentrations in bearing areas
  - Under girders or timber stringers
  - Above piles

Abutment or Pier Caps

- Types
  - Timber - found on timber pile bents
  - Concrete - found on concrete or steel
  - Steel - found on steel or timber pile bents
- Confirm and/or record:
- ✓ Total number of individual caps at each abut and pier (west:east or south:north) (e.g. 3:3)
- ✓ Record Detailed rating boxes for caps
  - record number of caps not visible in "N" box
  - record "0" if timber caps are rated 4 or more or if caps are not timber
- ✓ Provide cap rating - refer to Section 8.5
- ✓ Record Type and size of caps – if different sizes provide comment
  - Use nominal dimensions-(250, 305, 356mm)

Abutment or Pier Caps

- Look for:
  - Concrete caps with wide cracks, delamination, spalls, corrosion of rebar, other deterioration
  - Material defects
    - Especially decay in timber
    - Check shape of timber caps (bulging/crushing)
  - Good contact between girders and caps , and between caps and piles
  - Fire damage-reduced section and strength
  - Evidence of defective connections
    - Corrosion of dowels or drift pins
    - Broken, cracked or poor welds
  - Capitals
    - proper size for pile
  - Location and installation of steel cap stiffeners
    - over pile locations
    - on both sides of web
  - Rotation or displacement
    - Usually indicates substructure movement

Timber Caps – Abutments or Piers

- Decay in timber
  - check moist areas - contact between girders, piles, sheeting planks
  - check cut ends, dowel, drift, and bolt holes
  - most often occurs in the cap interior while the treated surface remains sound
  - look for discoloration at bottom of caps where moisture leaches out decay by-products
  - look for crushing or bulging especially in high stress areas at piles or under girders
  - sound caps with hammer to detect hollow areas
  - Recommend Level 2 coring if any decay present or suspected based on visual clues

Rating Abutment/Pier Caps

- Refer to Section 8.5.3 in Manual
- Rate according to condition and functionality
- Record number of caps rated N, 1, 2 & 3 in Detail Rating Field. Record "0" if caps rated >3
- Any deficiencies reducing ability to transmit loads rate 4 or less
- Spalling and rebar exposed - rate 4 or less
- Girder bearing less than 100mm rate 4 or less
- Girder bearing less than 75 mm rate 3 or less
- Timber caps with:
  - Vertical or horizontal splits extending through full dimension rate 4 or less
  - Early signs of rot rate 4 or less
  - Signs of bulging rate 3 or less
  - Signs of crushing rate 2 or less

Bulging Timber Cap–Rated 3

Crushing/Bulging Timber Pier Cap–Rated 2

Crushing/Bulging Timber Abutment Cap–Rated 2

Crushing/Cracked Timber Pier Cap – Rated 2

Crushing/Cracked Timber Abutment Cap – Rated 2

Crushing Timber Cap – Rated 2

Timber Corbels Major Bridges

Level 2 Timber Coring

Level 2 Core Samples

Core shavings with rot

Good texture and color – no rot

Fire Damaged Timber Cap with Section Loss

Concrete Pier Cap with Spalling

Abutment and Pier Piles

8.8. ABUTMENT BEARING PILES AND PIER SHAFT / PILES

Bridge Component				Last	Now	Explanation of Condition
(Total Number of Bearing Piles :)						
Piles Detail Rating						
	N (count)	1 (count)	2 (count)	3 (count)		
Last						
Now						
Abutment Piles or Pier Shaft/Piles						
Greatest Height (m)						

- Applies to piles at abutments and piers
- Piles receive the loads from the caps and transmit them to the ground
- Piles also accommodate lateral loads
  - ice and drift
  - earth pressure
- Record Detail Ratings as "0" if timber piles rated 4 or more - or if not timber piles

Abutment and Pier Piles

- Pile types
  - Timber
  - Steel H-pile
  - Steel pipe pile filled with concrete
  - Concrete
- Record the maximum pier height
  - Measure from lowest point to top of pier cap

Abutment and Pier Piles

- Look for:
  - Material defects
    - Cracks, decay of timber piles (especially in wet/dry zone
    - Cracks, corrosion/loss of section of steel piles
  - Collision damage from ice, drift or vehicles (Lead pile especially)
  - Abrasion from ice or drift
  - Bowing due to excessive earth pressure or vertical loads
  - Misalignment (out of plumb – not sharing loads) due to lateral forces
  - Uneven spacing due to poor construction
  - Signs of heaving or settlement. Note in vertical misalignment

Abutment and Pier Piles

- Confirm and/or record:

✓ Total number of bearing piles at each abutment and pier (west:east or south:north)

✓ Example 8:7 (numbers may be different)

✓ Record Detailed Rating boxes for piles

- record total number of abut/pier piles not visible ("N")
- record "0" if timber piles caps are rated 4 or more or if piles are not timber

✓ Provide rating for abut and pier piles - refer to Section 8.8

Abutment and Pier Piles

- Rate according to condition and functionality
- Do not consider
  - Stability - rate under abutment or pier stability
  - Bracing - rate under bracing
  - Struts - rate under struts
- Piles that are not sharing the loads from the superstructure - rate 4 or less
- Wide splits or cracks (>15mm) rate 4 or less
  - ➢ If repaired (banded, clamps, struts) rate 5.
- Horizontal bending cracks rate 3 or less
- Crushing from horizontal load of struts rate 3 or less
- Piles showing duress (bowing) under loads - rate 2 or less
- Piles with bulging outer fibers - rate 2
- Record number of timber piles rated N, 1, 2 or 3 in pier and abutment Detail Ratings (0 if piles rated >3 or if not timber piles)

Timber Abutment Piles Bulging – Rated 2

Timber Abutment Piles Bulging – Rated 2

Timber Abutment Piles Bulging/ Bowing– Rated 2

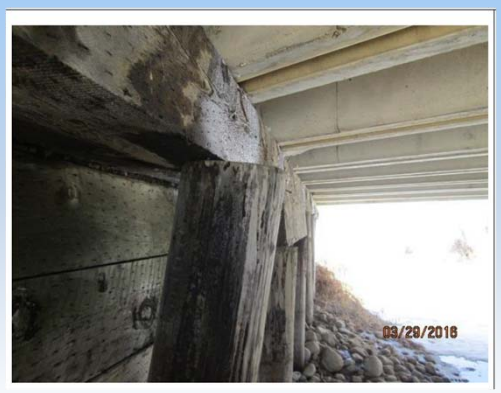
Timber Abutment Piles Wide Split–Rated 3

Timber Abutment Piles Horizontal Bending Crack–Rated 3

Timber Pier Piles with Rot – Rated 3

Timber Piles Repaired with Steel Splice

Timber Pile Not Sharing Load – Rated 3



Paint / Coating

Nose Plate	4	4	Stream has degraded below bottom of nose plates.
Paint/Coating	X	X	No paint on nose plate.
(Colour Description :)			
(Colour Code :)			

- Applies to abutments and pier elements
- Steel
  - Paint
  - Galvanizing
- Concrete
  - Cosmetic coatings
  - Pigmented Sealers
  - Waterproofing coatings
- Does not refer to the creosote on timber components
- Refers to nose plate coating only on timber piers

Paint / Coating

- No coating on treated timber substructures therefore rate X.
  - unless there is a nose plate then rate plate coating
- Check areas exposed to moisture and or salt
  - under leaking joints
  - water line
  - ground line
- Check areas that are difficult to coat
  - edges and corners
  - bolts and connections
  - areas with poor access

Paint / Coating

- Rate according to condition and ability to protect the underlying element
- Top coat deteriorating but prime coat intact - rate 5
- Pitting or loss of section of underlying element - rate 4 or less
- Coatings for aesthetics only (cosmetic coatings on concrete) - rate 3 or more
- If no coating on steel elements and there is corrosion, rate 4 or less.

Abut/Pier Stability

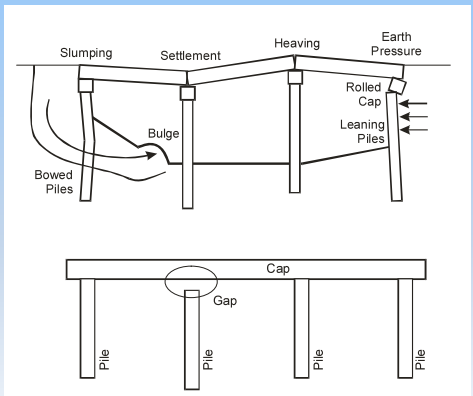
Substructure				
Bridge Component		Last	Now	Explanation of Condition
Abutments				
Abutment Stability)				
Pier Stability				

- Applies to abutments and piers but rated separately
- Can cause failure of the structure or problems with superstructure
- Small movement can be tolerated
- Excessive movements are those which affect load carrying capacity, level of service or cause distress to bridge elements

Abut/Pier Stability

- Types
  - Rotational or dipping
    - excessive earth pressure
    - Scour/erosion
    - Superstructure movement
  - Vertical
    - heaving due to frost
    - settlement due to inadequate bearing capacity
  - Horizontal
    - movement of soil mass or slope failure

Abut/Pier Stability



Abut/Pier Stability

- Span alignment problems detected in superstructure inspection may indicate substructure instability
- Rotational Movement - look for:
  - mis-alignment of caps with backwalls or piles (rotating or rolling)
  - damage to connections at bearing areas
  - damage to anchoring system
  - signs of embankment movement

Abut/Pier Stability

- Lateral Movement - look for:
  - uneven bearing areas
  - horizontal misalignment between spans
  - separation between backwall and wingwalls
  - signs of embankment movement
  - out of plumb piles
  - bowed struts
  - broken backwall scab/anchor pile connections

Abut/Pier Stability

- Vertical Movement - look for:
  - unevenness in superstructure
  - gaps between piles and caps
  - misalignment of structural elements
- Can have serious scour without affecting stability
- Movement that requires monitoring - rate 4 or less
- Movement causing damage to any bridge element - rate 4 or less

Abut/Pier Stability Bowed Struts

Stability – Heaved Pier

Scour / Erosion

Substructure				
Bridge Component		Last	Now	Explanation of Condition
Abutments				
Scour/Erosion				
Piers/Bents				
Scour				

- Abutments and piers rated separately
- Refers to removal of material by flowing water stream or approach drainage
- Most bridge failures associated with scour / erosion during floods
- Only scour which affects or has the potential to affect the abutments or piers

Scour / Erosion

Definition – refer to 16.2

- Scour – Removal of streambed material due to increased velocities caused by obstruction or constrictions
- Erosion – general removal of material on stream banks, drainage ditches etc. by flowing water
- Factors
  - stream geometry
  - type of material in stream banks and bed
  - obstructions
    - ice, drift, piers, abutments, river training works
  - alignment of piers and abutments
  - degree or constriction at bridge
  - severity of flood

Scour / Erosion

- Look for:
  - A variation from the natural stream banks or bed
  - General stream degradation and associated slumping of banks
  - Loss of material
    - toe of headslopes
    - in front of abutment backwalls
    - around piers
  -
  - scour if any debris is present

Scour / Erosion

- Determine the extent of the scour / erosion and probable cause
- Approach road drainage that is also causing abutment erosion rated in Abut Scour/Erosion
- Scour or erosion causing loss of fill material from below or behind backwall rate 4 or less
- If stability of structure threatened rate 3 or less
- If vertical bank at the abutment rate 3 or less
- If loss of fill is safety concern resulting in a hazard, rate 2 or less

Bracing / Struts / Sheathing

Bridge Component		Substructure Last	Now	Explanation of Condition
Bracing/Struts/Sheathing				

- Applies to piers only
  - Bracing or sheathing on piers
  - Struts which extend between abutment or pier piles
- Bracing and sheeting
  - For load distribution between piles
  - To give the pier rigidity
  - Bracing are single planks or steel members connecting the piles
  - Sheathing is a solid wall of planks on both sides of the pier
    - usually combined with a nose plate

Bracing / Struts / Sheathing

- Struts
  - Normally timber
  - To prevent the earth pressure from pushing the abutment piles out
  - if no struts, check that other pile anchor systems in place for backwall type abutment

Bracing / Struts / Sheathing

- Look for:
  - Material defects
  - Adequate connections
    - struts include retainer planks (horizontal planks on piles supporting struts)
  - Whether struts interfere with passage of drift or ice
  - Struts bear on piles and not caps
  - Missing or bowing struts

Bracing / Struts / Sheathing

- Rate according to condition and functionality
- All elements a single rating - use the "Explanation of Condition" to identify details
- If struts are bowed, missing, or bear on caps instead of piles
  - significant abutment movement has not occurred rate 4
  - Significant movement, rate 3 or less.
- If sheeting on pier does not extend to waterline or above high water level rate 4
- Loose/missing sheathing rate 4 or less
- Cracked/broken bracing rate 4 or less

Bracing / Struts / Sheathing

Piers/Bents					
(Type : **PIER-COLUMN**)					Caps cored Aug. 25/15 Pier 2 has 1 100x305 T.T. on top of caps Pier 1 has 2 - 100x305 T.T. on top of caps Beginning rot in all 100x305 T.T. top planks at both piers.
(Total Number of Caps/Corbels : **8:5**)					
Bearing Seats/Caps/Corbels Detail Ratings					
	N (count)	1 (count)	2 (count)	3 (count)	
Last	0	0	0	0	
Now	0	0	0	0	
Bearing Seats/Caps/Corbels				6	4
(Type : **TREATED TIMBER**)					
(Depth(mm) : **305**)					
(Width(mm) : **356**)					
(Total Number of Bearing Piles : **10:9**)					Piles cored Aug. 25/15 P1-P4, P6 and P2-P5, P6, P8 and P9 all with beginning rot at base of pile Wide checking to Pier 2, Pile 9 - Ok.
Piles Detail Ratings					
	N (count)	1 (count)	2 (count)	3 (count)	
Last	0	0	0	0	
Now	0	0	0	0	
Pier Shaft/Piles				5	4
Greatest Height (m)		5.30			
Bracing/Struts/Sheathing				4	4

Nose Plate

Nose Plate	4	4	Stream has degraded below bottom of nose plates.

- Applies to piers only
- Located on the upstream side
- Protects pier from impact or abrasion from ice or drift
- Made from steel and bolted or welded to pier
- Found on H-pile and sheeted timber piers

Nose Plate

- Look for:
  - Material defects
  - Adequate connections to pier shaft/piles
  - Impact damage
- Rate according to condition and functionality
- Do not rate damage to pier - rate under piles or bracing/sheeting
- Missing nose plate on timber pier prone to damage from ice or drift rate 3 o less
- Timber pier with no plate and damaged rate X and recommend installation in comments and recommendations

Nose Plate

Debris

Debris (Y/N)	Yes		Old piles.

- Applies to substructure as a whole –abuts and piers
- Material deposited in the bridge opening
  - trees and vegetation
  - logs
  - boulders
  - beaver dams
  - Refuse (tires, washing machines, etc)
  - old piling under bridge

Debris

- Problems caused by debris
  - reduction in flow carrying capacity of bridge
  - scour
  - impedes fish passage
  - upstream siltation

Debris

- Look at the entire bridge opening for any debris accumulation
- If debris is located away from the bridge, record under the “Channel” section
  - If has an effect on the bridge or has the potential to
- Indicate whether any significant debris is present by **Y**es or **N**o
  - If Yes, explain
- No rating is required but the presence of debris may affect the Substructure General Rating
- Old piling is considered debris, note in Explanation

Abutments

Alberta Transportation — Bridge Inspection & Maintenance System (Web 2005) — 73333 -1 Bridge

Substructure						
Bridge Component					**Last**	**Now**	**Explanation of Condition**
Abutments							
(Extended Backwall Piles (Y/N) : **Y**)							
(Extended Backwall Piles Spacing(mm) : **1500**)							
(Total Number of Caps/Corbels : **1:1**)							
Bearing Seats/Caps/Corbels Detail Ratings							Caps cored July 16, 2014. .
	N (count)	1 (count)	2 (count)	3 (count)			
Last	0	0	0	0			
Now	0	0	1	1			
Bearing Seats/Caps/Corbels					6	2	A1 cap is crushing. A2 cap is beginning to bulge.
(Type : **TREATED TIMBER**)							
(Depth(mm) : **305**)							
(Width(mm) : **305**)							
Backwalls/Breastwalls					3	3	Undermined at east abutment and breastwall planks missing and detached.
Greatest Height (m)	3.10						
Wingwalls					5	5	
(Total Number of Bearing Piles : **6:6**)							Piles cored July 16, 2014. A1-P1 is bowing and has rot full height. P6 is cracked and bulging at groundline and has rot full height. P3 has rot, P4, P5 beginning rot. A2-P1, P6 have rot. P4, P5 have beginning rot.
Piles Detail Ratings							
	N (count)	1 (count)	2 (count)	3 (count)			
Last	0	0	2	3			
Now	0	0	2	3			
Piles					2	2	
Paint/Coating					X	X	
Abutment Stability					3	3	Rotted and bulging piles.
Scour/Erosion					3	3	Undermined and eroded at A2.

Piers

Piers/Bents					
(Type : **PIER-COLUMN**)					Caps changed in 1988.
(Total Number of Caps/Corbels : **3:3**)					
Bearing Seats/Caps/Corbels Detail Ratings					
	N (count)	1 (count)	2 (count)	3 (count)	
Last	0	0	0	0	
Now	0	0	0	0	
Bearing Seats/Caps/Corbels				6	6
(Type : **TREATED TIMBER**)					
(Depth(mm) : **300**)					
(Width(mm) : **350**)					
(Total Number of Bearing Piles : **5:5**)					Wide cracks and outer fibers are bulging at west pier P5 and east pier - P2, P5. Remaining piles have wide cracks and suspect rot.
Piles Detail Ratings					
	N (count)	1 (count)	2 (count)	3 (count)	
Last	0	0	2	8	
Now	0	0	3	7	
Pier Shaft/Piles				2	2
Greatest Height (m)	4.50				
Bracing/Struts/Sheathing				5	4	Missing 1 bottom plank at P2 but allows for pile inspection.
Nose Plate				4	4	Stream has degraded below bottom of nose plates.
Paint/Coating				X	X	No paint on nose plate.
(Colour Description :)					
(Colour Code :)					
Pier Stability				4	4	Rot in pier piles.
Scour				5	5	Minor scour behind both piers.
Debris (Y/N)	Yes					Old piles.
Substructure General Rating				**2**	**2**	

General Rating

- Governed by; refer to 1.10.3 and 8.15
  - Structural load carrying members
  - Caps/Seats ratings
  - Pile ratings
  - Backwall rating of 2 or less
  - Abutment and/or pier stability ratings
- The structural element ratings for both the abutments and piers must be taken into account when determining Substructure General Rating

Questions??

Culverts - Basic Structural Considerations

https://m.youtube.com/watch?v=NTbhyHNA1Vc

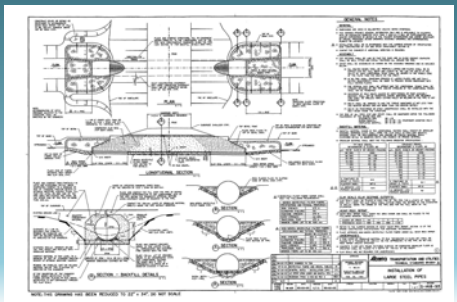
Introduction

- ~ 6000 bridge size culverts in Alberta
- Two types of culverts:

➢ Rigid Structures (concrete or timber)

➢ Flexible Structures (corrugated metal)

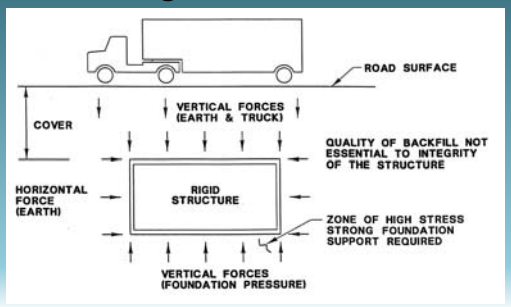
Std. Drawing S1418



Rigid Structures

- Concrete (5%) – either box or pipe
- Timber (1%) - no longer being built
- No noticeable deflection under loads
- Concrete is a durable material
- Concrete is relatively expensive

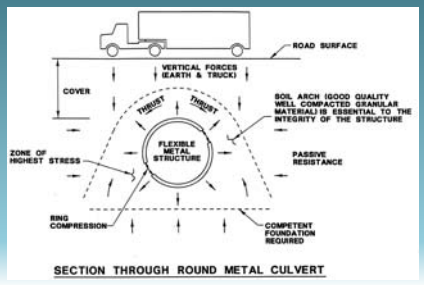
Rigid Structures



Flexible Structures

- Metal Culverts comprise 94%
- Fabricate to almost any shape
- Relatively cheap
- Backfill & Installation CRITICAL
- Susceptible to structural problems
- Prone to corrosion, abrasion

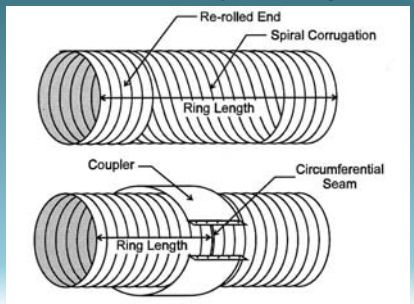
Flexible Structures



SECTION THROUGH ROUND METAL CULVERT

Basic Structural Considerations

CSP (field jointing)



Flexible Culverts

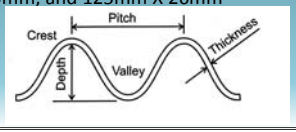
- Two Types:
  - ➢ Corrugated Steel Pipe (CSP)
  - ➢ Structural Plate Corrugated Steel Pipe (SPCSP)

Corrugated Steel Pipe (CSP)

- Complete rings fabricated in plant
- Rolled helical sections, re-rolled ends
- Joined by couplers
- Bridge sizes range from 1500 to 3600
- Common sizes 1800 to 3000 (in 200mm increments)
- Length to suit transportation (2.5 to 15.0m)

CSP Properties

- Common Thickness
  - 2.8mm, 3.5mm, 4.2mm
- Common Profiles
  - 68mm (Pitch) x 13mm (depth)
  - 76mm X 25mm, and 125mm X 26mm



Structural Plate Corrugated Steel Pipe (SPCSP)

- Flat plate is corrugated & punched
- HD galv. then curved to shape
- Five thickness – 3, 4, 5, 6, and 7mm
- Profiles - pitch x depth
  - ➢ 152 x 51
  - ➢ 380 x 140
  - ➢ 400 x 150
- Plates bolted together

SPCSP (cont.)

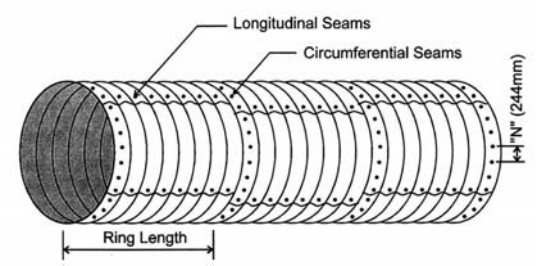
- Plate lengths
  - 3050mm (10 ft)
  - 3670mm (12 ft)
- Plate width 5N, 6N, and 9N

N is the circumferential bolt spacing
N = 3pi (244mm or 9.6")
N/ring = 4(dia. in feet)
(i.e. 10ft dia = 40N)

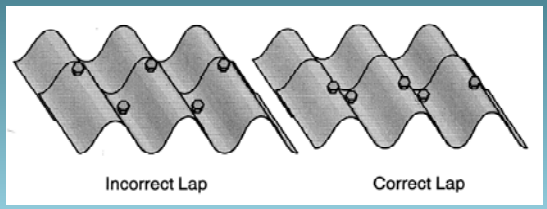
SPCSP - some recent products

- Atlantic Industry's 'Bolt-a-Plate
  width 1067, length 3N to 16N
- Twister Pipe's 'MP 200'
  pitch 200, depth 55mm
- SuperCor, and Bridge Plate
  (pitch 380, depth 140)
- New coating systems

SPCSP (field bolting)



SPCSP (longitudinal lapping)



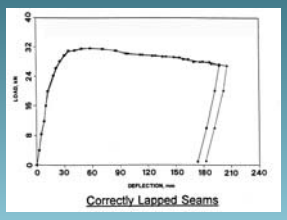
Properly Lapped Seam

Bolt in valley is nearest visible edge

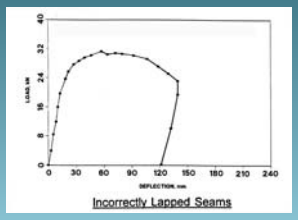
Improperly Lapped Seam

Bolt in valley is farthest from visible edge

SPCSP (seam strength tests)



Correctly Lapped Seams



Incorrectly Lapped Seams

Both types of laps can carry about the same load
Correctly lapped seams are more ductile - don't normally develop cracks

Questions??

Culvert Inspection and Rating

Introduction

- Bridge sized culverts have an equivalent diameter of 1500mm or greater
- Bridge site that requires a 1500 mm pipe due to hydraulic discharge
- Will routinely inspect smaller culverts if there are several (low level crossing)
- May also inspect if multiple small culverts are equivalent in hydraulic capacity to bridge-sized (2-1200mm)
- May inspect certain other non-bridge sized culverts (3 - 900mm)

Introduction

- Many different types of culverts – refer to Table 1.1 in Manual
- Vast majority are CSP or SPCSP in various shapes - round, arch pipe, horizontal ellipse
- Three culvert forms (Cul1, CulE, CulM)
- Same forms used for all types of culverts
- Timber pipe (TP) culverts exception
  - Use TT form

Form Types

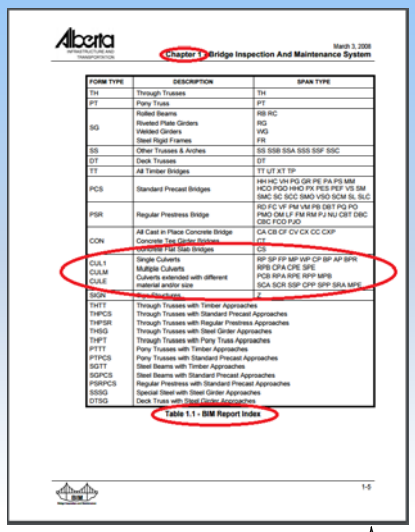
- CUL1
  - Single culvert or single culvert extended with same material and size
- CULM
  - Two or more culverts (MP, SP or BP etc.)
  - Includes 1 Upstream & 1 Downstream End section for each Barrel section
  - Exception is Concrete Boxes (BP) where single U/S and single D/S sections for all barrel sections
  - Includes 2 cell box extended with single steel
- CULE
  - Single culvert extended with different material and/or size
  - One Upstream & Downstream section, Barrel sections for all cells and/or pipes

Inventory Information

Bridge Culvert Information								
Number of Culverts		1						
Pipe #	Barrel	Span	Rise (or Dia.)	Type	Length	Corr. Profile	Pl./Slab Thickness	Shape
1	MAIN		1800	MP	33	125X26	2.8	ROUND
Special Features								
Special Features Comment								

- Extracted from BIS
- Span/rise is original design shape
- If round then only rise is recorded
- Span types – refer to Table 1.1 and Sec. 13.2.3
- Corrugation Profile and Plate Thickness selected from Table 13.1 and 13.2 (p.13.5 in manual)
- Specific information is provided for all pipes
  - a culvert extended with same material and size is considered to be one culvert (Cul1)

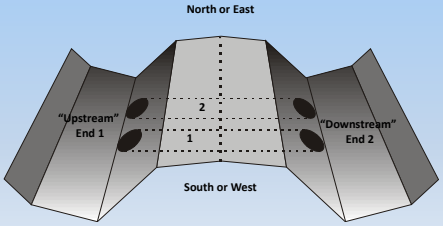
Culvert Span Types



Numbering and Identification

- Where the culvert does not carry flow determine "upstream" and "downstream"
  - Look in direction of increasing chainage
    - (to north or east)
  - Left is "upstream" (end 1)
  - Right is "downstream" (end 2)
  - Keep same choice for each subsequent inspection

Numbering and Identification



Numbering and Identification

- Primary span is the largest span at the site
- Secondary span is the smaller span
- Multiple culverts of same dimension are numbered in order of increasing chainage (from south to north or west to east)
- Multiple culverts also have same Ring numbering system (R1, R2, R3, etc.)

Ends - General

- Individual rating sections for the Upstream and Downstream ends
- Single upstream and downstream end sections for the CUL1, CULE forms
- Separate Upstream and Downstream ends for each Barrel section on CULM forms - except Concrete Boxes
- Upstream and Downstream sections are identical
- Items are inspected and rated the same way for both ends

Ends - General

Downstream End				
Culvert Component		**Last**	**Now**	**Explanation of Condition**
Direction		S		
End Treatment (Concrete, Steel, Others, None)	STEEL			
Headwall		X	X	
Collar		X	X	
Wingwalls		X	X	
(Shape :)				
Cutoff Wall		X	X	
Bevel End		8	8	
Heaving (mm)	0			
Invert Above/Below Stream Bed	BELOW			
Above/Below (mm)	200			
Scour Protection		8	8	
(Type : **RIP RAP**)				
(Avg. Rock Size(mm) : **300**)				
Scour/Erosion		8	8	
Beavers (Y/N)	No			
Downstream End General Rating		**8**	**8**	

Ends - End Treatment

- Purpose:
  - Improve aesthetics
  - Improve hydraulic performance
  - Prevent undermining due to scour
  - Prevent scour of the embankment
  - Reduce piping along or under the culvert
  - Resist uplift due to buoyancy forces
  - Shorten the culvert
  - Stiffen the ends

End Treatment -Types

- Steel:
  - Most common
  - Bevel end with no concrete treatment
- Concrete
  - Presence of any or all of: Headwall, Collar, Wingwall, Cutoff Wall
- Other
  - Timber Culvert with Timber End Treatment
- None
  - Square end – no Bevel present

Bevel Ends – End Treatment Type is "Steel"

Bevel Ends with Full Concrete End Treatment - Type is "Concrete"

Bevel End with Full Concrete End Treatment - Type is "Concrete"

End Treatment - Headwall

Culvert Component	Downstream End			
		Last	Now	Explanation of Condition
Headwall				

- Located over the crown
- Usually attached to the barrel
- Purpose:
  - Aesthetics
  - Strengthen end
  - Resist buoyancy force
  - Retaining walls

End Treatment - Headwall

- Look for:
  - Signs of movement or tilting
  - Loose connections
- Rate according to condition of material and functionality of component
- Condition affecting functionality rate 4 or less

End Treatment - Collar / Slope Protection

Culvert Component	Downstream End			
		Last	Now	Explanation of Condition
Collar/Concrete Slope Protection				

- Located along the beveled slopes of flexible culverts between headwall and cutoff wall
- Usually constructed from concrete
- Usually used with and connected to headwall and cutoff walls
  - May be used alone

End Treatment - Collar / Slope Protection

- Purpose:
  - Aesthetics
  - Stiffen the bevel
  - Resist buoyancy force
  - Improve hydraulic efficiency of end
  - Concrete slope protection
    - protect against scour / erosion
    - reduces piping potential

End Treatment - Collar / Slope Protection

- Look for:
  - Evidence of piping or scour / erosion
  - Loose connections
  - Voids underneath or settlement
- Rate according to condition of material and functionality of component
- If piping, rate 4 or less:
  - Also rated under bevel end and barrel

End Treatment - Wingwalls

Wingwalls (Shape : **FLARE**)	5	5	Both wings pushing towards streambed. North wall is 100 mm at top and 65 mm away from barrel worst of all four corners.

- Generally found at culverts that do not have bevels
- Shape is either Parallel or Flared to culvert axis
- Main difference from Bevel is Wingwall is not attached to the barrel
- Usually constructed from concrete or steel
- Purpose
  - Improve hydraulic efficiency
  - Retain embankment fill

End Treatment - Wingwalls

- Record Shape as “Parallel” or ‘Flare” (to culvert axis)
  - Parallel wingwall
    - Req’ less scour protection between walls
  - Flared wingwalls
    - more hydraulic efficient
- May have a reinforced concrete slab between
  - Prevents undermining of wingwalls due to scour
  - Act as struts for greater stability
  - If present rate with wingwalls

End Treatment - Wingwalls

- Look for:
  - Evidence of movement
  - Loose connections (gap at barrel)
  - Scour / erosion at toe or behind wingwall
- If wingwall is unstable rate 4 or less
- Separation losing fill rate 4 or less
- Includes rating of wingwall floor slab

End Treatment – Flared Wingwalls

End Treatment - Cutoff Wall

		Downstream End		
Culvert Component		Last	Now	Explanation of Condition
Cutoff Wall				

- Located at the end of the culvert
- Vertical wall extending down below the bottom of the culvert
- Depth exceeds the depth of the riprap or concrete apron
- Usually constructed from concrete or steel
- Purpose:
  - Reduce potential for undermining of end of culvert
  - Minimize possibility of piping
  - Resist buoyancy force

End Treatment - Cutoff Wall

- Look for evidence of:
  - Undermining
  - Piping
  - Uplift
  - Loose connections
- Usually not possible to inspect since they are submerged or covered with ice or debris
  - If not visible rate “N”
  - If certain not present rate “X”
- If piping, rate 4 or less
  - May also affect Bevel End and Barrel Rating

Ends - Bevel End

	Downstream End		
Culvert Component	Last	Now	Explanation of Condition
Bevel End			
Heaving (mm)			
Invert Above/Below Stream Bed			
Above/Below (mm)			

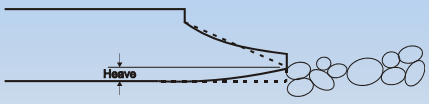
- Sloped section at the end of the culvert
- Permanently attached to the barrel
- Generally parallel to the culvert axis
- Bevel types
  - Full bevel
  - Step bevel

Ends - Bevel End

- Compared to projecting ends, bevel ends are more:
  - Aesthetic
  - Economical
  - Hydraulically efficient
- Compared to projecting ends, bevel ends on corrugated steel culverts are more flexible and susceptible to:
  - Deform due to lateral earth pressure
  - Uplift due to buoyancy
  - Heave due to frost action

Ends - Bevel End

- Measure or estimate heaving of bevel and record amount

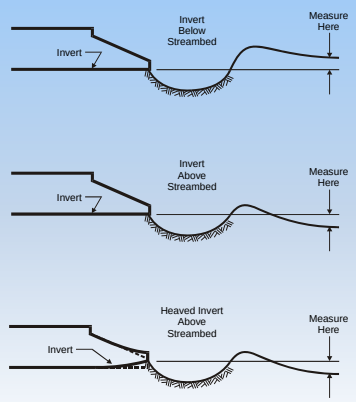


- Often best place to estimate is from inside barrel looking back to Bevel
- Use waterline as level
- Some heave is tolerable as long as water is entering Bevel

Ends - Bevel End

- If possible, measure or estimate height above or depth below streambed and record amount in mm. (may not be able to measure or confirm measurements in high water or winter).
- Normally “Below” as designed to be buried ¼ diameter below streambed.
- If invert is “at streambed” record Above/Below as 0mm.
- Find a representative natural streambed location
  - Discount presence of localized scour hole or deposits (aggrading) at end of culvert

Ends - Bevel End



Ends - Bevel End

- Look for:
  - Piping
  - Deformation
  - Impact damage
  - Corrosion that affect strength
  - Abrasion
- If piping, rate 4 or less
  - Also rated under End Treatment if present
- Defects/deformations not affecting function rate 6 or less (un-supported bevel - no heave)
- Severe corrosion affecting strength (perforations) rate 4 or less – otherwise corrosions should not affect rating
- If no bevel, rate "X"
  - Underpasses often have square ends

Ends - Bevel End

Ends - Scour Protection

Scour Protection	8
(Type : **RIP RAP**)	
(Avg. Rock Size(mm) : **600**)	

- Usually heavy rock riprap
- The current version of Std. Drawing S-1418 shows the minimum requirements for riprap
  - Coverage
  - Size
  - Minimum thickness
  - Gradation
- http://www.transportation.alberta.ca/index.htm

Ends - Scour Protection

- Purpose is to prevent scour and erosion at culvert ends which may:
  - Undermine the culvert
  - Undermine the sideslopes
  - Cause the formation of sand bars

Ends - Scour Protection

- Record the type of Scour Protection
  - If none exists and none is required, record type as “NATURAL”
  - If none exists and some is require, record type as “NONE”
- Estimate and record the average size (rock only)
- Look for:
  - Durability of riprap - e.g. sandstone is not acceptable
  - Shape – flat rocks not desirable
  - Displacement or movement
  - Scour
  - Current standards on S- 1418

Ends - Scour Protection Ratings

- No scour/erosion or displacement rate 7 or more
- If none exists and none is required record type as “NATURAL” and rate 7 or more
- If none exists but is required record type as “NONE” and rate 4 or less (also make recommendation)
- Generally not rated higher than Scour rating – especially when Scour is 4 or less
- Protected area is smaller than required or rock gradation or quality is inadequate rate 4 or less
- Concrete protection with excessive settlement or undermining rate 4 or less
- Cattlepasses that handle drainage rate – otherwise X

Ends - Scour / Erosion

		Downstream End		
Culvert Component		Last	Now	Explanation of Condition
Scour/Erosion				

- Removal of material from the streambed, banks or sideslopes by the action of flowing water and/or constrictions or obstructions (refer to Section 16.2 in manual).
- Effects:
  - Undermine the culvert
  - Undermine the sideslopes
  - Impede fish passage
  - Alter culvert hydraulics

Ends - Scour / Erosion

- Two types:
  - General – uniform lowering of original stream
  - Local – occurring at specific locations
- Look for:
  - Scour holes, especially at downstream ends
  - Undermining of culvert end or sideslopes
  - Slumping of sideslope or banks
  - Areas where flow impinges on banks, sideslopes or protection systems
  - Areas susceptible to high velocities and undermining
    - culvert footings
    - ends or bottoms of wingwalls and cutoff walls
    - sides of collars
    - ends or bottoms of ends of protection systems

Ends - Scour / Erosion

- Rate the presence and extent of scour and adverse effects on culvert, embankment, streambed and banks
- If culvert and embankment are not affected, rate 5 or more
- Scour/erosion affecting culvert, rate 4 or less

Ends - Scour / Erosion

Ends - Scour / Erosion

Ends - Beaver Activity

Structure Usage				
		Last	Now	Explanation of Condition
Channel (U/S and D/S)				
Alignment		5	5	
Bank Stability		5	5	
HWM (m below Top of Culvert)				(High water 1.2m above streambed @ outlet.) No visible HWM. Drift on floor of R1-R4
Drift (Y/N)	Yes			
Channel Bottom Degrading/Aggrading	DEGRADING			At D/S only
Beavers (Y/N)	Yes			Beavers at both U/S and D/S
(Fish Compensation Measure 1 : **NONE**)				
(Fish Compensation Measure 2 : **NONE**)				
Channel General Rating		5	5	

- Beavers frequently construct dams at inlet or inside culverts
- Effects:
  - reduced flow capacity
  - Flooding upstream
  - Scour
  - Ponding of water inside culverts preventing inspection

Ends - Beaver Activity

- Indicate the presence of beaver dams in or near the culvert by **Y**es or **N**o
- If “yes”, provide comment
- No rating required but may affect
  - End General Rating
  - Scour
  - Waterway Adequacy in Barrel section

Ends - General Rating

- Governing elements: (Refer to 1.10.7 & 13.5.10)
  - Headwall
  - Collar
  - Wingwall
  - Cutoff Wall
  - Bevel end
  - Scour protection
  - If all are rated “X” then provide rating based on general condition of culvert end

Barrel - Rigid Types

- Made from concrete or timber
- Designed to carry loads without deflection (Rise and Span measurements normally not necessary).
- Culvert carries entire load with no reliance on surrounding fill for support.
- Generally more expensive but more durable, last longer and require less structural maintenance.

Barrel - Flexible Types

- Made from corrugated steel
- Low strength
- Dependent on surrounding backfill for support
- Culvert deflects under load until the backfill picks up the stress
- Entire load carrying system cannot be inspected directly (I.e. can inspect culvert but not backfill)
- Flexible culverts more susceptible to failure by:
  - Change in shape due to excessive deflection
  - Defective joints - cracks, open joints, cusped seams, etc.
  - Severe corrosion
  - Uplift of ends due to buoyancy forces

Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
(Pipe # : 1, Primary Span, Location Code: MAIN, Span (mm): 2325, Rise (mm): 2544, Type: SPE)				
Barrel Last Accessible Date	06-Jul-2015			Plates from bottom are 6N, 5N, 5N, 6N.
Special Features				
Special Feature		7	7	Struts installed in 1997. 3.5 heavy wall steel struts on 6" x 6" TT.
(Type : VERT STEEL STRUTS)				
Special Feature			X	
(Type :)				
Roof		3	3	Rating due to deflection.
Measured Rise (mm)	2170			
Measured At Ring No.	9			
Sag (mm)	374			
Percent Sag	15			
Sidewall		2	2	Where bolted correctly sidewalls are crimping & cracked @ R11, 13, 15.
Measured Span (mm)	2670			
Measured At Ring No.	9			Cracked seams.
Deflection (mm)	345			
Percent Deflection	15			
Floor		4	4	(Rating due to floor bulge. 02-Sep-2011)
Bulge (mm)	200			Could not confirm bulge due to depth of water.
Measured At Ring No.	6			
Abrasion (Y/N)	No			
Circumferential Seams		4	4	Bolts pulled through @ 4 rings.
Separation (mm)	0			
Longitudinal Seams		2	2	Cracks in both W & E sidewalls at R2-5 and R7.
Total No. of Cracked Rings	9			
Total No. of Rings with Two Cracked Seams	5			
Min. Remaining Steel Between Cracks (mm)	25			R11 is cracked where bolted correctly at W side.
Proper Lap (Y/N)	No			At ring 6, E sidewall.
Longitudinal Stagger (Y/N)	Yes			
Coating		4	4	Corrosion with pitting.
Corrosion By Soil (Y/N)	Yes			
Corrosion By Water (Y/N)	Yes			
Camber POS/ZERO/NEG	NEG			
Ponding (Y/N)	No			
Fish Passage Adequacy		4	5	
Baffle		X	X	
(Type :)				
Waterway Adequacy		3	5	Drift on floor of R1-R4.
Icing (Y/N)	No			
Silting (Y/N)	No			
Drift (Y/N)	Yes			
Barrel General Rating		**3**	**3**	1 point increase for struts.

Barrel - General

Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
Barrel Last Accessible Date				

- If barrel is accessible provide current date
- Not accessible explain why & retain previous date
- Rate elements **N** if not visible
- Previous comments are retained and dated
- If more than one barrel indicate location (west) or span number

Barrel - Special Features

Special Features				
Special Feature		7	7	Struts installed in 1997. 3.5 heavy wall steel struts on 6" x 6" TT.
(Type : VERT STEEL STRUTS)				
Special Feature			X	
(Type :)				

- Cannot be rated under another component
- May be temporary or permanent
- Must be visible to inspecct
  - Special design features not usually inspectable (ribs, thrust blocks, etc.)

Barrel - Special Features

- Examples
  - Struts
  - Shotcrete beams
  - Abrasion plates
  - Concrete Floor
  - Storm Drains
- Record type
- Provide additional information in Explanation of Condition
  - Description
  - Location
  - Dimensions
  - Inspection procedures
- Provide rating based on condition /functionality

Barrel - Special Features Shot-crete Beam

Barrel - Special Features Struts – Rated 3

Barrel - Deformation

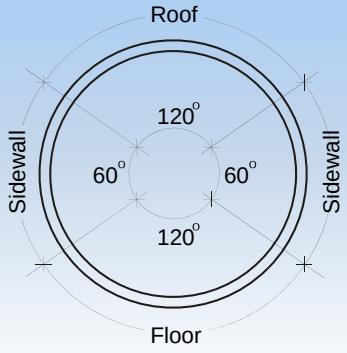
Roof		3	3	Rating due to deflection.
Measured Rise (mm)	2170			
Measured At Ring No.	9			
Sag (mm)	374			
Percent Sag	15			
Sidewall		2	2	Where bolted correctly sidewalls are crimping & cracked @ R11, 13, 15.
Measured Span (mm)	2670			
Measured At Ring No.	9			Cracked seams.
Deflection (mm)	345			
Percent Deflection	15			
Floor		4	4	(Rating due to floor bulge. 02-Sep-2011)
Bulge (mm)	200			Could not confirm bulge due to depth of water.
Measured At Ring No.	6			
Abrasion (Y/N)	No			
Circumferential Seams		4	4	Bolts pulled through @ 4 rings.
Separation (mm)	0			
Longitudinal Seams		2	2	Cracks in both W & E sidewalls at R2-5 and R7.
Total No. of Cracked Rings	9			
Total No. of Rings with Two Cracked Seams	5			
Min. Remaining Steel Between Cracks (mm)	25			R11 is cracked where bolted correctly at W side. At ring 6, E sidewall.
Proper Lap (Y/N)	No			
Longitudinal Stagger (Y/N)	Yes			

Barrel - Ring

- Different elements make up a complete ring:
  - Roof
  - Sidewall
  - Floor
  - Bolted or riveted seams
  - Circumferential seams (bolted (SPCSP) or external coupler (CSP))
- Purpose:
  - Carry water flow or traffic
  - carry loads and transmit to surrounding soil
  - Prevent infiltration of fill

Barrel - Ring

- For round culverts, use approximate arcs shown
  - Use longitudinal seam if close



Barrel – Ring Defects

- Flexible Steel culverts look for:
  - Deformation (measure crest to crest)
  - Localized crimping or buckling
  - Longitudinal seam problems
  - Corrosion
  - Abrasion on floor
- Rigid Timber culverts look for :
  - Material defects – rot decay
- Rigid Concrete culverts look for :
  - Structural problems - cracking
  - Material defects - corrosion, scaling, freeze-thaw damage

Barrel - Roof

Flexible Culverts:

- Record lowest measured Rise in mm (crest-crest). Mark in culvert for future reference.
- Record Ring number measurements taken.
- If floor bulge occurs at same location add bulge to measured rise and explain in comments.
- Calculate and record Sag in mm (design –measured rise).
- Calculate and record % Sag.
- Rate Roof based on % Sag (Table 13.3) or other visual defects.
- If not able to measure Rise due to ice, silt, concrete floor, etc. a Roof rating is still required based on visual evidence and estimated sag.

Barrel – Roof Ratings

Flexible culverts - continued

- Presence of temporary repairs has no influence.
- Sag within 5% , no corrosion - rate 7
- Sag within 7% , no pitting - rate 5
- Sag within 10%, corrosion pitting – rate 4
- Sag 11-15%, isolated perforations – rate 3
- Sag >15%, roof flattening, reverse curvature , extensive perforations – rate 2.
- Reverse curvature in flat HE or round under low cover, severe perforations – rate 1.
- Consider Longitudinal Seam rating if in Roof.

Rigid Culverts:

- Rate Roof based on visual evidence, defects
- Measurements not required

Barrel – Roof Ratings Reverse Curvature-Rated 2

Barrel - Sidewall

Flexible Culverts:

- Record greatest measured Span in mm. (crest-crest). Mark in culvert for future reference.
- Record Ring number measurements taken.
- Calculate and record Deflection in mm (measured rise - design).
- Calculate and record % Deflection.
- Rate Sidewall based on % Deflection (Table 13.3) or other visual defects.
- If not able to measure Span due to size, ice, etc. a Sidewall rating is still required based on visual evidence and estimated deflection.

Barrel – Sidewall Ratings

- Deflection within 5% , no corrosion - rate 7
- Deflection within 7% , no pitting - rate 5
- Deflection within 10%, corrosion pitting – rate 4
- Deflection 11-15%, crimping or buckling, isolated perforations – rate 3 or less.
- Deflection >15%, crimping/buckling with plate shear, extensive perforations – rate 2 or less.
- Consider Longitudinal Seam rating if in Sidewall (e.g. - Longitudinal Seam in Sidewall rated 2 governs Sidewall rating).

Rigid Culverts:

- Rate Sidewall based on visual evidence, defects
- Measurements are not required

Barrel – Sidewall Inward Movement – Rated 2

Barrel – Sidewall Buckling – Rated 3 or less

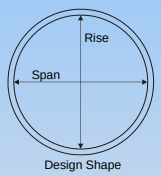
Barrel - Floor

- Check timber floors for rot, missing sections.
- Check concrete floors for cracking, spalling, missing sections.
- Check steel floors for cracks, crimping/buckling, defective seams, corrosion, abrasion.
- Measure or estimate floor bulge and record ring number.
- For flexible culverts - If greatest floor bulge is occurring in same ring as worst roof deflection add bulge to measured Rise
- Indicate abrasion on floor by Yes or No. if yes provide comment.

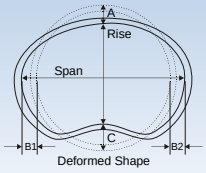
Barrel - Floor

- Rate flexible culvert floors as per Table 13.3:
- Isolated perforations rate 4
- Extensive perforations rate 3
- Severe perforations rate 2
- <5% bulging, minor abrasion and corrosion, no buckling or seam defects rate 6 or more
- Seam rating may govern if located in floor

Barrel - Ring



Design Shape



Deformed Shape

A = Roof Sag
B1 + B2 = Sidewall Deflection
c = Floor Bulge

Barrel - Circumferential Seams

		Bridge Culvert Barrel		
Culvert Component		Last	Now	Explanation of Condition
Circumferential Seams				
Separation (mm)				

- Refers to seams joining individual rings or sections of culvert
- Found on most types of culverts
  - Bolted seams on SPCSP
  - Couplers on CSP or Riveted pipes
  - Joints in precast concrete
  - Construction joints in cast-in-place concrete

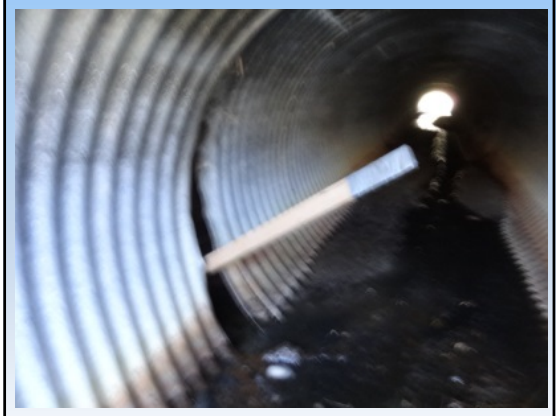
Barrel - Circumferential Seams

- Purpose
  - Join rings
  - Prevent infiltration of backfill
- Most common problems are separation caused by settlement or corrosion of couplers
  - Especially CSP and precast concrete (settlement)
- Potential for safety problem if void develops in fill
- Look for:
  - Separation
  - Loose or missing couplers (corrosion)
  - Bent or broken edges on the rings
  - Misalignment of rings
  - Infiltration of backfill
  - Voids in surrounding fill

Barrel - Circumferential Seams

- Record width of worst separation.
- Gap but no soil infiltration - rate 4.
- Gap with minor soil infiltration - rate 3.
- Void from loss of material due to soil infiltration - rate 2.
- Severe loss of material due to soil infiltration - rate 1.
- Cracking from over torqueing of bolts but no growth or problems – rate 5.
- Cracking due to roof sag rate4 or less.
- May affect Roof, Sidewall or Floor rating if severe (2 or less).

Barrel - Circumferential Seam Void Rated 2



Barrel - Circumferential Seam – Material Loss and Voids Rated 2

Barrel - Longitudinal Seams

Longitudinal Seams		2	2	Cracks in both W & E sidewalls at R2-5 and R7.
Total No. of Cracked Rings	9			
Total No. of Rings with Two Cracked Seams	5			
Min. Remaining Steel Between Cracks (mm)	25			R11 is cracked where bolted correctly at W side.
Proper Lap (Y/N)	No			At ring 6, E sidewall.
Longitudinal Stagger (Y/N)	Yes			

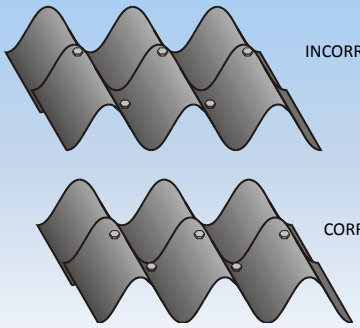
- Applies to SPCSP and CSP riveted culverts
- All others, Rate “X”

Barrel - Longitudinal Seams

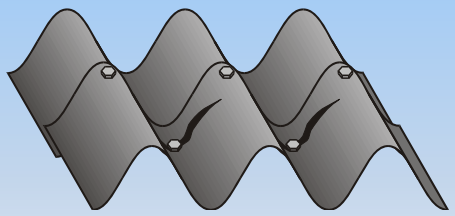
- Purpose
  - Join individual plates in ring
  - Transmit loads between plates
  - Approx. 75% bending strength of plates
- Indicate if all seams properly lapped by Yes or No
  - If No, provide comment
- Indicate if seams staggered by Yes or No
  - Within same arc only
  - At change of arc should not be staggered
  - If No provide comment
  - Most common problem is cracking
  - Especially on improperly lapped seams

Barrel - Longitudinal Seams

- Typical longitudinal seams



Typical longitudinal seams



Cracked Seam

Barrel - Longitudinal Seams Cracked Seams

- Record and comment on number of rings with cracked seams
- Record and comment on number of rings with 2 or more cracked seams (may cause catastrophic failure)
- Record least remaining steel between cracks and record location in comments (“At R9”)
- Mark and date ends of worst cracks – pencil is best
- Properly lapped seam has bolt in valley nearest visible edge of plate

Barrel - Longitudinal Seams Other Problems

- Poorly nested plates
  - Improper fabrication and/or poor assembly
- Cusping
  - Sharp break or discontinuity in curvature
  - Occurs most often at longitudinal seams
  - Improper fabrication , poor assembly/plate rotation during torqueing
  - Improper backfill
- Bolt tipping
  - High ring compression causing plate slippage and/or hole elongation
- Plate distortion
  - High ring compression, improper assembly and backfill
- Corrosion

Barrel - Longitudinal Seams Rating

- Rate as per Table 13.3
- All seams properly lapped and no defects rate 9
- If seams are not properly lapped but in otherwise excellent condition - rate 7
- >100mm remaining steel between cracks rate 4
- 50 – 100mm remaining steel between cracks - rate 3
- <50mm remaining steel between cracks rate 2
- Two cracked seams in same Ring – rate 2
- Rating for longitudinal seams may also affect Roof, Sidewall and Floor ratings
- Rate riveted longitudinal seams in CSP

Barrel – Wrong Lap - Cracked Longitudinal Seam - <50mm Remaining Steel-Rated 2

Barrel – Cracked Longitudinal Seam and Wrong Lap

Barrel - Coating

Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
(Pipe # : , Primary/Secondary Span, Location Code : , Span (mm) : , Rise (mm) : , Type :)				
Coating				
Corrosion By Soil (Y/N)				
(Corrosion by Water (Y/N)				

- Applicable to steel culverts only
- Applies mainly to zinc or aluminized coating
  - Can include other types - bituminous
- Purpose is to protect the steel from corrosion
  - Zinc & aluminum protect by sacrificial action

Barrel - Coating

- Corrosion can occur on soil or water side of culvert
- Soil side corrosion is generally visible above waterline and most common at seams
  - Can lead to perforations
  - Difference in backfill resistivity
  - Corrosive chemicals in backfill or water in fill
- Water side corrosion usually occurs in lower areas
  - Abrasion can remove protective coating
  - Water may have low pH or contain corrosive chemicals
  - Anaerobic bacteria may live in stagnant water

Barrel - Coating

- Look for:
  - Fabrication or installation defects or damage
  - Loss of coating - Corrosion
  - Rust stains from bolt holes or seams
  - Perforations
- Record if corrosion is on SOIL and/or WATER side – provide comment if Yes
- Rate according to Table 13.3
- Superficial corrosion no pitting – rate 5 or 6
- Corrosion with pitting in roof or sidewall rate 4
- Isolated perforations in roof or sidewall, extensive perforations in floor - rate 3
- Extensive perforations in roof or sidewall, severe perforations in floor - rate 2
- Severe perforations in roof or sidewall - rate 1
- Rating of Coating may affect other elements ratings

Barrel Coating – Sidewall Perforations and Separation

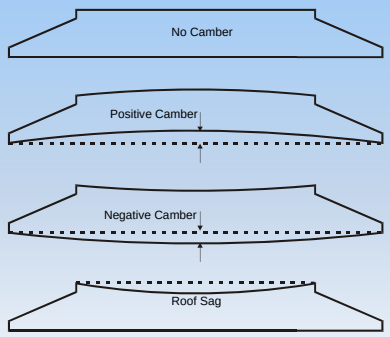
Barrel Coating – Floor Severe Perforations

Barrel - Camber

Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
Camber POS/ZERO/NEG				

- Refers to longitudinal gradeline of invert
- No rating is required
- If water line is level can be used to determine camber
- Record whether camber is **P**OSITIVE, Zero (**0**), or **N**EGATIVE
- If significantly **P**OSITIVE or **N**EGATIVE provide Explanation

Barrel - Camber



Barrel - Ponding

Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
Ponding (Y/N)				

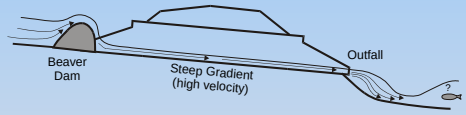
- Refers to ponded water which adversely affects the culvert
  - Especially underpasses
- Does not refer to normal amounts of ponded water
  - Buried ¼ dia. below SB so expect standing water
  - Normal water level in stream
  - Invert normally set below streambed
- No rating required
- Indicate presence of ponding by **Y**es or **N**o
- If "yes", explain

Barrel - Fish Passage Adequacy

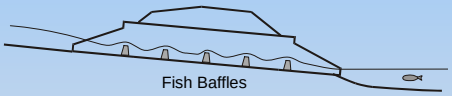
Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
Fish Passage Adequacy				
Baffle (Type :)				

- Inspector should assume ALL culverts are fish bearing even when dry
- Refers to ability of culvert to accommodate fish passage U/S and D/S
- May have fish baffles to:
  - provide rest areas
  - reduce velocities
  - provide minimum water levels

Barrel - Fish Passage Adequacy



Barrel - Fish Passage Adequacy



Barrel - Fish Passage Adequacy

- Types of baffles
  - Spoilers
    - Concrete or steel projections
  - Large boulders
  - Weirs
    - Extend fully across floor
    - May have notches
  - Bolted to floor to prevent displacement

Barrel - Fish Passage Adequacy

- Record type of baffle or NONE
- Look for:
  - Excessive velocities
    - Scour
    - Silt deposition downstream
  - Steep gradient in culvert
  - Drops at ends of culvert
  - Anything which could block flow or affect water levels
    - Dirt
    - Beaver dams
  - Condition and functionality of baffles including anchorages

Barrel - Fish Passage Adequacy

- Culverts used as Animal/Cattle passes Rate X unless also designed to handle flows
- Rate whether flowing or dry
- If in line with or below streambed rate 5 or more
- U/S or D/S ends above streambed rate 4 or less

Barrel - Waterway Adequacy

		Bridge Culvert Barrel		
Culvert Component		Last	Now	Explanation of Condition
Waterway Adequacy				
Icing (Y/N)				
Silting (Y/N)				
Drift (Y/N)				

- Refers to the ability of the culvert to safely pass the design flow
  - Maintain Freeboard
  - Pass drift without damage
  - No damage from backwater created

Barrel - Waterway Adequacy

- Adequately sized culvert may be affected by:
  - Ice build up
  - Silt deposition
  - Drift accumulation
  - Beaver dams
  - Ponding
  - Repair or rehabilitation work
    - Shotcrete beams
    - Struts

Barrel - Waterway Adequacy

- Indicate presence of ice build up (icing) by **Y**es or **N**o if Yes explain
  - Not normal freezing of ponded water
  - Results from active springs which freeze and causes layers of ice to build up
  - If previously Yes - leave and retain comments adding date of previous inspection
- Indicate presence of silt build up (Silting) by **Y**es or **N**o, if Yes explain
  - Invert normally below streambed
  - Minor accumulation of silt expected
- Indicate presence of drift in Barrel by **Y**es or No
- If “yes”, explain

Barrel - Waterway Adequacy

- Look for:
  - High water marks (not normal flow lines)
  - Potential damage from backwater
  - Potential for drift
  - Evidence of high velocities
    - Scour
    - Silt deposition downstream
  - Presence and effect of items which can affect adequacy

Barrel - Waterway Adequacy

- Rate "X" if not a drainage culvert
- Adequate opening rate 5
- HWM above crown, 4 or less
- Culvert blockage 50% or more rate 3 or less

Barrel - Waterway Adequacy-100% Blockage

Barrel - Waterway Adequacy - 50% Blockage

Barrel - General Rating

- Governed by the following element ratings : (refer to 1.10.8 and 13.6.14)
  - Roof
  - Sidewalls
  - Longitudinal seams
  - Circumferential seam rating of 2 or less
  - Corrosion rating of 2 or less
- Barrel not accessible - rate barrel elements "N"
- If previous Barrel General Rating was 4 or less then carry over previous General Rating rating and provide Explanation of Condition ("carried forward")
- If previous Barrel General Rating was 5 or more rate current General Rating "N"

Effects of Struts on Barrel General Rating

- Inspector may increase General Rating by 1 or 2 points but not exceed rating of 4.
- Rating Conditions
  - struts in place more than 2 years
  - struts rated 5 or more
  - 1 permanent reference for monitoring
  - struts inspected after any significant event
  - consider culvert size and depth of cover (failure of large diameter culvert under high fill may not be as serious as under low fill)
  - does not apply when deflections >30% or cracked seams with less than 25mm remaining steel
  - applied to general rating only, element ratings remain unchanged

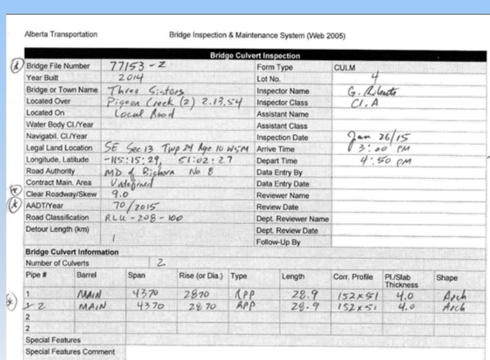
Questions??

Inspection Form Completion

Verifying and Updating Inventory Data

- Inspector is responsible for obtaining, verifying and updating inventory data during inspection
- Check off each inventory item to indicate it was verified
- If item cannot be confirmed/verified do not check off – make comment why
- Not necessary to change data if measurement is only slightly different
- Inventory changes are made directly on the inspection form

Verifying and Updating Inventory Data


Alberta Transportation   Bridge Inspection & Maintenance System (Web 2005)

Bridge Culvert Inspection

Bridge File Number	77153 - Z	Form Type	CULM
Year Built	2014	Lot No.	4
Bridge or Town Name	Three Sisters	Inspector Name	G. Roberts
Located Over	Pigeon Creek (2) 2.13.54	Inspector Class	Cl. A
Located On	Local Road	Assistant Name	
Water Body Cl./Year		Assistant Class	
Navigabil. Cl./Year		Inspection Date	Jan 26/15
Legal Land Location	SE Sec 13 Twp 24 Rge 10 W5M	Arrive Time	3:00 PM
Longitude, Latitude	-115:15:29, 51:02:27	Depart Time	4:50 PM
Road Authority	MD of Bighorn No 8	Data Entry By	
Contract Main. Area	Undefined	Data Entry Date	
Clear Roadway/Skew	9.0	Reviewer Name	
AADT/Year	70/2015	Review Date	
Road Classification	RLU - 208 - 100	Dept. Reviewer Name	
Detour Length (km)	1	Dept. Review Date	
		Follow-Up By	

Bridge Culvert Information

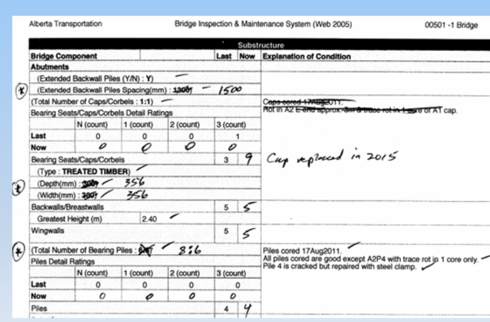
Number of Culverts: 2

Pipe #	Barrel	Span	Rise (or Dia.)	Type	Length	Corr. Profile	Pl./Slab Thickness	Shape
1	MAIN	4370	2870	RPP	28.9	152x51	4.0	Arch
2	MAIN	4370	2870	RPP	28.9	152x51	4.0	Arch
2								
2								

Special Features
Special Features Comment

- Inventory changes or revisions are made directly on the inspection form

Verifying and Updating Inventory Data


Alberta Transportation   Bridge Inspection & Maintenance System (Web 2005)   00501 -1 Bridge

Substructure

Bridge Component		Last	Now	Explanation of Condition
Abutments				
(Extended Backwall Piles (Y/N) : Y)				
(Extended Backwall Piles Spacing(mm) : ~~1300~~ 1500				
(Total Number of Caps/Corbels : 1:1)				~~Caps cored 17Aug2011.~~ Rot in A2 ~~E end approx. 3m & trace rot in 1 core~~ of AT cap.
Bearing Seats/Caps/Corbels Detail Ratings				
Bearing Seats/Caps/Corbels		3	9	Cap replaced in 2015
(Type : TREATED TIMBER)				
(Depth(mm) : ~~300~~ 356				
(Width(mm) : ~~300~~ 356				
Backwalls/Breastwalls		5	5	
Greatest Height (m)	2.40			
Wingwalls		5	5	
(Total Number of Bearing Piles : ~~6:6~~ 8:6				Piles cored 17Aug2011. All piles cored are good except A2P4 with trace rot in 1 core only. Pile 4 is cracked but repaired with steel clamp.
Piles Detail Ratings				
Piles		4	4	

Bearing Seats/Caps/Corbels Detail Ratings:

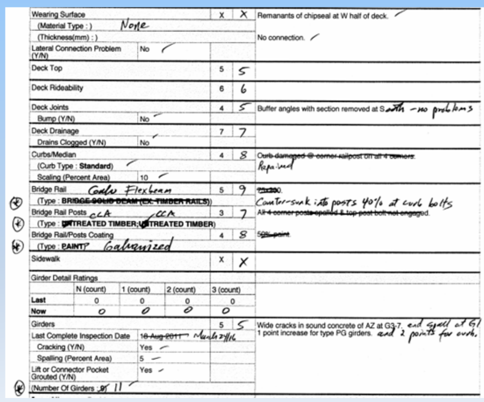
	N (count)	1 (count)	2 (count)	3 (count)
Last	0	0	0	1
Now	0	0	0	0

Piles Detail Ratings:

	N (count)	1 (count)	2 (count)	3 (count)
Last	0	0	0	0
Now	0	0	0	0

- Inventory changes are made directly on the inspection form

Verifying and Updating Inventory Data



Component	Value	Last	Now	Explanation of Condition
Wearing Surface		X	X	Remanants of chipseal at W half of deck.
(Material Type :)	None			
(Thickness(mm) :)				No connection.
Lateral Connection Problem (Y/N)	No			
Deck Top		5	5	
Deck Rideability		6	6	
Deck Joints		4	5	Buffer angles with section removed at South – no problems
Bump (Y/N)	No			
Deck Drainage		7	7	
Drains Clogged (Y/N)	No			
Curbs/Median		4	8	~~Curb damaged @ corner railpost on all 4 corners.~~ Repaired
(Curb Type : Standard)				
Scaling (Percent Area)	10			
Bridge Rail	Galv Flexbeam	5	9	~~15x200~~.
(Type : BRIDGE ~~SOLID BEAM (EX. TIMBER RAILS)~~)				Counter-sunk into posts 40% at curb bolts
Bridge Rail Posts	CCA	3	7	~~All 4 corner posts spalled & top post bolt not engaged.~~
(Type : UNTREATED TIMBER;UNTREATED TIMBER)	CCA			
Bridge Rail/Posts Coating		4	8	~~50% paint~~.
(Type : PAINT?	Galvanized			
Sidewalk		X	X	

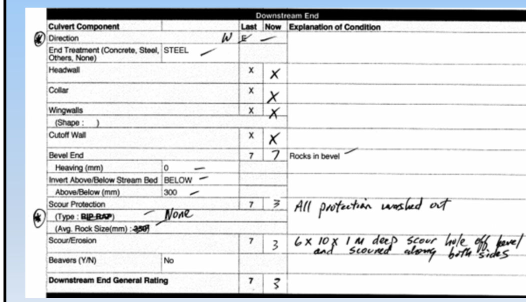
Girder Detail Ratings

	N (count)	1 (count)	2 (count)	3 (count)
Last	0	0	0	0
Now	0	0	0	0

Component	Value	Last	Now	Explanation of Condition
Girders		5	5	Wide cracks in sound concrete of AZ at G3-7. and spall at G1 1 point increase for type PG girders. and 2 points for curb.
Last Complete Inspection Date	~~18-Aug-2011~~ March 24/16			
Cracking (Y/N)	Yes			
Spalling (Percent Area)	5			
Lift or Connector Pocket Grouted (Y/N)	Yes			
(Number Of Girders : ~~9~~ 11				

- Inventory changes are made directly on the inspection form

Verifying and Updating Inventory Data



Downstream End

Culvert Component		Last	Now	Explanation of Condition
Direction	W	~~E~~		
End Treatment (Concrete, Steel, Others, None)	STEEL			
Headwall		X	X	
Collar		X	X	
Wingwalls		X	X	
(Shape :)				
Cutoff Wall		X	X	
Bevel End		7	7	Rocks in bevel
Heaving (mm)	0			
Invert Above/Below Stream Bed	BELOW			
Above/Below (mm)	300			
Scour Protection		7	3	All protection washed out
(Type : ~~RIP-RAP~~)	None			
(Avg. Rock Size(mm) : ~~350~~)				
Scour/Erosion		7	3	6 x 10 x 1 m deep scour hole off bevel and scoured along both sides
Beavers (Y/N)	No			
Downstream End General Rating		7	3	

- Inventory changes are made directly on the inspection form

Verifying and Updating Inventory Data

- Culvert design dimensions are shown on first page of culvert form
- SPCSP equivalent round should be changed to correct dimensions
- Used to determine sagging and deflecting measurements
- If culvert is not deformed, large sag and deflection values may indicate wrong design dimensions - then use measurements from both ends

Verifying and Updating Inventory Data

- Incorrect Inventory data is changed by crossing out recorded value and writing in new information
- Update and verify Inventory data directly on the form
- Record data only in values that box is asking for (mm, m, %, Y/N)
- Minor changes to things like roadway width are not required

Supporting Information

- Ratings of 4 or less must have an explanation of condition
- Ratings of 3 or less must have 3 things;

1. Supporting comment
2. Supporting photograph
3. Recommendation for action

- Action may be in the form of:
  - Maintenance recommendations
  - Monitoring on regular inspection cycle
  - Monitoring on a shorter inspection cycle if warranted
  - Don't overuse monitoring
- Photographs, quantities, measurements and/or sketches are provided for ratings of 3 or less or any maintenance recommendation regardless of rating

BIM Y/N Inventory Questions

- Explanation of condition is required when answering YES for certain areas
- Exceptions for Class B inspector are
  - approach guardrail meeting standards
  - Longitudinal seams proper lap
  - Longitudinal seams staggered
- if NO, provide comments explaining why

Significant Changes From Previous Rating

- Ratings of most elements do not change significantly over an inspection cycle
- Provide an explanation of condition if rating has changed significantly
- Required even if rating is 5 or more
- For example:
  - treated timber piles rated 8 and 21 months later piles rated 5 - why the big change?

Significant Changes From Previous Rating

- Some elements are expected to change significantly over an inspection cycle
- For example:
  - Timber strip deck rated 8 and 57 months later, rating reduced to 4
  - Scour protection rated 7 and after flood reduced to 3

Measurement Based Ratings

- Record the actual measured values in space provided or if space not provided in Explanation of Condition
- Record the location of any measurements of defects in space provided or if space not provided in the Explanation of Condition
  - 250 x 400 spall in A1 abutment seat under G3
  - wide longitudinal crack in unsound concrete of Sp1-G3 AZ in 1 leg.

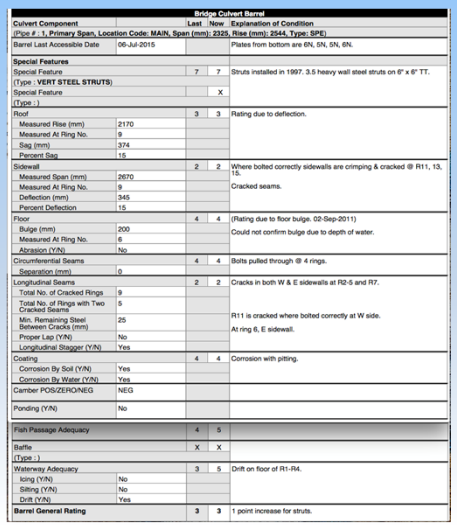
Previous Comments

- Comments from previous inspection which no longer apply must be deleted
- Carry over previous comments if information cannot be confirmed or denied
  - place brackets around comment or part thereof and add date the comment originated – if known. (deck ices in WBL)
- If element cannot be seen or is not accessible to confirm comments or data
  - Do not check mark data (don't confirm)
  - Explain why inaccessible or not visible
  - Retain comment in brackets. Add date comment originated - if known

Previous Comments

- Types of information retained:
  - measurements that cannot be verified
  - previous high water marks
  - information recorded during particular weather conditions
  - information recorded during particular season

Sample Completed Form



Bridge Culvert Barrel				
Culvert Component		Last	Now	Explanation of Condition
(Pipe # : 1, Primary Span, Location Code: MAIN, Span (mm): 2325, Rise (mm): 2544, Type: SPE)				
Barrel Last Accessible Date	06-Jul-2015			Plates from bottom are 6N, 5N, 5N, 6N.
Special Features				
Special Feature		7	7	Struts installed in 1997. 3.5 heavy wall steel struts on 6" x 6" TT.
(Type : VERT STEEL STRUTS)				
Special Feature			X	
(Type :)				
Roof		3	3	Rating due to deflection.
Measured Rise (mm)	2170			
Measured At Ring No.	9			
Sag (mm)	374			
Percent Sag	15			
Sidewall		2	2	Where bolted correctly sidewalls are crimping & cracked @ R11, 13, 15.
Measured Span (mm)	2670			
Measured At Ring No.	9			Cracked seams.
Deflection (mm)	345			
Percent Deflection	15			
Floor		4	4	(Rating due to floor bulge. 02-Sep-2011)
Bulge (mm)	200			Could not confirm bulge due to depth of water.
Measured At Ring No.	6			
Abrasion (Y/N)	No			
Circumferential Seams		4	4	Bolts pulled through @ 4 rings.
Separation (mm)	0			
Longitudinal Seams		2	2	Cracks in both W & E sidewalls at R2-5 and R7.
Total No. of Cracked Rings	9			
Total No. of Rings with Two Cracked Seams	5			
Min. Remaining Steel Between Cracks (mm)	25			R11 is cracked where bolted correctly at W side. At ring 6, E sidewall.
Proper Lap (Y/N)	No			
Longitudinal Stagger (Y/N)	Yes			
Coating		4	4	Corrosion with pitting.
Corrosion By Soil (Y/N)	Yes			
Corrosion By Water (Y/N)	Yes			
Camber POS/ZERO/NEG	NEG			
Ponding (Y/N)	No			
Fish Passage Adequacy		4	5	
Baffle		X	X	
(Type :)				
Waterway Adequacy		3	5	Drift on floor of R1-R4.
Icing (Y/N)	No			
Silting (Y/N)	No			
Drift (Y/N)	Yes			
Barrel General Rating		**3**	**3**	1 point increase for struts.

Photographs and Sketches

- Excellent means of providing supporting information
- Required for all ratings of 3 or less
- Required for all maintenance recommendations regardless of rating
- Not acceptable to say “see photo” on form
- 4 standard photos normally required;
  - Road alignment looking increasing chainage
  - Profile – normally U/S
  - Channel alignment looking U/S
  - Channel alignment looking D/S

Photographs and Sketches

- Submit color photos with inspection form to AT data entry consultant
- Minimum 5 megapixels
  - One hard copy of all photographs if AT managed structure
  - Two hard copies if non AT structure
- Two photos per page (3 ½ x 5 or 4 x 6) with descriptive text, inspector and stream name, date, BF# , Page #.
- Submit electronic copies of photos with inspection reports in pdf file with min. 300 dpi and unlocked for copying in following format;

BF12345-01_LVL1_YYYYMMDD_P.pdf

Photographs and Sketches
BF01310-01_LVL1_20130823_P

Photographs and Sketches
BF01310-01_LVL1_20130823_P

Estimating Quantities

- Inspectors are to estimate quantities for recommended repairs and maintenance
- Record in Maintenance Inspector Comments (expandable). Use separate sheet only if necessary
- Place in pre-prepared maintenance areas whenever possible
- Examples:

- PLACE ADDITIONAL RIPRAP - 3m^3 Class 1 rock at D/S end
- PATCH DECK - 5 timber stripdeck planks, each 75x300x 3 m long

Inspection Checks

- Inspector should do the following checks before leaving the site:
  - all ratings have been entered
    - » element condition ratings entered
    - » General Rating entered
    - » Estimated Replacement Year
  - condition ratings consistent with BIM manual
  - ratings are supported by
    - » explanations of condition (ratings of 4 or less)
    - » photos (and sketches if necessary) (3 or less)
    - » recommendations for maintenance, monitoring. other appropriate action (3 or less)
  - inventory information verified or changed
  - maintenance recommendations are appropriate
  - maintenance recommendations are supported with material dimensions and quantities.

Inspection Checks

- Office follow-up:
  - Low rating advisories or 2 Notifications sent to Bridge Manager (and LRA if applicable)
  - Answer questions raised during the inspection
  - Review previous inspection history in BIS
  - Review standard or site specific drawings
  - Review for appropriate maintenance, monitoring and timing
  - load restrictions and other signing
  - notify road authority
  - prepare photos in standard format with descriptive comments
  - Prepare electronic photos

Estimated Replacement Year Standard Bridges (Table 11.1)

	LIFE EXPECTANCY		
TYPE	LOW	AVE	HIGH
Untreated Timber	10	15	20
Treated Timber	35	40	45
Prestressed - Composite	55	60	70*
Prestressed **	40	45	60*
Precast (Except PA & PX)**	30	35	50
Precast (PA) & Other (PX)	25	30	45

*Use maximum of 50 years for timber substructure

**Add 5 years if overlaid with concrete

Considerations:

- Traffic - volume, amount of truck traffic, log haul
- Salt usage - road surfacing, traffic, climatic conditions
- Deck drainage, leakage
- Decay favourable conditions

Estimated Replacement Year Culverts

TYPE	LIFE EXPECTANCY LOW	AVE	HIGH
Concrete	40	60	80
Corrugated Steel	25	45	60
Timber and Other	20	35	60

Considerations:

- Deformation and cracking (quality of installation)
- Corrosive or chemically aggressive environment
- Abrasive bed load
- Decay favorable conditions, preservative treatment
- Refer to Table 13.4 – Life Expectancy Table for Culverts

Special Comments

Special Comments for Next Inspection	Inspect struts yearly. 2 Notification sent to LRA and Bridge Manager June 6, 2015. Cracks stable since last inspection, but sidewall deflection appears to be worse. Currently scheduled for design in 2015 and replacement in 2016.

- Special comments useful for next inspection
  - Notification to BM and LRA of low structural ratings
  - Measurements for monitoring purposes
  - Monitoring locations
  - Recommendation for reduced cycle
  - Data is not sortable

Level II Inspections

- Detailed inspection requiring specialized equipment and/or expertise
- Gathers specific measurements or observations
- Recommended by Level I inspectors
- Reviewed by Bridge Manager and/or LRA
- Do not proceed until Bridge Manager an/or LRA has been contacted regarding:
  - technical need
  - funding

Timber Coring

- Recommended when there are suspicions of rot in timber
- Carried out by Class A inspector
- Focus normally on critical structural elements:
  - caps
  - piles
  - stringers

Level 2 - Culvert Barrel Measurement

- Recommended when critical barrel elements rated 3 or less and safety concerns identified
  - roof rating
  - sidewall rating
  - longitudinal seam rating
- Recommend when two inspections completed without access to barrel section

  or

  schedule Level I inspection during low flow or winter conditions
- Some culverts barrels are inaccessible year round

Bridge Maintenance Recommendations

Alberta Transportation — Bridge Inspection & Maintenance System (Web 2005)

Maintenance Recommendations			
Inspector Recommendations	Year	Inspector Comments	Depar
REPAIR/REPLACE BRIDGE RAIL			
SEAL CURBS			
PATCH DECK	2016	2 m2 partial depth NH - If bridge not replaced.	
OVERLAY DECK			
STRAIGHTEN/REPLACE MEMBERS	2016	Band A2-P6 - If bridge is not replaced.	
WASHING	2016		
SHOTCRETE REPAIRS			
CORE TIMBER CAPS/CORBELS			
REPAIR/REPLACE TIMBER CAPS	2016	Replace all caps (If bridge is not replaced.)	
REPAIR ABUTMENT SCOUR/EROSION			
PLACE ADDITIONAL RIP RAP	2016	35m3 of Cl. 1 at NW wing-If bridge not replaced.	
REMOVE DRIFT ACCUMULATION			
INSTALL STRUTS			
OTHER ACTION	2015	Assess for allowable loading post to 10T in interim.	
OTHER ACTION	2016	Replace bridge.	
OTHER ACTION			
OTHER ACTION			

- Place recommendations in pre-prepared areas.
- Use Other Action only if no pre-prepared area available
- Record Year based on priority levels associated with ratings
- Provide material sizes and quantities

Culvert Maintenance Recommendations

Maintenance Recommenda		
Inspector Recommendations	Year	Inspector Comments
SHOTCRETE REPAIRS		
PLACE ADDITIONAL RIP RAP	2016	30m3 Class 2 at D/S, if not replaced within 5 years.
REMOVE DRIFT ACCUMULATION	2016	At D/S and in barrel, if not replaced
INSTALL CONCRETE/STEEL LINING		
INSTALL STRUTS		
INSTALL CONCRETE COLLAR/CUTOFF		
REPAIR SEAMS		
OTHER ACTION	2015	Design replacement structure.
OTHER ACTION		
OTHER ACTION	2017	Replace culvert.
OTHER ACTION		

- Place recommendations in pre-prepared areas.
- Use Other Action only if no pre-prepared area available
- Record Year based on priority levels associated with ratings
- Provide material sizes and quantities

Supporting Information

Proposed Long-Term Strategy	
On 3-Year Program (Y/N)	
Proposed Action	
Previous Inspector's Name	
Next Inspection Date	
Inspection Cycle (months)	

- Information provided by TIMS data base
- Inspection Cycle shown is normally default but may be reduced
- Reduction to inspection cycle cannot be done by inspector – only recommended by inspector
- Reduced Cycle set by Department

Questions??

BRIDGE MAINTENANCE & INSPECTION RESPONSIBILITIES

Need for Inspection and Maintenance

- Safety
- Protection of investment
- maximize functional life

Legislation

- Municipal Government Act
  - Definitions
    - (z) road… includes a bridge forming part of a public road
    - 16 (1) The title to all roads in a municipality, other than a city is vested in the Crown in right of Alberta

Municipal Government Act (Continued)

- 18 (1) …a municipality has the direction, control and management of all roads within the municipality
- 532 (1) Every road… must be kept in a reasonable state of repair by the municipality having regard to
  - (a) character of road…
  - (b) the area it is located
- 532 (2) The municipality is liable for damage caused by… failing to perform its duty…
- 532 (4) A municipality is not liable… unless… loss or damage beyond what is suffered by… all other persons affected by the state of repair.

Municipal Government Act (Continued)

- 532 (6) A municipality is liable… only if "it" should have known of the state of repair
- 532 (7) A municipality is not liable… if "it" proves that it took reasonable steps to prevent the disrepair...
- 533 A municipality is not liable for damages caused if it took reasonable steps to prevent…
  - (a) by the presence, absence or type of any wall, fence, guard rail… traffic control device… adjacent… in… on a road.

Public Highways Development Act

- (4) All provincial highways are subject to direction, control and management of the Minister
- (8) The Minister may make regulations… for
  - (a) design and standards for construction for secondary roads
  - (b) standards for maintenance for secondary roads

Public Highways Development Act

- (2) ...each highway authority is responsible for costs of construction and maintenance of all highways subject to its control and management
- 19) The Minister has the direction, control and management of
  - (a) roads in improvement districts
  - (b) highways through Indian Reserves…
  - (c) highways in cities if title vested in Crown.
  - (forestry roads & secondary highways by agreement…)

Public Highways Development Act (Continued)

- 21 (1) The Minister may enter into an agreement with any… municipality… "to" contribute to the cost of construction and maintenance of any street or road…
- 52 (1) …the Minister may direct construction or maintenance of a bridge… or enter into an agreement… for
  - (a) paid by Crown
  - (b) Paid by municipality… or other person
  - (c) apportioned between Crown and… other
  - whichever the Minister directs.

Traffic Safety Act

- 15 (1) …municipality may authorize… placing of traffic control devices
- 16 (1) …municipality may make by-laws
  - (a) …restricting weights of vehicles…
  - (p) …closing or restricting… highway… bridge…

Department Policies

- Outline methods of operation
- How legislation is implemented

Legal Liability

- responsibilities defined by
  - legislation
  - policies and procedures
- cannot guarantee accidents will not happen or damage will not occur
- liable - exposed or open to something undesirable such as loss arising from injury or damage to another person or property

Due Diligence

- Not liable for damages or loss if:
  - work is in keeping with legislation, policies or procedures
  - work in keeping with accepted / prevailing standards
  - actions are “reasonable”

Current Maintenance Delivery Process - LRA

- LRA's complete required maintenance activities using either in-house work forces or contracted forces.
- The LRA relies heavily on the accuracy and completeness of the BIM inspection report.
- Quantities shown in the maintenance section of the BIM report form the basis of the scope of work.
- A quality BIM report is expected, and greatly assists the LRA in the delivery of their maintenance program.

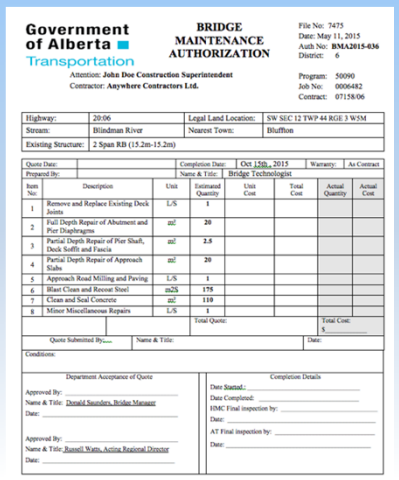
Current Maintenance Delivery Process - AT

- AT Regional bridge offices currently utilize their respective Highway Maintenance Contractor (HMC) to complete required maintenance activities.
- Maintenance and Rehabilitation work is also delivered through the provincial tender process.
- If utilizing the HMC, a Bridge Maintenance Authorization is generated which details the scope of work and the quantities. This document also forms a part of the contractual agreement between AT and the HMC.
- In either case, contractors submit quotes based on the scope of work and quantities, among other things.

Current Maintenance Delivery Process - AT

- Similar to the LRA, AT bridge staff also rely heavily on the accuracy and completeness of the BIM inspection report.
- Quantities shown in the maintenance section of the BIM report form the basis of the scope of work for either the HMC BMA or provincial tender.
- A quality BIM report is expected, and greatly assists AT bridge staff in the delivery of their maintenance program.
- A second trip to the field by AT staff to gather or confirm quantities is not desirable.

Current Maintenance Delivery Process - AT



Government of Alberta
Transportation

BRIDGE MAINTENANCE AUTHORIZATION

File No: 7475
Date: May 11, 2015
Auth No: **BMA2015-036**
District: 6

Attention: **John Doe Construction Superintendent**
Contractor: **Anywhere Contractors Ltd.**

Program: 50090
Job No: 0006482
Contract: 07158/06

Highway:	20:06	Legal Land Location:	SW SEC 12 TWP 44 RGE 3 W5M
Stream:	Blindman River	Nearest Town:	Bluffton
Existing Structure:	2 Span RB (15.2m-15.2m)		

Quote Date: | Completion Date: Oct 15th, 2015 | Warranty: As Contract
Prepared By: | Name & Title: Bridge Technologist

Item No.	Description	Unit	Estimated Quantity	Unit Cost	Total Cost	Actual Quantity	Actual Cost
1	Remove and Replace Existing Deck Joints	L/S	1				
2	Full Depth Repair of Abutment and Pier Diaphragms	m²	20				
3	Partial Depth Repair of Pier Shaft, Deck Soffit and Fascia	m²	2.5				
4	Partial Depth Repair of Approach Slabs	m²	20				
5	Approach Road Milling and Paving	L/S	1				
6	Blast Clean and Recoat Steel	m2S	175				
7	Clean and Seal Concrete	m²	110				
8	Minor Miscellaneous Repairs	L/S	1				
			Total Quote:		Total Cost: $		

Quote Submitted By: | Name & Title: | Date:

Conditions:

Department Acceptance of Quote
Approved By:
Name & Title: Donald Saunders, Bridge Manager
Date:
Approved By:
Name & Title: Russell Watts, Acting Regional Director
Date:

Completion Details
Date Started:
Date Completed:
HMC Final inspection by:
Date:
AT Final inspection by:
Date:

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

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

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/SIGN IN NEAR FUTURE, BEFORE NEXT INSPECTION
2	MAJOR DETERIORATION AND/OR DISTRESS ENDANGERING FUNCTIONALITY	HIGH PRIORITY - FOR REPLACE/REPAIR/SIGN, CONTINUED OBSERVATION REQUIRED UNTIL WORK DONE
1	COLLAPSE IMMINENT/DANGER TO USERS	CLOSE/REPAIR/SIGN AND/OR REPLACE AS SOON AS POSSIBLE - IMMEDIATE ACTION REQUIRED

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

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						

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						

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

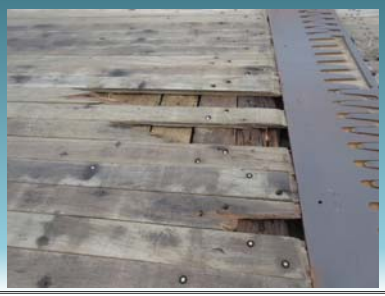
Scour hole in bridge approach caused by flood water erosion. (Battle River Hwy 2)

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



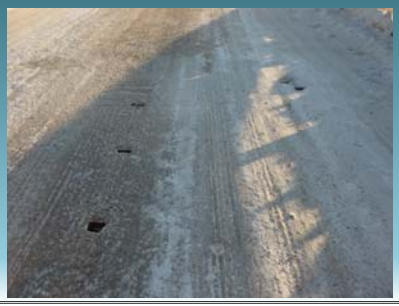
Worn/rotten timber strip deck.

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)

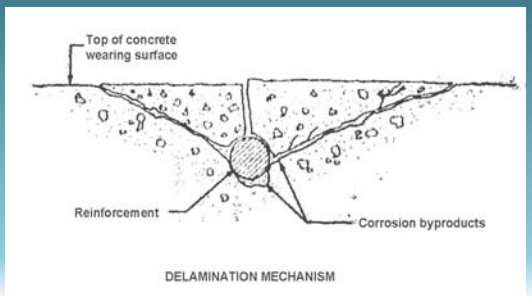
- Girders
  - cracked timbers
    - repair / replace
  - spalled concrete
    - shotcrete repair (do cost benefit)
    - replace stringers
  - girder longitudinal joint connections
    - replace bolts, replace grout
  - lift hook pockets
    - replace grout
  - concrete / ACP overlay (do cost benefit)

Bending crack on timber stringer.

Rotten timber stringer.

Spalled girder legs.

Concrete spalling mechanism by rebar corrosion.



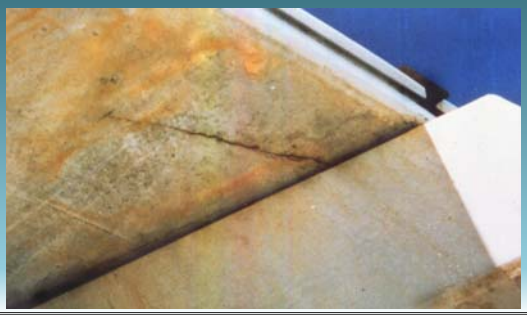
Corrosion cracking on pre-stressed girder underside

Girder being repaired with stand and stirrups exposed but still bonded

Repaired pre-stressed girder

Non-functional bolted connectors.

SM-SC prestressed girder cracks.



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

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

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.

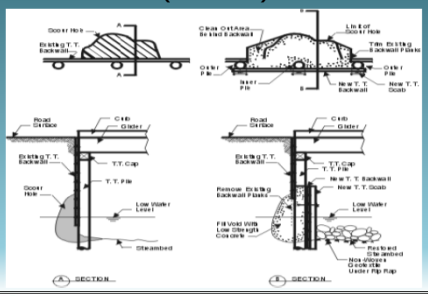
Substructure Maintenance (Cont'd)

- 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)

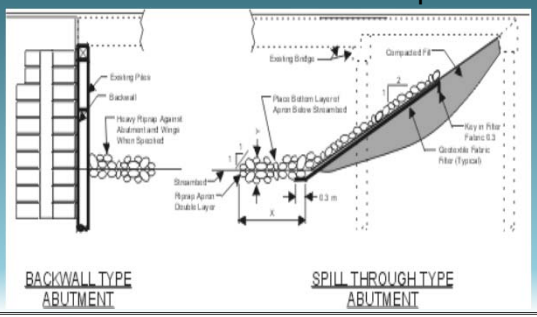
- Scour / Erosion
  - erosion of headslope
    - repair / place rock rip-rap
  - scour at piers
    - fill hole with rock

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

CULVERT MAINTENANCE

Culvert Maintenance

- Similar to bridges
  - approach road
  - channel
- Structurally different
  - upstream end
  - downstream end
  - barrel

Maintenance Recommendations

Maintenance Recommendations						
Inspector Recommendations	Year	Inspector Comments	Department Comments	Target Year	Est. Cost	Cat #
SHOTCRETE REPAIRS						
PLACE ADDITIONAL RIP RAP						
REMOVE DRIFT ACCUMULATION						
INSTALL CONCRETE/STEEL LINING						
INSTALL STRUTS						
INSTALL CONCRETE COLLAR/CUTOFF						
REPAIR SEAMS						
OTHER ACTION						
OTHER ACTION						
OTHER ACTION						
OTHER ACTION						
Last Structural Condition Rating (%)		Last Bulldozer Rating (%)		Estimated Replacement Year		Maintenance Required (Y/N)
Special Comments for Next Inspection			Department Comments			
Maintenance Reviewed By			Date		Estimated Total	
Proposed Long-Term Strategy						
On 3-Year Program (Y/N)						
Proposed Action						
Previous Inspector's Name			Previous Inspector's Name			
Next Inspection Date			Next Inspection Date			
Inspection Cycle (months)						
Comment						

- CULM and CULE form recommendations are identical

Approach Road Maintenance

- Embankment
  - slides, slumps, etc.
    - repair by removing failed material & replacement with competent, compacted material
  - remaining items same as for bridges

Upstream / Downstream End Maintenance

- Upstream & Downstream ends have the same inspection items
- Head Wall
  - usually a low maintenance item
  - broken, spalled concrete
    - patch
  - scaled concrete
    - repair & seal (when salt applied to roads)

Upstream / Downstream End Maintenance (Cont'd)

- Collar / Concrete Slope Protection
  - scoured / eroded
    - compacted fill and rock riprap
  - settled & broken
    - replace with fill and riprap

Adding end treatment to existing culvert.

Upstream / Downstream End Maintenance (Cont'd)

- Wingwalls
  - deteriorated concrete
    - chip out and replace
  - separated from barrel
    - fill gap with flexible material
  - pushing inwards
    - strut between

Damaged floor at outlet transition.

Horizontal Strut

Upstream / Downstream End Maintenance (Cont'd)

- Cutoff Wall
  - usually buried if present
  - if not present and a problem with piping
    - Install cut off wall

Adding cut-off wall to existing culvert.

Wash out due to piping
(Brewster Creek Sunchild Road)

Upstream / Downstream End Maintenance (Cont'd)

- Bevel End
  - excessive heaving
    - remove and reset with end treatment
    - replace with new end treatment
  - folding in
    - add collar
  - current end treatment requirements are:
    - 1.5 to 3.0m special conditions
    - 3.0 to 4.5m upstream end only
    - >4.5m both ends

Heaved inlet on CSP culvert.

Upstream / Downstream End Maintenance (Cont'd)

- Scour Protection
  - Erosion / scour
    - add suitable size rock riprap with filter cloth to apron and/or around collar or bevel
- Scour / Erosion
  - scour / erosion
    - add rock riprap with filter cloth to suit velocities anticipated

Culvert Maintenance

High velocity at outlet during high water
(Big or Bald Mountain Hwy 40)

Culvert Maintenance

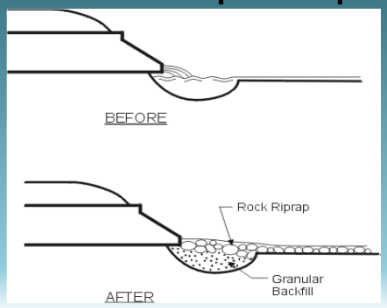
Extreme turbulence at outlet.

Culvert Maintenance

Downstream bed erosion and bank erosion at bend.

Culvert Maintenance

Downstream Apron Repair



Upstream / Downstream End Maintenance (Cont'd)

- Rock Riprap Material Size versus Stream Velocity

Riprap Class		Allowable Velocity
Class 1m	-	2.0 m / sec
Class 1	-	3.0 m / sec
Class 2	-	4.0 m / sec
Class 3	-	4.7 m / sec

Upstream / Downstream End Maintenance (Cont'd)

- Degradation
  - restore stream bed elevation
  - add material
- Aggradation
  - restore stream bed elevation
  - remove material

Stream degradation and scour hole.

Hanging outlet due to degradation and scour.

Culvert Maintenance

Typical scour and degradation at outlet

Culvert Maintenance

New rip rap added to bevel and apron

Culvert Maintenance

Streambed aggradation (Cougar Creek Canmore).

Culvert Maintenance

Restored inlet.

Barrel Maintenance

- Roof
  - Sagging 15% or more
  - Reverse curvature
    - add struts (or install liner if still adequate capacity).

Reverse curvature in roof

Barrel Maintenance

- Sidewall
  - deflecting
    - add struts (or install liner if adequate capacity)
  - corroded
    - Install liner
    - cathodic protection (not as common as previously)

Failed SPCSP culvert (inadequate backfill).

Soil side corrosion, perforated side wall.

Barrel Maintenance

- Floor
  - bulging
    - Place U/S cut-off wall if piping
    - add struts or install liner
  - corroding
    - cast concrete floor
    - cathodic protection

Floor perforations

Arch shaped CSP with heaved floor and deflecting roof.

Culvert Maintenance

Strutted barrel

Culvert Maintenance

Concrete arch culvert with curved wingwalls in Feb. (Weed Creek)

Culvert Maintenance

Arch culvert after high water in July.

Culvert Maintenance

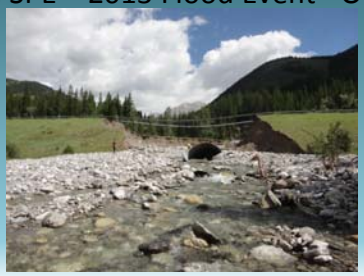
Culvert outlet after high water.

Culvert Maintenance

Inlet of new culvert, following winter.

Culvert Maintenance

Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event - Outlet



Culvert Maintenance

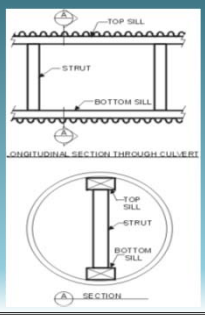
Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event - Inlet

Culvert Maintenance

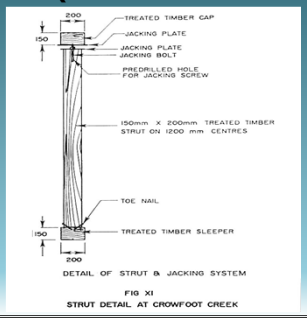
Hwy. 40 Lineham Creek – Washout of 4.3m SPE – 2013 Flood Event

Hwy. 40 Lineham Creek – Replacement with 8-14-8M SLW girders in 2015

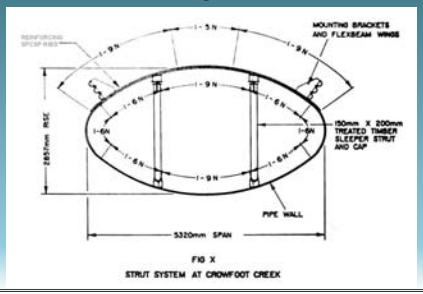
Timber Strutting of Metal Culverts



Strut detail (Crowfoot Creek Hwy 1).



Strutting arrangement for horizontal ellipse.



Culvert Maintenance

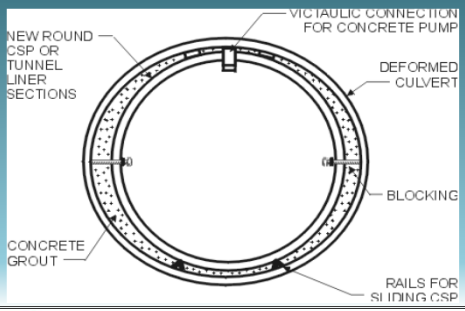
Installing adjustable struts.

Culvert Maintenance

Completed installation.

Culvert Maintenance

Culvert Liners



Culvert Maintenance

Installing a CSP liner.

SPCSP liner is assembled outside and then pulled into existing culvert.

For larger culverts, tunnel liner plates are used.

Liner installed ready for grouting.

Barrel Maintenance

- Circumferential Seams
  - separated
    - inject concrete or grout
    - Install inside coupler plates
- Longitudinal Seams
  - cracked
    - monitor
    - shotcrete reinforcement
    - cast 1/2 arc concrete
    - install liner

Culvert Maintenance

Properly lapped seam.

Culvert Maintenance

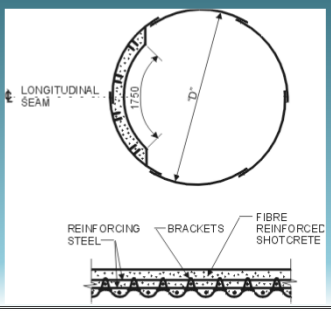
Incorrectly lapped seam with poor nesting

Culvert Maintenance

Incorrectly lapped seam with cracks

Culvert Maintenance

Longitudinal Seam Reinforcing



Culvert Maintenance

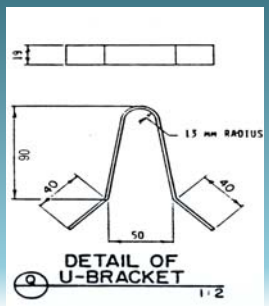
Shotcrete repairs of cracked seams during winter.

Culvert Maintenance

Reinforcing and shear connectors fastened to culvert.

Culvert Maintenance

Shear connector detail.

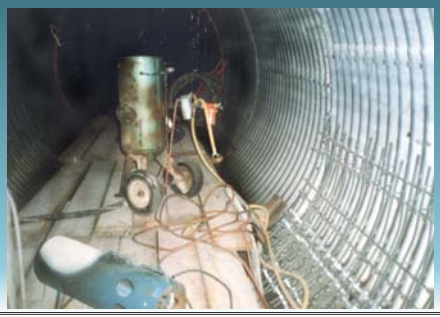


Culvert Maintenance

Shear connectors and rebar in place over cracked seam.

Culvert Maintenance

Shot blaster and heater for inside the culvert.



Culvert Maintenance

Heater inside culvert. Must be maintained at +5º C.

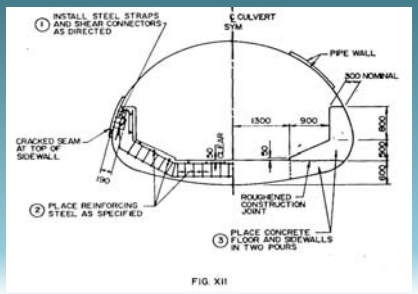
Culvert Maintenance

Applying the shotcrete.

Culvert Maintenance

Completed shotcrete reinforcing beams.

Bottom reinforcement for arch shaped culvert. (Nose Creek Hwy 2)

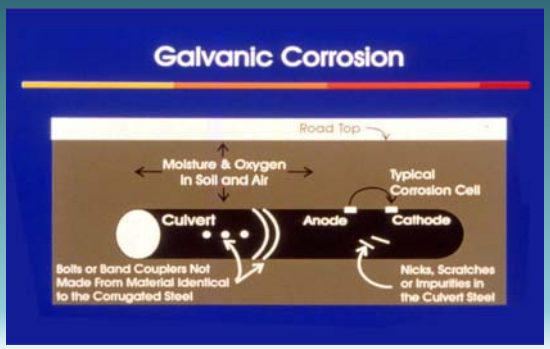


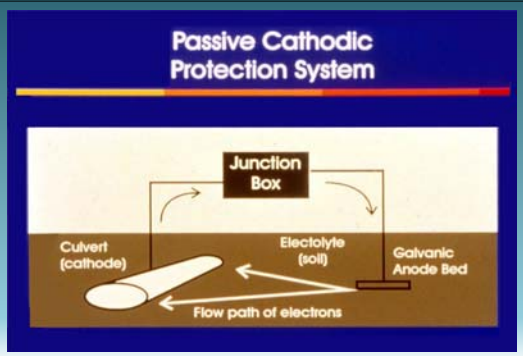
Reinforcing installed for arch culvert reinforcement.

Floor cast inside arch culvert.

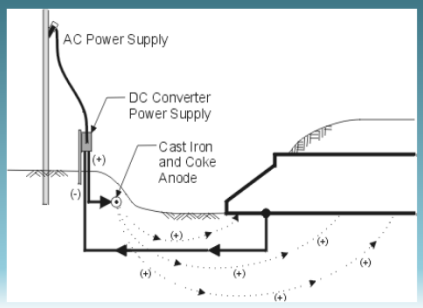
Barrel Maintenance

- Coating
  - Corrosion
    - Soil side corrosion
      - Liner
      - Cathodic protection (not as common as previously)
    - Water side corrosion
      - Concrete floor
      - Liner

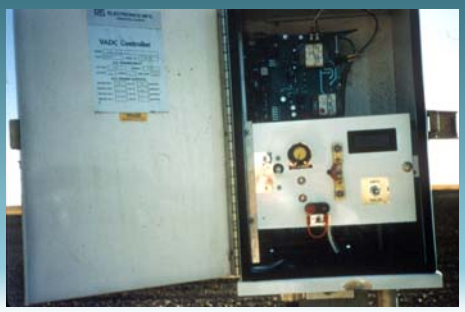




Culvert Cathodic Protection



DC power supply (AC to DC converter).



Cast iron and carbon anode.

Cross-section of anode.

Barrel Maintenance (Cont'd)

- Fish Passage Adequacy
  - add baffles
    - cast concrete
    - rocks
    - weir type
  - repair / build downstream apron
- Waterway Adequacy
  - install additional culvert (jacking)
  - remove drift or silt
  - install stream lining

Channel Maintenance

- Similar to bridges - Degrading (scour), Aggrading
- Drift more of a concern
- Beavers are common
- High velocities at outlet

Culvert Maintenance

Drift collected at inlet (Whitecourt Creek).

Culvert Maintenance

Drift in strutted barrel

Culvert Maintenance

Questions???

Grade Separation Inspection and Rating

Grade Separation Form

- Applies to structures which have traffic going over **and** under
- Applies to Wildlife/Cattlepass or Pedestrian Underpass structures
- Replaces channel section
- Has items specific to under/overpass rather than channels
- Generated automatically
- Can be requested for blank forms
- Refer to Chapter 10 in BIM Manual for Bridges
- Refer to Chapter 13 – section 13.8 for Culverts

Grade Separation Form

- Generated for following usage types:
  - **GS** - vehicle grade separation
  - **PS** - pedestrian grade separation
  - **SP** - stockpass or cattlepass
  - **RO** - railway overpass
  - **RU** - railway underpass
  - All types above can be either bridge or culvert Grade Separation

Traffic Grade Separation - Bridge

Traffic Grade Separation - Culvert

Bridge Grade Separation - Pedestrian

Culvert Grade Separation - Pedestrian

Grade Separation – Animal Underpass

Grade Separation – Railroad Overpass

Grade Separation – Railroad Underpass

Bridge Grade Separation Form

Bridge Section – Chapter 10

Structure Usage				
		Last	Now	Explanation of Condition
Grade Separation				
Road Alignment		7	7	
Traffic Safety Features		4	4	1 damaged post at W.B median and wrong lap at NW.
Type	GUARDRAIL			
Slope Protection		4	4	Broken around pier columns-200mm at North & 120 mm at South. Settled 100mm at North top sections. Sealed, in some areas, open gaps in others.
(Type : **CONCRETE; CONCRETE**)				
Bank Stability		5	5	
Drainage		5	4	Ponding water at west toe of headslope - not affecting driving lanes.
Grade Separation General Rating		**4**	**4**	

Culvert Grade Separation Form

Culvert Section–Chapter 13 Section 13.8

Structure Usage				
		Last	Now	Explanation of Condition
Grade Separation				
Road Alignment		X	X	
Roadway Surface		6	6	
(Type : **SOIL**)				
Icing (Y/N)	No			
Traffic Safety Features		X	X	
Type	None			
Lighting		X	X	
Barrel Leakage (Y/N)	No			
Drainage		4	4	Average 150mm water and ice in pipe.
Structure In Use (Y/N)	No			Fencing is down.
Grade Separation General Rating		**4**	**4**	

Road Alignment

- Refers to alignment up to and through the Bridge/Culvert including surface condition
- Look for:
  - Cracks, heaves & roughness
  - Super elevation & orientation
  - Accessibility for stock
  - Collision potential
- If alignment can be safely driven at legal or posted speed limit, rate 5 or more.
- For Railway, Pedestrian and Animal underpasses rate alignment “X”.

Roadway Surface

- Refers to Culvert Grade Separations and Animal/Pedestrian Underpasses
- Purpose is to provide a surface for traffic usage
  - Smooth surface
  - No holes, depressions or projections
  - Not slippery
- Record type of surface
  - Asphalt
  - Concrete
  - Gravel
  - Soil
- Look for defects that might affect high load vehicles
- Defects that create hazards to traffic or pedestrians
- Record the presence of icing on the roadway Y/N – comment if Yes. May affect Drainage rating.
  - ➢ If defects a problem for stock/traffic, rate 4 or less
  - ➢ If hazardardous, rate 2 or less (holes, projections, icing on traffic or pedestrian surfaces)

Traffic Safety Features

- Refers to curbs, medians, guardrails, advance warning signs, crash protection, etc.
- Not applicable for stock underpasses
- Indicate type and rate condition and functionality
- If not present record type as “None” and rate “X”

Slope Protection

- Refers to protection system on headslopes
- Look for:
  - evidence of settlement
  - cracked, broken or bulging concrete protection
  - Deck drainage away from system
  - voids under concrete slabs
- Note graffiti
- Rate 4 or less for:
  - ➢ Significant settlement or moving downwards
  - ➢ Significant heaving or cracking of concrete slope protection
  - ➢ Voids under concrete slope protection

Bank Stability

- Refers to stability of bridge headslopes
- Look for:
  - damage or displacement
  - settlement at abutment and piers
  - bulging at toe of slope
  - loss of material at toe of slope

Rate 4 or less if:

- Settled and exposing underside of abutment seat
- Instability that affects the Substructure or Superstructure
- Instability requiring monitoring

Drainage

- Refers to the ability to dispose of water at:
- Toe of headslopes and transitions on bridges
- Roadway surface from Culvert Grade Separations
- Ends and barrel of Pedestrian or Animal underpasses

- Typ. water sources are deck and approach road drainage, ditch drainage, and weep holes.
- Some underpasses are also designed for water flow
  - See “Special Comments for Next Inspection”

Drainage

- On Bridge or Culvert Grade Separations handling vehicle traffic look for:
  - Ponding at toe of headslopes and transitions or inside culverts
  - Blockage of existing drainage systems
  - Damage to embankments
  - Record “Yes” if barrel leakage - comment

Ratings:

- If functioning and no damage to slope protection, embankments and no bank instability rate 5 or more
- If damage or slope instability rate 4 or less
- If drainage causes ponding or icing on travel lanes and potential traffic hazard rate 2 or less

Drainage

- On Pedestrian/Animal Underpasses look for:
  - Ponding in culvert barrel or at ends
  - Any condition contributing to icing
  - Damage to sideslopes or embankments
- Record “Yes” if barrel leakage and provide comment. Rating is not required but if “Yes” leakage may effect rating of Roadway surface and Drainage
  - Ratings:
    - If functioning and no damage to sideslope or embankment rate 5 or more
    - If poor drainage causes icing or ponding around animal underpasses rate 4 or less
    - If drainage causes ponding or icing and potential hazard on pedestrian underpass 2 or less

Animal Underpass – Other Drainage Considerations

- Normally these are not applicable (rate "X")
  - scour and scour protection at ends
  - fish passage in barrel
  - waterway adequacy in barrel
- If designed to also handle water flow
  - Note in "Special Comments for Next Inspection" (This culvert also handles drainage. 05/06/2016)
  - Inspect and provide ratings for:
    - scour and scour protection at ends
    - fish passage
    - waterway adequacy

Animal Underpass – Handles Drainage

Animal Underpass – Handles Drainage

Lighting

- Refers to lighting in culvert grade separations and pedestrian underpasses
- Not applicable for stock underpasses - rate X
- If lighting does not exist but in opinion of inspector is required rate X and provide comment and recommendation
- Minor damage that does not affect operation or functionality rate 5
- Defects affecting operation and functionality rate 4 or less

Structure In Use

- Refers to whether the Stock underpass is used for it's intended purpose
- Indicate "In Use" by **Y**es or **N**o
- Provide comment/explanation if "No"

General Rating – Grade Separations

- Governing Elements – (refer to 1.10.5 and 10.7 (Bridges), 1.10.10 and 13.8.7 (Culverts)).
  - Road Alignment rating
  - Traffic Safety Features rating
  - Bank Stability rating
  - Drainage rating

Sample Completed Form - Grade Separation

Structure Usage				
		Last	Now	Explanation of Condition
Grade Separation				
Road Alignment		7	7	
Traffic Safety Features		4	4	1 damaged post at W.B median and wrong lap at NW.
Type	GUARDRAIL			
Slope Protection		4	4	Broken around pier columns-200mm at North & 120 mm at South. Settled 100mm at North top sections. Sealed, in some areas, open gaps in others.
(Type : **CONCRETE; CONCRETE**)				
Bank Stability		5	5	
Drainage		5	4	Ponding water at west toe of headslope - not affecting driving lanes.
Grade Separation General Rating		**4**	**4**	

General Rating – Animal or Pedestrian Underpasses

- Governing Elements – (refer to 1.10.10 and 13.8.7)
  - Road Surface rating
  - Drainage rating

Sample Completed Form - Cattlepass

Structure Usage				
		Last	Now	Explanation of Condition
Grade Separation				
Road Alignment		X	X	
Roadway Surface		6	6	
(Type : **SOIL**)				
Icing (Y/N)	No			
Traffic Safety Features		X	X	
Type	None			
Lighting		X	X	
Barrel Leakage (Y/N)	No			
Drainage		4	4	Average 150mm water and ice in pipe.
Structure In Use (Y/N)	No			Fencing is down.
Grade Separation General Rating		**4**	**4**	

https://extranet.inftra.gov.ab.ca/inftra_login.html

Questions??