



**INFRASTRUCTURE AND
TRANSPORTATION**

TECHNICAL STANDARDS BRANCH

BRIDGE AESTHETICS STUDY

COHOS EVAMY

Version 1.0

Dated April 2005

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PREFACE

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“The information contained in this Study has been compiled by Cohos Evamy for the use and guidance of Alberta Infrastructure and Transportation and their assigns. It is intended to be a ‘design tool’ to provide bridge engineers with guidance, and ideas to assist them when considering the aesthetic aspects of new structures.

To illustrate a concept the Study may contrast ‘ordinary’ with ‘better’ solutions, but it is acknowledged that for some situations, site specific conditions may dictate that a ‘better solution’ is not practical, or that an ‘alternate solution’ is more appropriate. Accordingly it is not intended that the Study be used as a ‘sole reference’, and it is the responsibility of those using this information to ensure that the recommendations are suitable for their use, and to supplement them as required.

Alberta Infrastructure and Transportation assumes no responsibility for errors or omissions, and will not accept liability of any nature whatsoever that may be suffered by the use of the information contained in this Study.”

ACKNOWLEDGEMENTS

This Bridge Aesthetic Study was prepared under the direction of Clive Clarke, Ernie Waschuk, and Greg Whyte of the Technical Standards Branch of Alberta Infrastructure and Transportation. The regional bridge staff and other Technical Standards Branch staff provided additional comments and assistance.

Neil Robson, Jim Montgomery, and Donna Clare of Cohos Evamy prepared this study.

All photographs were either taken by Cohos Evamy or provided by Alberta Infrastructure and Transportation. Cohos Evamy prepared all drawings.

Thanks to Clive Clarke of Alberta Infrastructure and Transportation who provided critical reviews of the study and offered many valuable suggestions.

Executive Summary

This study has been developed for use by Alberta Infrastructure and Transportation, and their assigns. It provides an overview on the aesthetics of bridges, and primarily focuses on structures constructed in the Province of Alberta.

Bridges are powerful examples of human intervention on the landscape. A bridge designed without consideration of aesthetics can serve its function, but it can be unattractive and a visual barrier. A well-designed bridge appeals to everyone, not just engineers and architects

The engineering approach to bridge design is often to consider a bridge as an abstract structural form independent of its surroundings. The architectural approach is often to integrate the bridge into the surroundings in spite of the shortcomings of the bridge's structural form. A successful bridge designer must consider both the abstract structural form and the integration of the bridge into the surroundings.

The design of aesthetically pleasing bridges is a difficult task. There is no correct answer. The designer must respect: economy, transmission of forces to the ground in the most direct manner, constructability and durability, the environment, and adjacent structures, landscape, and properties.

The study examines bridge aesthetics, the determinants of bridge appearance, and provides examples of bridges that are aesthetically pleasing. The study is intended to be used by bridge designers as an aid to assist in decision making thereby helping to ensure that aesthetically pleasing and functional bridges are constructed in the Province of Alberta.

1. Design Process

Current Design Process

- Design bridges to be functional
- Design bridges with low capital costs
- Design bridges with low maintenance costs
- Design bridges for a life of 75 years

Bridge aesthetics are often not considered in the current design process

1

Design Process

Typical starting point for bridge engineer on highway projects:



- There is a road from Point A to Point B with a few bridges in between
- Highway planning satisfies the functional plan but does not consider bridge aesthetics

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2. Why Consider Bridge Aesthetics?

- Bridges are powerful examples of human intervention in the landscape*
- Many designers focus on the function of bridge structures, but give little consideration to aesthetics
- A well designed bridge appeals to everyone, not just engineers and architects*
- A bridge designed without consideration of aesthetics can serve its function, but can be unattractive and a visual barrier

* Clare (2004)

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Why Consider Bridge Aesthetics?



Pont du Gard Bridge near Nîmes, France (18 BC) (For description, see Dupré, 1997)

Most engineers would be of the opinion that they had achieved success if they were responsible for the design of this bridge

- Early example of an aesthetically pleasing bridge
- Aqueduct bridge originally used by the Romans satisfied primary function of transferring water from a spring near Uzès to Nîmes

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3. Bridge Aesthetics

The design of an aesthetically pleasing bridge is a difficult task

- There is no correct answer
- Designer must respect
 - **Economy**
 - **Transmission of forces to the ground in the most direct manner**
 - **Constructability and durability**
 - **Environment**
 - **Adjacent structures, landscape and properties**
- It is easier to be a critic than a designer of aesthetically pleasing bridges

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Bridge Aesthetics

- Engineering approach to design often is to consider a bridge as an abstract structural form independent of surroundings
- Architectural approach to design often is to integrate the bridge into the surroundings in spite of the shortcomings of the bridge's structural form
- The successful bridge designer must consider both abstract structural form and the integration of the bridge into the surroundings

(Menn, 1990; Clare, 2004)

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4. Determinants of Bridge Appearance

Gottemoeller (1998) has studied bridge aesthetics. He is of the opinion that the determinants of bridge appearance are in order of importance:

- 4.1 Overall Structural Configuration
- 4.2 Superstructure Shape
- 4.3 Pier Shape
- 4.4 Abutment Shape
- 4.5 Colours
- 4.6 Surface Textures and Ornamentation
- 4.7 Signing, Lighting and Landscaping
- 4.8 Miscellaneous Details

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4.1 Overall Structural Configuration

The overall structural configuration of a bridge is determined from the:

- Horizontal and Vertical Geometry
- Superstructure Type
- Pier Placement
- Abutment Placement and Height

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Overall Structural Configuration

4.1.1 Horizontal and Vertical Geometry

In the design of a bridge, the horizontal and vertical geometry of a bridge will:

- Be selected to satisfy the requirements of the site conditions
- Relate to the type of bridge crossing
- For highway bridges, be selected by the roadway designers to satisfy traffic movement and safety concerns

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Horizontal and Vertical Geometry Highway Crossing



Hwy 1 at Lake Louise
(above)

- These bridges have good proportions, with pleasing span to depth ratios

BF 70481 MacKenzie Road
over Hwy 2 (beside)



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Horizontal and Vertical Geometry Highway Crossing



Bridge at airport in Porto, Portugal

The horizontal and vertical geometry of the roadway have influenced the structural system selected for this bridge

- Box girder bridges are more suitable to resist torsion
- Elegant pier shape

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Horizontal and Vertical Geometry River Crossing



BF 73809E McLeod River

The horizontal and vertical geometry of the roadway at this river crossing have resulted in a bridge with an ordinary appearance

- Traditional piers (large monolithic structures)
- Piers dominate the view when seen from a skew to the front elevation

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Horizontal and Vertical Geometry River Crossing



Peace River Bridge
at Fort Vermillion
(above)

James MacDonald Bridge across North
Saskatchewan River, Edmonton (beside)



The designers of these river crossings have worked within the constraints of the roadway geometry to achieve structures with pleasing appearances. Haunched girders have been used for the Edmonton bridge. A special pier shape has been used to reduce ice loads for the Fort Vermillion bridge

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Horizontal and Vertical Geometry River Crossing



LRT Bridge across Fraser River in
Vancouver

The requirements for a large channel for the navigation of ships on this river resulted in the selection of an aesthetically pleasing, long span cable-stayed bridge

- Bridge allows unobstructed views
- Deck is very slender
- Towers are well proportioned

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Horizontal and Vertical Geometry Reservoir Crossing



Bridge crossing reservoir for Libby Dam, Montana

- Piers are secondary to the dominant superstructure
- Two-column piers look smaller than an equivalent wall pier

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Horizontal and Vertical Geometry Valley Crossing



White Pass and Yukon Route Heritage Railroad Bridge, Alaska (above)

- Large valleys with competent rock foundations allow designers to select long span arch structures providing unobstructed views

Modern arch bridge
Porto, Portugal (beside)



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Horizontal and Vertical Geometry

Pedestrian Bridge



Millennium Bridge, London (2000)
(For description, see Wells, 2002)

The designers took great care in the proportioning of this tension ribbon bridge, but the novel geometry and long spans resulted in low natural frequencies of vibration that resulted in large lateral movements under pedestrian traffic. Dampers were installed immediately after the bridge was opened to reduce vibrations

- Long superstructure span minimizes the number of piers in the water
- Pier geometry is tapered slightly and is proportionate to the superstructure elements

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Overall Structural Configuration

4.1.2 Superstructure Type

- Engineers normally select the most economical superstructure for the span
- The superstructure type selected is influenced by horizontal geometry
- The superstructure type selected is often influenced by construction constraints

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Superstructure Type

Structural Type	Material	Range of Spans (m)	Maximum Span in Service (m)
Slab	Concrete	0-20	
Girder	Concrete	12-250	240, Hamana-Ko Lane
	Steel	30-260	261, Sava I
Cable-Stayed	Concrete	<250	235, Maracaibo
	Steel	90-850	856, Normandy
Truss	Steel	90-550	550, Quebec (rail)
			480, Greater New Orleans, Nos. 1 and 2 (road)
Arch	Concrete	90-300	305, Gladesville
	Steel Truss	240-500	510, New River Gorge
	Steel Rib	120-360	365, Port Mann
Suspension	Steel	300-1400	1410, Humber

(Barker and Puckett, 1987)

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Superstructure Type Short Span Bridges Commonly Constructed In Alberta



BF 80451 Headworks Canal south of Magrath

For short span bridges, economy and constructability are important considerations. The designer of aesthetically pleasing bridges must work within these constraints.

- Precast girders bearing on cast-in-place pier cap supported on galvanized pipe piles
- Clean lines, economical, simple construction, and low maintenance

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Superstructure Type Medium Span Bridges Commonly Constructed In Alberta

- Steel plate girders
- Bulb tee girders
- Cast-in-place concrete slab, or box girder



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Superstructure Type Longer Span Bridges Commonly Constructed In Alberta

- Steel plate girders
- NU girders
- Box girders



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Superstructure Type Truss Bridges



Connors Road Pedestrian Bridge (top image)
Low Level Bridge, Edmonton (bottom image)

- Efficient structural systems
- Imposing appearance
- By today's standards are rarely considered to be aesthetically pleasing

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Superstructure Type Truss Bridges



Railway bridge
in Avignon,
France

- Historically interesting to bridge engineers
- Large number of piers and buoys clutter the view
- Deep superstructure, blocks out the surrounding landscape

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Superstructure Type

Arch Bridges



Geres,
Portugal

- Arch bridges have a slender, attractive appearance



Seine River in Paris, France

25

Superstructure Type

Cable-Stayed Bridges



Alex Fraser Bridge across the Fraser River in Vancouver, during construction

- Considered to be an aesthetically pleasing bridge
- Economical use of materials
- No unnecessary embellishments added

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Superstructure Type

4.1.3 Adjacent Structures Should Respect Each Other



- The structural configuration of the new bridge in the foreground does not relate to that of older bridge in the background

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Overall Structural Configuration

4.1.4 Pier Placement

In selecting pier placement, designers typically consider:

- Foundation conditions
- Clearance requirements
- Hydrotechnical requirements
- Economical span lengths

For aesthetically pleasing bridges, designers must also consider:

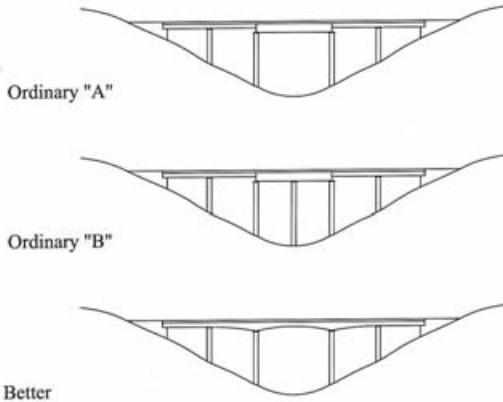
- Topographic features
- Sightlines through the substructure
- The ratio of span lengths to pier heights

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Pier Placement Span Arrangement

Discontinuous superstructure and an even number of spans detract from the appearance of the superstructure

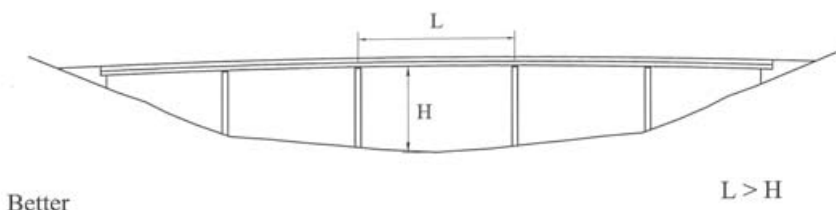
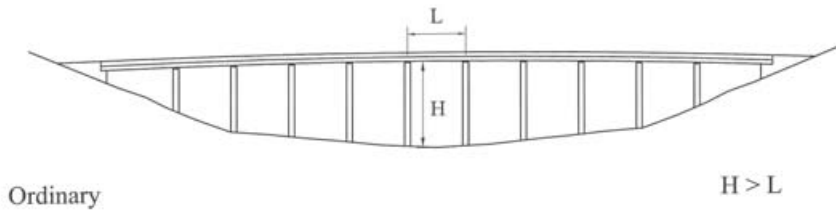
The Rosebud bridge has an odd number of spans, producing a centre span rather than a central pier



BF 9943 Rosebud River/CNR

(Gottemoeller, 1998)

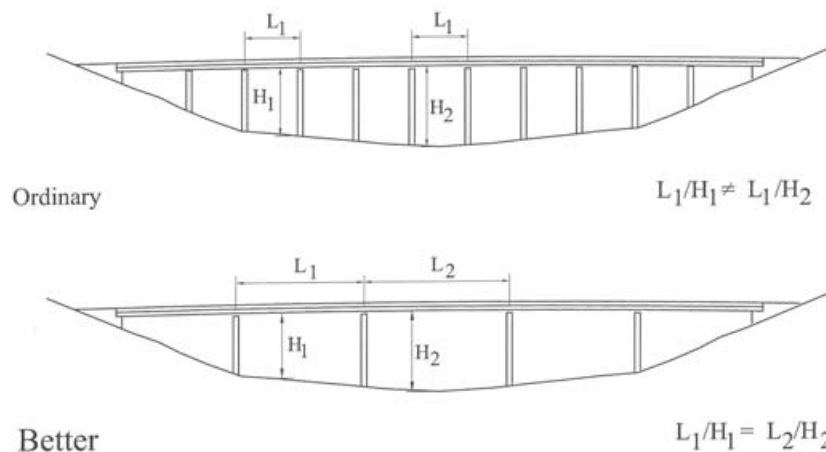
Pier Placement Span to Pier Height Ratio



(Gottemoeller, 1998)

Pier Placement

Consistent Proportions of Span to Height



(Gottemoeller, 1998)

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Pier Placement

Single Shaft Pier Ratio

- Gottemoeller (1998) suggests a pier width transverse to the span of less than the span/8 for bridges with narrow superstructure widths relative to span lengths
- The Sheep River Bridge has large, monolithic piers. Slender piers similar to those used at Castor Creek may have improved the appearance



BF 74031 Sheep River

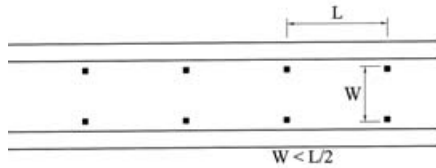


BF 1402 Castor Creek

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Pier Placement

Two or More Column Pier Ratio



Plan View

Sketch above shows the ratio of column spacing to span length recommended by Gottemoeller, 1998



BF 81801 Dunbow Road G/S

- Using only two columns opens up the substructure dramatically
- Using a pier cap would appear out of place with the low clearance height

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Pier Placement

Two or More Column Pier Ratio



Grade Separation at Wabamun

- Multiple columns give a more open view than a solid pier
- Aesthetics could have been improved if only two columns were used

34

Overall Structural Configuration

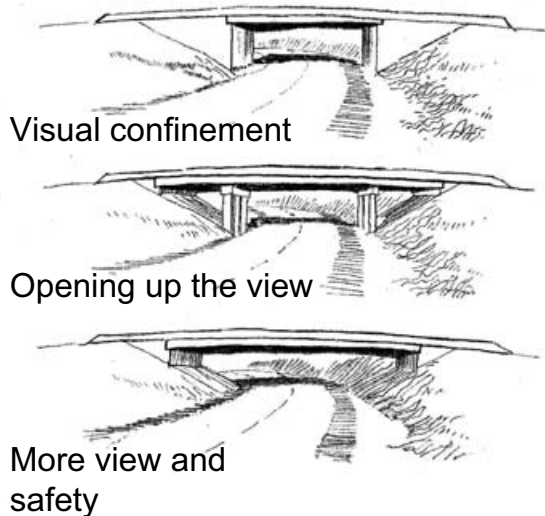
4.1.5 Abutment Placement and Height

Abutments initiate a bridge at one end and terminate it at the other. The appearance of a bridge is generally improved if:

- Abutments appear small relative to the bridge superstructure
- Abutments are placed near the top of the bank, out of the way of traffic or water below
- Head slopes flatter than 1 vertical to 2 horizontal are used

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Abutment Placement and Height Opening Up the View to Motorists



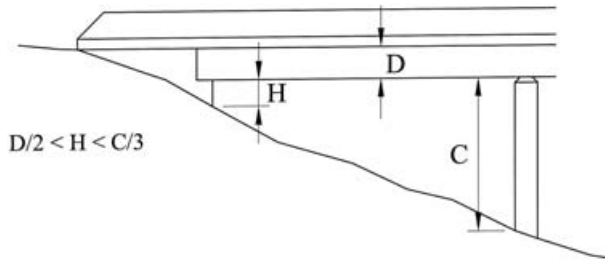
Hwy 1 at Lake Louise

- Open view
- No piers or abutment directly adjacent to the road

(Gottemoeller, 1998)

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Abutment Placement and Height Desirable Proportions

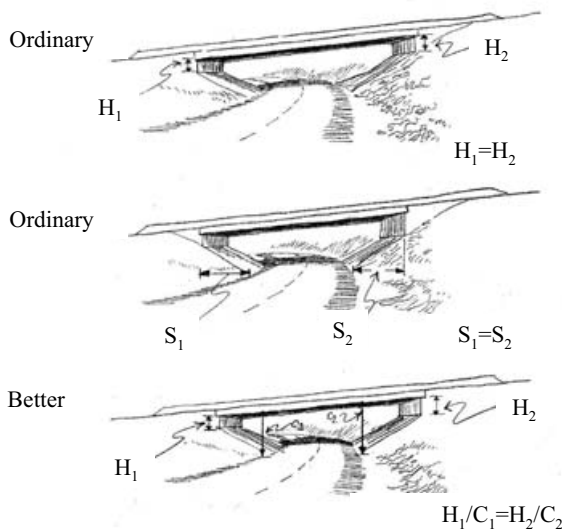


BF 70481 MacKenzie Road
over Hwy 2

(Gottemoeller, 1998)

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Abutment Placement and Height Desirable Abutment Proportions



- When one side of the bridge is higher than the other, keep abutment proportions similar
- Proportions for the bridge in the bottom sketch are preferable

(Gottemoeller, 1998)

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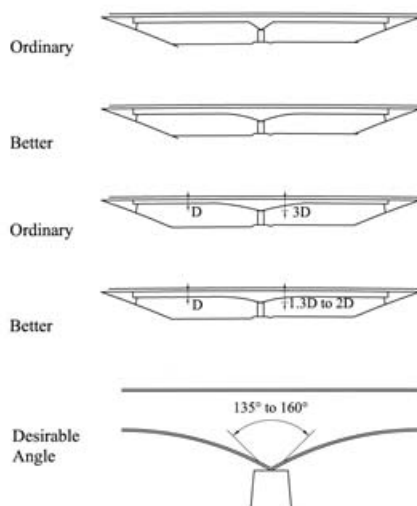
4.2 Superstructure Shape

The shape of the bridge superstructure is determined by:

- Girder Configuration
- Deck Slab Cantilever
- Parapets
- Railing Details
- Pedestrian Cages

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Superstructure Shape 4.2.1 Girder Configuration



Aesthetic proportions for haunched girders

(Gottemoeller, 1998)

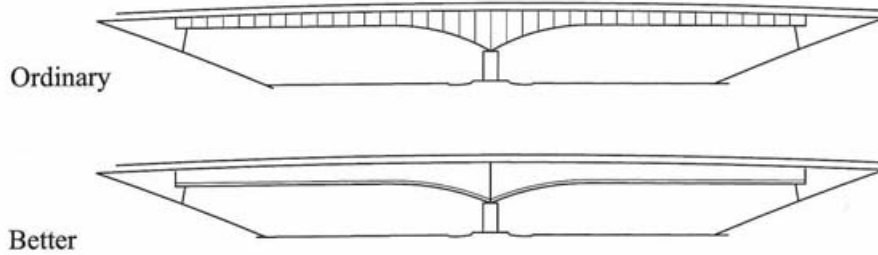


James MacDonald Bridge across North Saskatchewan River, Edmonton

- Nicely proportioned haunched girders

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Superstructure Shape Girder Configuration



- Vertical stiffeners make girders look heavier than horizontal stiffeners
- Use vertical stiffeners on inside and horizontal stiffeners on outside

(Gottemoeller, 1998)

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Superstructure Shape Girder Configuration



Pedestrian Bridge at Puerto Vallarta,
Mexico airport

- Increased depth at middle of main span
- Span arrangement and pedestrian cage detract from the appearance of the bridge

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Superstructure Shape

4.2.2 Deck Slab Cantilever



BF 81802 Bow River Bridge Deerfoot Extension

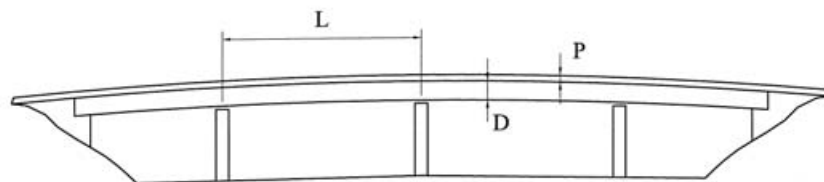
- Appearance could be improved if the deck had a larger cantilever past the web of the exterior girders
- Diaphragms between the piers are not visible in elevation providing a cleaner appearance

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Superstructure Shape

4.2.3 Parapets

Desirable proportions for parapet heights
(minimum safety requirements may still govern)



$$D/4 < P < D/2$$

$$P > L/80$$

(Gottemoeller, 1998)

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Superstructure Shape

4.2.4 Railing Details



- Mixing steel handrail with concrete makes it appear discontinuous
- Appearance could have been improved by using a continuous steel handrail

Mackenzie Blvd. Over Deerfoot Trail

Superstructure Shape

4.2.5 Pedestrian Cages



Pedestrian bridge across Whitemud Drive near 159th Street in Edmonton



Pedestrian bridge proposed across Terwillegar Drive south of 40 Avenue in Edmonton

- Pedestrian cage appears to have been designed for function alone
- Superstructure appearance would be improved with a parabolic shape

- Pedestrian cage has been used as a design feature

4.3 Pier Shape

- Wide variety of pier shapes have been used throughout the province of Alberta
- Although many different pier shapes are illustrated in the following slides, simple piers without unnecessary embellishments are preferable
- Typically, the use of large, solid piers should be avoided

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4.3 Pier Shape

The following types of pier shapes have been used or considered for Alberta bridges:

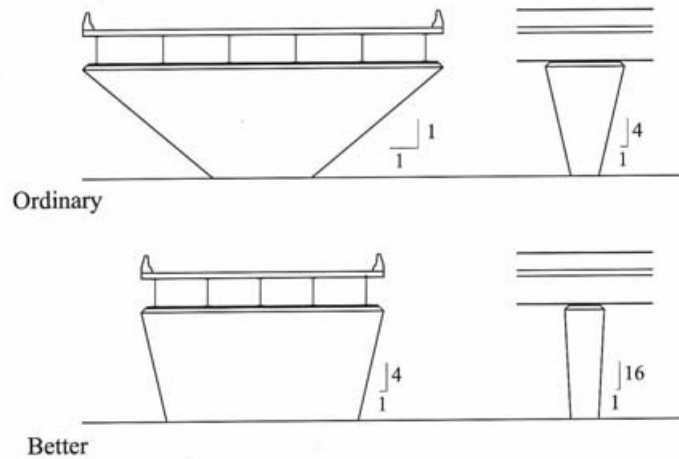
- Tapered Piers
- Wide Base Piers
- Varying Width Piers
- Column Piers
- Pipe and HP Pile Piers

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Pier Shape

4.3.1 Tapered Piers

V-shaped piers with too much taper look top heavy



(Gottemoeller, 1998)

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Pier Shape

Tapered Piers



BF 82011 196th Avenue
Over Deerfoot Trail

- Well proportioned tapered pier
- Opening in the centre contributes to an attractive pier
- Quality construction techniques



Deerfoot Trail at MacKenzie Blvd.

- Well proportioned tapered pier
- Holes in the pier do not achieve the desired appearance of “openness”

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Pier Shape

Tapered Piers



BF 7740 Pembina River At Entwistle

- Well proportioned tapered pier
- Slender appearance rising out of water is attractive

- Well proportioned tapered piers
- Appearance would be pleasing with or without the openings at the top



BF 81802 Bow River Bridges,
Deerfoot Trail Extension

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Pier Shape

4.3.2 Wide Base Piers



BF 82058 Three Sisters Creek Road /
Highway 1

- Pier is wider than the superstructure and may become stained over time
- Unique/unusual pier
- Contrast of steel and concrete is appealing

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Pier Shape

Wide Base Piers



BF 73809W McLeod River Bridge At Whitecourt

- Large, solid pier
- Obstructs view of surrounding landscape



North of BF 73809

- Large pier
- Sloped upstream face to reduce ice forces creates an unsymmetrical pier
- Obstructs view of surrounding landscape

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Pier Shape

Wide Base Piers



- Top of pier is same width as superstructure
- Sloped upstream face to reduce ice forces is copied on the downstream face to maintain symmetry
- Sloped faces start low on the pier which reduces the size of the cross-section

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Pier Shape

Wide Base Piers

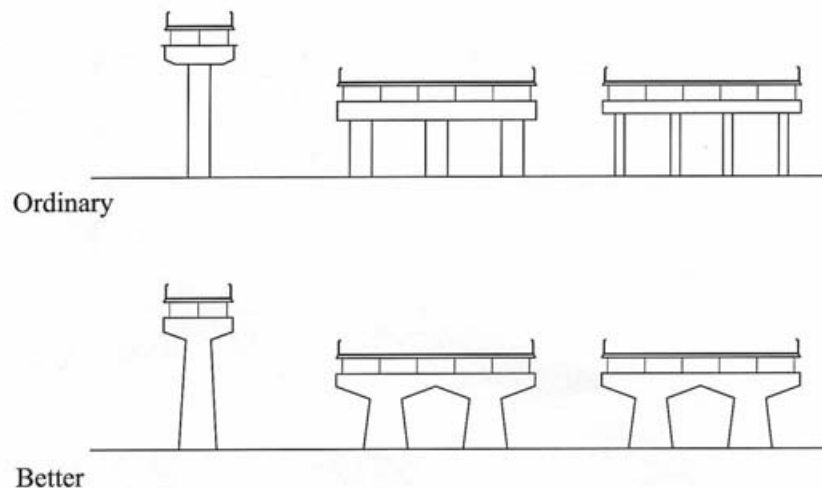


- Large, solid pier
- Sloped faces create symmetry
- Starting the sloped edge at the top of the pier increases the size of the cross-section

BF 73810E Athabasca River Bridge

Pier Shape

4.3.3 Varying Width Piers



Pier Shape

Varying Width Piers



BF 1402 Castor Creek

- Well proportioned pier
- Ends of pier cap do not extend beyond width of the superstructure

- Well proportioned pier
- Staining of the pier is unattractive



BF 81555W Oldman River Bridge

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Pier Shape

4.3.4 Column Piers



BF 78360 Century Road/Hwy 16X

- Splitting of pier works well here as a solid pier would appear too massive
- Pier cap provides continuity between the elements



BF 77750 Highway 16X

- Separated columns give a segregated look
- A solid, tapered pier or smaller columns with a pier cap may have been an improvement

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Pier Shape Column Piers



BF 77750 Highway 16X

- For reasons of safety and aesthetics, the end elevations of piers should be narrow and chamfered or rounded



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Pier Shape Column Piers



Anthony Henday Drive Over North Saskatchewan River, Edmonton

- Open pier appears less dominant than a solid pier
- Pier cap visually reduces the height of substructure



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Pier Shape Column Piers



BF 9943 Rosebud River / CNR

- Unique pier geometry on the 40 year old bridge
- Two columns, rather than three, may have been preferable

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Pier Shape 4.3.5 Pipe Pile Piers



BF 77460 Shunda Creek Bridge

- Pipe pile piers with steel cross bracing
- Painting is severely damaged
- Older type of construction (rarely used now)



BF 78227 Baptiste River NW, of Rocky Mountain House

- Pipe pile pier with plated web
- Older type of construction (rarely used now)
- End of pier cap rounded to compliment piles
- Good workmanship

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Pier Shape Pipe Pile Piers

- Round pipe columns are attractive
- Rectangular caps do not harmonize well with columns



BF 9619 Mink Creek Bridge



BF 80445 St Mary Canal Bridge NE of Spring Coulee

- Multi span standard bridges require quite a few pipe pile piers
- The use of galvanized pipe piles minimizes the visual impact, resulting in a “light” appearance to the substructure

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Pier Shape HP Pile Piers



BF 73328 Prest Creek Bridge Hwy 47

- Pier constructed from galvanized HP shapes for columns and a structural steel pier cap
- Pipe columns with concrete pier caps are usually considered to be more attractive

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4.4 Abutment Shape

- The components of abutments should be aligned so that so they relate to each other and the bridge piers, superstructure, guardrails, handrails and parapets
- Consideration should be given to sloping the abutments towards the span, as this gives the appearance that the bridge grows out of the abutments

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Abutment Shape 4.4.1 Component Alignment



BF 73810E Athabasca River Bridge At Whitecourt

- Quality concrete work
- Excellent alignment of various components



BF 73485 Shunda Creek Bridge East Of Nordegg

- Elements of the abutment are all at right angles which is consistent with the pier caps
- Span arrangement and variation in pipe column size from pier to pier is awkward

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Abutment Shape

Component Alignment



MacKenzie Blvd Over Deerfoot Trail

- No alignment between concrete coping, abutment, or curbs
- Numerous lines in elevation should be avoided
- Perhaps eliminate second curb line

- Better alignment of components
- Unusual abutment appearance. Back portion of wingwall slopes towards the span



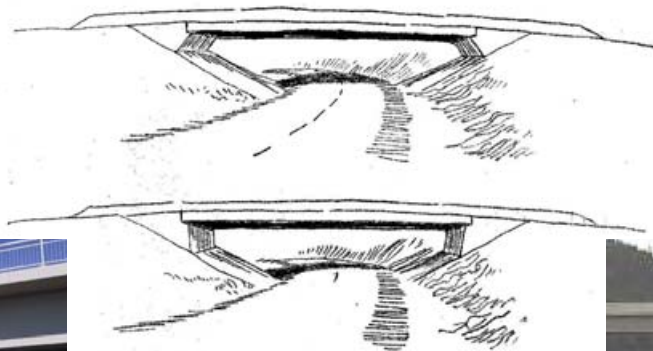
BF 82011 196th Avenue Over Deerfoot Trail

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Abutment Shape

4.4.2 Sloping Abutment

Sloping abutments frame the opening and make the bridge seem more continuous



(Gottemoeller, 1998)



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Abutment Shape

4.4.3 SPCSP Abutment

BF 8027 Hwy Over
A Watercourse SE
Of Pincher Creek



- Interesting abutment innovation used for a short span bridge

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4.5 Colours

- Colours can be applied to the steel components of bridges through the use of paint, galvanizing and atmospheric corrosion resistant material
- Concrete components of bridges can be coloured by using special cements in the mix or by applying pigmented sealers and coatings
- Care should be taken to ensure that the application of paints and coatings does not significantly increase maintenance costs

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Colours

4.5.1 Steel Members

- For environmental and financial reasons, Alberta Transportation has discontinued the painting of steel members for new bridges
- Girders are typically fabricated using atmospheric corrosion-resistant steel (Grade 350A)
- Bridge rails and pier piles are galvanized
- Consideration could be given to painting steel members to improve appearance for selected bridges

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Colours

Steel Members – Weathering Steel



- Inconsistent weathering of atmospheric corrosion-resistant steel
- Girders are sandblasted in the shop to remove millscale. If care is not taken during deck construction, the appearance of girders can be affected by contamination

BF 81555W Oldman River Bridge

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Colours

Steel Members - Column Piers

- Typical maintenance problem with painted pipe piles



BF 08157 Bearhead Creek Local Road
SE of Nampa



BF 1604 Local Road over Waskatenau
Creek

- Alignment of columns and bracing is good
- Care should be taken to avoid spray painting the rocks

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Colours

4.5.2 Concrete

- Coloured concrete has generally not been used for bridges constructed in Alberta
- Information on the use of coloured concrete is available in PCI (1989)
- Concrete can be cast in a variety of colours
- White or brown cement can be used for concrete where appropriate to improve appearance and match surroundings
- Pigmented sealers and coatings can be used to colour the surface of concrete members but there are durability concerns

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Colours

4.5.3 Sealers



BF 73810W Athabasca River

- Anti-graffiti coatings can be applied to concrete to facilitate graffiti removal
- Alternatively, sealers and coatings can be used to cover graffiti on existing concrete surfaces

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4.6 Surface Textures and Ornamentation

- Surface textures and ornamentation can be used to differentiate and clarify the various components of a bridge
- For highway traffic traveling at high speeds, the surface textures and ornamentation must be large and distinct to be understood
- Surface textures and ornamentation become more important at street and pedestrian speeds



(Gottemoeller, 1998)

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Surface Textures and Ornamentation

4.6.1 Surface Textures

- Ribs are continuous from abutment seat to wingwall
- Gives a consistent appearance



BF 77173W Country Hills Blvd / Deerfoot Trail



BF 75420E Hwy 2/11 Grade Separation At Red Deer

- Horizontal ribs on the abutment seat are inconsistent with the solid wingwall that includes a motif

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Surface Textures and Ornamentation

4.6.2 Ornamentation



BF 75420E Hwy 2/11 Grade Separation At Red Deer

- Stylized artistic motif
- Can be complimentary to the structure and environment in the appropriate setting

- A stylized artistic motif is effective if utilized in the appropriate location



BF 7740 Pembina River At Entwistle

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Surface Textures and Ornamentation Ornamentation



BF 78154 King Street Over Hwy 63
G/S At Fort McMurray

- Pier surface treatment does little to enhance the lines of this bridge, and is probably too elaborate to be appreciated by motorists passing by at high speed

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4.7 Signing, Lighting, and Landscaping

- Avoid mounting signs on bridges, as these detract from the overall appearance of the bridge
- Feature lighting can improve the appearance of bridges in urban areas
- Landscaping can be used to enhance the appearance of an attractive bridge

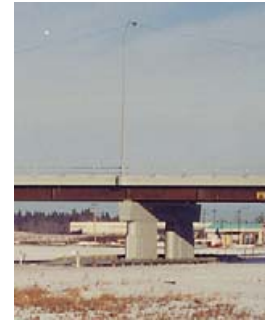
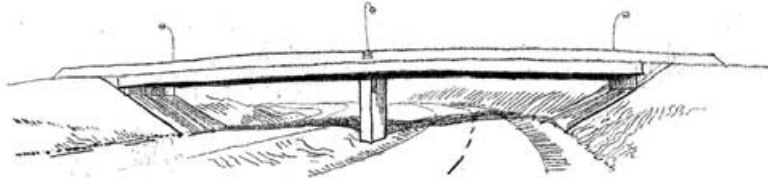


80

Signing, Lighting, and Landscaping

4.7.1 Lighting

- Supports for traffic lighting should be coordinated with structural features



(Gottemoeller, 1998)

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Signing, Lighting, and Landscaping

Lighting



- Good use of feature lighting

Ellerslie Road over Hwy 2, Edmonton

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Signing, Lighting, and Landscaping

4.7.2 Landscaping



BF 82058 Three Sisters Creek Road

- Riprap in place of concrete headslope on a grade separation seems out of place
- Perhaps a natural slope could be used instead, however it is difficult to grow vegetation under a bridge

- Natural headslope is appropriate given the surrounding landscape
- Requires appropriate drainage measures to prevent erosion



BF 9943 Rosebud River / CNR

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Signing, Lighting, and Landscaping

Landscaping

BF 82008 130th
Avenue Over Deerfoot
Trail In Calgary



- High quality erosion control and landscaping

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4.8 Miscellaneous Details

- There are a number of miscellaneous details that should be attended to by the designer to avoid detracting from the appearance of an otherwise attractive bridge
- These details include the making of adequate allowances for the drainage of moisture away from the structure, the hiding of the conduits and pipes for utilities, and the design of the components that allow for the inspection of the bridge components

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Miscellaneous Details

4.8.1 Drainage



BF 73809E McLeod River Bridge

- Attention to drainage details on and around the structure is essential if durability performance is to be optimized
- Water stains on wingwall and face of abutment seat

- Concrete drain trough runs down headslope rather than sideslope
- Produces a more appealing elevation view to bridge since trough drains are not present
- Greater risk of headslope erosion



BF 73809E McLeod River Bridge
At Whitecourt

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Miscellaneous Details

Drainage



For the bridge at left

- Deck drain fabricated from Grade 350A steel to match the girders
- Deck drain hidden by the wingwall does not have to match the girder colour



For bridge at right

- A better attempt needs to be made to conceal the deck to grade drain



Grade Separation at Wabamun

BF 73809W McLeod River Bridge At Whitecourt

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Miscellaneous Details

Drainage



- Consider the overall impact on the elevation view when determining the number and position of deck drains

BF 81555W Oldman River Bridge

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Miscellaneous Details

Drainage



- Drain trough terminal protections at toe of slope protection could have been substituted with rock riprap to improve the bridge aesthetics

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Miscellaneous Details

4.8.2 Utilities



BF 80454 Irrigation Canal near Magrath

- Cable hanging over the edge of the curb needs to be relocated
- Typically cables are accommodated in the continuous PVC duct available in the curb, or alternatively cast into the structure
- Utilities hanging from or attached to a bridge are usually unsightly and invariably problematic if/when widening or major maintenance is required

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Miscellaneous Details

4.8.3 Access



BF 81556W Hwy 3 over Hwy 23 near Monarch

- Abutment seats can be too high for inspection access to the bearings, without the use of a ladder
- The centre of the headslope is not the preferred location for an abutment drain. It increases the risk of headslope erosion.

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Miscellaneous Details

Access



- Access hatches provided in the soffit of the slab
- Good details

BF 81801 Dunbow Road G/S
BF 82011 196th / Deerfoot

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5. Aesthetically Pleasing Bridges

- Are “simpler”...with fewer individual elements... which are similar in function, size and shape
- Lines of structure are continuous
- Shapes of structural members reflect forces on them
- Integrate into their surroundings

(Gottemoeller, 1998)

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Aesthetically Pleasing Bridges



Alex Fraser Bridge, Vancouver

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Aesthetically Pleasing Bridges



James MacDonald
Bridge, Edmonton
(above)

Belgravia Road / 116
Street, Edmonton
(below)



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Aesthetically Pleasing Bridges



Hwy 1 at
Lake Louise
(above)

Animal Overpass
Structure near
Banff (below)



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Aesthetically Pleasing Bridges



Solferino Bridge, Paris, France (1999)
(For description, see Wells, 2002)

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Aesthetically Pleasing Bridges



Pia Maria Bridge, Porto, Portugal (Gustave Eiffel, 1877)
(For description, see Billington, 1983)

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Aesthetically Pleasing Bridges



Arch Bridge in
Porto, Portugal
(above)

Hwy 1, South of
San Francisco
(beside)



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Aesthetically Pleasing Bridges



Pedestrian Bridge across
Memorial Drive, Calgary
(above)



Pedestrian Bridge
across Deerfoot Trail,
Calgary (beside)

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5.1 Aesthetically Pleasing Bridges That Integrate Into Their Surroundings



May Day Bridge across River Vltava (Moldau) in Prague (1901)
(For description, see Browne, 1996)

- Bridge is integrated into the urban environment

- Bridge relates to the surrounding architecture and landscape



Rhonda, Spain

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Aesthetically Pleasing Bridges That Integrate Into Their Surroundings



Alamillo Bridge, Seville, Spain (1992)
(For description, see Pollalis, 1999)

- Bridge is integrated into its urban surroundings

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6. Retaining Walls

- Walls are used to retain soil adjacent to roadways and bridges
- For most installations, structural performance and lowest cost are the criteria used in the selection of retaining wall configurations
- Designers need to give consideration to the appearance of walls, particularly in urban areas
- Retaining wall appearance can be improved by the proper selection of configuration, the use of colour, and the use of texture and ornamentation

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Retaining Walls

6.1 Configuration

- Align walls in continuous horizontal curves related to roadway geometry and topographic features...Walls composed of straight edges and angles seem out of place and threatening
- Shape wall tops in continuous curves that reflect and smooth out the topography

Retaining Walls Configuration



- Large number of vertical reveals present
- Wall appears segmented rather than continuous
- Exposed anchorages could have maintenance issues

BF 77173W Country Hills Blvd /
Deerfoot Trail

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Retaining Walls 6.2 Colour



BF 77260 CPR Overpass at Aldersyde

- MSE wall panels are the same colour as the bridge structure

- Colour of the MSE walls does not match the bridge structure or the surroundings



BF 81801 Dunbow Road G/S

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Retaining Walls

6.3 Ornamentation



- Attractive images cast into the retaining wall
- The use of vegetated terraces is effective in reducing the “visual height” of the wall

Memorial Drive near Zoo, Calgary

7. Culverts

- Culverts are used as an alternative to conventional short-span bridge structures for the crossing of creeks and streams
- To improve the aesthetics of culverts, the designer must pay attention to the installation of riprap at the inlets and outlets, the configuration of the concrete at the culvert ends, the concrete surface treatment and ornamentation, and the control of erosion

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Culverts 7.1 Riprap



BF 81332 Bullshead Creek Near Dunmore

- Effectively placed riprap
- Natural looking channel

- Riprap is slightly deficient, but it is being stabilized by the re-growth of vegetation
- Concrete end treatment is pleasing



BF 75069 Hwy 36 over Irrigation Canal

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Culverts Riprap



BF 75069 Hwy 36 over Irrigation Canal

- To improve hydraulic efficiency the riprap should be flush (or slightly above) the top of the collar
- Concrete end treatment is well constructed

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Culverts Riprap



BF 6523 Ghostpine Creek near Huxley

- Unusual use of riprap between the twin culverts

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Culverts Riprap



BF 74106 Hwy 24 over Canal

- A concrete transition between the headwalls would have been more appealing than using riprap
- Common concrete collar works well



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Culverts Riprap

- The use of salvage material as riprap should be avoided
- Old technology, rarely used now
- Environmentally unfriendly, aesthetically displeasing, and not usually effective



- In the past, salvage material has been combined with riprap to reduce costs

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Culverts

7.2 Concrete End Treatment



BF 72284 Manatokan Creek Hwy 55

- Concrete end treatment looks neat and efficient
- For short spans a Thrie-beam bridgerail would give smoother lines

- Concrete end treatment using vertical ribs



BF 74883 Hwy 36 N of Vauxhall

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Culverts

Concrete End Treatment

- Partial concrete end treatment is “old technology”, but still may be considered a viable option for economic reasons
- Aesthetically, this end treatment is rarely pleasing and does not enhance the structural performance of the culvert



- Aesthetically, this 4.3m culvert could have benefited from a concrete end treatment
- Current guidelines recommend that culverts 3 to 4.5m in diameter have concrete end treatment at the upstream end only. Culverts over 4.5m diameter have concrete end treatments at both ends

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Culverts

Concrete End Treatment



- Appealing concrete work on the collar and cut-off wall
- Top component yet to be cast

BF 81332 Bullshead Creek near Dunmore

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Culverts

Concrete End Treatment



- Special features were incorporated into this design to compliment the location
- Rounding the end corners of the headwall and using a bridgerail rather than large rocks might have been more attractive

Rundle Penstocks outfall for dam near Kananaskis

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Culverts

7.3 Concrete Headwalls

- Concrete reflects good workmanship



BF 73920E Two Creeks Culvert on Hwy 43



BF 2157 Rosebud River near Didsbury

- Arch-Beam-Culvert with an appealing appearance

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Culverts

Concrete Headwalls



BF 73920E Two Creek Culvert on Hwy 43

- Good workmanship
- Headwalls seem to dominate the opening, although the use of panels helps to moderate the visual impact
- Straight headwalls shorten the structure, but are not very efficient from a hydraulic perspective

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Culverts

7.4 Erosion



- Sideslope erosion around a culvert can become extensive
- Additional measures to control run-off and reduce velocities are required

- Absence of riprap protection has resulted in significant sideslope erosion
- Culvert would have benefited from a concrete end treatment (aesthetically and structurally)



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Culverts

Erosion



Headslope Erosion

- This type of erosion is not unusual around the ends of culverts
- To help mitigate the problem, appropriate measures are required to control run-off flow and reduce velocities
- Possible Solutions:
 - vegetate ASAP
 - terrace/step potential run-off channels
 - use small gabions, small riprap, straw bales, etc.

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8. Costs

- Structural modifications made for aesthetic reasons, excluding increases in span length
- Less than 2% of construction cost
- Spans slightly longer than economical minimum to improve appearance
- Up to 7% of construction cost

(Menn, 1990)

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Costs

- Where a bridge is part of an overall highway project, the increased costs to enhance bridge aesthetics are often negligible in comparison to the overall project costs

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9. Questions for Bridge Designers

- Describe the flow of forces that you intend to express in your structure. What is the load case? What are the primary structural elements?
- How do you intend to express this flow of forces? Arrangement of members? Shaping of members?
- How does the choice of materials relate to the flow of forces you are expressing?
- Is your structure efficient? Could it be made more efficient?
- What is new and innovative about your structural system?

(Gauvreau, 2003)

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Questions for Bridge Designers

- Have you used symbolic and/or abstract forms? If so, how? Why? How do these elements relate to the expression of the flow of forces?
- Are you working within the discipline of economy? If not, why not? What visual effect have you created?
- How does the structure relate to other structures (bridges, buildings, other structures) nearby?
- How does your structure relate to relevant historical structures? Are you working within a tradition or are you deliberately going against it?
- Have you used other structures as a source of inspiration? If so, which ones? If not, why not?

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