TECHNICAL STANDARDS BRANCH

BRIDGE AESTHETICS STUDY

Version 1.0
Dated April 2005
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PREFACE

COPYRIGHT 2005 ALBERTA INFRASTRUCTURE AND TRANSPORTATION
GOVERNMENT OF THE PROVINCE OF ALBERTA

“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

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
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)

Why Consider Bridge Aesthetics?

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 Uzes to Nimes

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

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 short comings 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)
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

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
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

Horizontal and Vertical Geometry

Highway Crossing

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

**Horizontal and Vertical Geometry**  
**Highway Crossing**

Bridge at airport in Porto, Portugal

**Horizontal and Vertical Geometry**  
**River Crossing**

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

BF 73809E McLeod River
Horizontal and Vertical Geometry
River Crossing

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.

Peace River Bridge at Fort Vermillion (above)

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

Horizontal and Vertical Geometry
River Crossing

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
Horizontal and Vertical Geometry
Reservoir Crossing

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

Bridge crossing reservoir for Libby Dam, Montana

Horizontal and Vertical Geometry
Valley Crossing

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

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

Modern arch bridge Porto, Portugal (beside)
Horizontal and Vertical Geometry
Pedestrian Bridge

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

(For description, see Wells, 2002)

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
Superstructure Type

<table>
<thead>
<tr>
<th>Structural Type</th>
<th>Material</th>
<th>Range of Spans (m)</th>
<th>Maximum Span in Service (m)</th>
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<tbody>
<tr>
<td>Slab</td>
<td>Concrete</td>
<td>0–20</td>
<td>240, Hamana-Ko Lane</td>
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<td></td>
<td>Steel</td>
<td>30-260</td>
<td>261, Sava I</td>
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<tr>
<td>Girder</td>
<td>Concrete</td>
<td>12-250</td>
<td>235, Maracaibo</td>
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<td></td>
<td>Steel</td>
<td>30-260</td>
<td>856, Normandy</td>
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<tr>
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<td>Concrete</td>
<td>&lt;250</td>
<td>480, Greater New Orleans,</td>
</tr>
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<td></td>
<td>Steel</td>
<td>90-850</td>
<td>Nos. 1 and 2 (road)</td>
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<td>Truss</td>
<td>Steel</td>
<td>90-550</td>
<td>550, Quebec (rail)</td>
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<td>Arch</td>
<td>Concrete</td>
<td>90-300</td>
<td>305, Gladesville</td>
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<tr>
<td></td>
<td>Steel Truss</td>
<td>240-500</td>
<td>510, New River Gorge</td>
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<td></td>
<td>Steel Rib</td>
<td>120-360</td>
<td>365, Port Mann</td>
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<tr>
<td>Suspension</td>
<td>Steel</td>
<td>300-1400</td>
<td>1410, Humber</td>
</tr>
</tbody>
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(Barker and Puckett, 1987)

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

Short Span Bridges Commonly Constructed In Alberta

BF 80451 Headworks Canal south of Magrath
Superstructure Type
Medium Span Bridges Commonly Constructed In Alberta

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

Superstructure Type
Longer Span Bridges Commonly Constructed In Alberta

- Steel plate girders
- NU girders
- Box girders
Superstructure Type
Truss Bridges

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

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

Superstructure Type
Truss Bridges

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

Railway bridge in Avignon, France
Superstructure Type
Arch Bridges

- Arch bridges have a slender, attractive appearance

Seine River in Paris, France
Geres, Portugal

Superstructure Type
Cable-Stayed Bridges

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

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

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
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.

Pier Placement
Span Arrangement

(Gottemoeller, 1998)

Pier Placement
Span to Pier Height Ratio

(Gottemoeller, 1998)
Pier Placement
Consistent Proportions of Span to Height

(Gottemoeller, 1998)

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
Pier Placement
Two or More Column Pier Ratio

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

Pier Placement
Two or More Column Pier Ratio

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

Grade Separation at Wabamun
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

Abutment Placement and Height
Opening Up the View to Motorists

Visual confinement
Opening up the view
More view and safety

Hwy 1 at Lake Louise
- Open view
- No piers or abutment directly adjacent to the road

(Gottemoeller, 1998)
Abutment Placement and Height
Desirable Proportions

Ordinary

H_1

H_1 = H_2

Ordinary

S_1

S_2

S_1 = S_2

Better

H_1

H_1/C_1 = H_2/C_2

• 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)
4.2 Superstructure Shape

The shape of the bridge superstructure is determined by:

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

Superstructure Shape
4.2.1 Girder Configuration

James MacDonald Bridge across North Saskatchewan River, Edmonton

- Nicely proportioned haunched girders

Aesthetic proportions for haunched girders
(Gottemoeller, 1998)
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)

Superstructure Shape
Girder Configuration

- Increased depth at middle of main span
- Span arrangement and pedestrian cage detract from the appearance of the bridge
Superstructure Shape
4.2.2 Deck Slab Cantilever

- 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

![Image of Bow River Bridge Deerfoot Extension]

Superstructure Shape
4.2.3 Parapets

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

![Diagram of parapet proportions]

\[ \frac{D}{4} < p < \frac{D}{2} \]
\[ p > \frac{L}{80} \]

(Gottemoeller, 1998)
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 cage appears to have been designed for function alone
- Superstructure appearance would be improved with a parabolic shape

Pedestrian bridge across Whitemud Drive near 159th Street in Edmonton

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

- 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

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
Pier Shape
4.3.1 Tapered Piers

V-shaped piers with too much taper look top heavy

(Gottemoeller, 1998)

Pier Shape
Tapered Piers

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

BF 82011 196th Avenue
Over Deerfoot Trail

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

Deerfoot Trail at MacKenzie Blvd.
Pier Shape

4.3.2 Wide Base Piers

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

BF 82058 Three Sisters Creek Road / Highway 1

Pier Shape

Tapered Piers

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

BF 7740 Pembina River At Entwistle

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

BF 81802 Bow River Bridges, Deerfoot Trail Extension
Pier Shape
Wide Base Piers

- Large, solid pier
- Obstructs view of surrounding landscape

BF 73809W McLeod River Bridge At Whitecourt

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

North of BF 73809

- 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
**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

Ordinary

Better

(Gottemoeller, 1998)
Pier Shape
Varying Width Piers

- Well proportioned pier
- Staining of the pier is unattractive

BF 1402 Castor Creek

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

BF 81555W Oldman River Bridge

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
Pier Shape
Column Piers

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

BF 77750 Highway 16X

Pier Shape
Column Piers

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

Anthony Henday Drive Over North Saskatchewan River, Edmonton
Pier Shape
Column Piers

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

BF 9943 Rosebud River / CNR

Pier Shape
4.3.5 Pipe Pile Piers

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

BF 77460 Shunda Creek Bridge

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

BF 78227 Baptiste River NW, of Rocky Mountain House
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

Pier Shape
HP Pile Piers

- 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

BF 73328 Prest Creek Bridge Hwy 47
4.4 Abutment Shape

- The components of abutments should be aligned so that 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.

4.4.1 Component Alignment

- Quality concrete work
- Excellent alignment of various components
- 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
Abutment Shape
Component Alignment

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

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

BF 82011 196th Avenue Over Deerfoot Trail

Abutment Shape
4.4.2 Sloping Abutment

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

(Gottemoeller, 1998)
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

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
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

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
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

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
Colours

4.5.3 Sealers

• 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

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)
Surface Textures and Ornamentation

4.6.1 Surface Textures

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

![Image of ribs and motif](image1.png)

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

![Image of horizontal ribs](image2.png)

BF 77173W Country Hills Blvd / Deerfoot Trail

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

Surface Textures and Ornamentation

4.6.2 Ornamentation

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

![Image of artistic motif](image3.png)

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

![Image of stylized motif](image4.png)

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

BF 7740 Pembina River At Entwistle
Surface Textures and Ornamentation

Ornamentation

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.

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.

4.7 Signing, Lighting, and Landscaping
Supports for traffic lighting should be coordinated with structural features.

(Gottemoeller, 1998)

Signing, Lighting, and Landscaping

4.7.1 Lighting

• Good use of feature lighting

Ellerslie Road over Hwy 2, Edmonton
83

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 82058 Three Sisters Creek Road

BF 9943 Rosebud River / CNR

84

High quality erosion control and landscaping.

BF 82008 130th Avenue Over Deerfoot Trail In Calgary
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.

Miscellaneous Details

4.8.1 Drainage

- 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

- 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.

BF 73809E McLeod River Bridge At Whitecourt
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

BF 73809W McLeod River Bridge At Whitecourt

Grade Separation at Wabamun

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
Miscellaneous Details

Drainage

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

Miscellaneous Details

4.8.2 Utilities

- 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
4.8.3 Access

- 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.

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

BF 81556W Hwy 3 over Hwy 23 near Monarch

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

(Agottemoeller, 1998)
Aesthetically Pleasing Bridges

Belgravia Road / 116 Street, Edmonton (below)

James MacDonald Bridge, Edmonton (above)

Hwy 1 at Lake Louise (above)

Animal Overpass Structure near Banff (below)
Aesthetically Pleasing Bridges

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

Aesthetically Pleasing Bridges

Pia Maria Bridge, Porto, Portugal (Gustave Eiffel, 1877)
(For description, see Billington, 1883)
Aesthetically Pleasing Bridges

Arch Bridge in Porto, Portugal (above)

Hwy 1, South of San Francisco (beside)

Aesthetically Pleasing Bridges

Pedestrian Bridge across Memorial Drive, Calgary (above)

Pedestrian Bridge across Deerfoot Trail, Calgary (beside)
5.1 Aesthetically Pleasing Bridges That Integrate Into Their Surroundings

- Bridge relates to the surrounding architecture and landscape

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

- Bridge is integrated into the urban environment

Rhonda, Spain

Aesthetically Pleasing Bridges That Integrate Into Their Surroundings

- Bridge is integrated into its urban surroundings

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

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

(Gottemoeller, 1998)
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

Retaining Walls
6.2 Colour

- Colour of the MSE walls does not match the bridge structure or the surroundings
- MSE wall panels are the same colour as the bridge structure

BF 77260 CPR Overpass at Aldersyde
BF 81801 Dunbow Road G/S
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.

Culverts

7.1 Riprap

- Riprap is slightly deficient, but it is being stabilized by the re-growth of vegetation.
- Concrete end treatment is pleasing.
- Effectively placed riprap.
- Natural looking channel.

BF 81332 Bullshead Creek Near Dunmore

BF 75069 Hwy 36 over Irrigation Canal
Culverts
Riprap

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

BF 75069 Hwy 36 over Irrigation Canal

Culverts
Riprap

- Unusual use of riprap between the twin culverts

BF 6523 Ghostpine Creek near Huxley
A concrete transition between the headwalls would have been more appealing than using riprap.

Common concrete collar works well.

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.
7.2 Concrete End Treatment

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

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.
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

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
Culverts

7.3 Concrete Headwalls

- Concrete reflects good workmanship

Culverts
Concrete Headwalls

- Arch-Beam-Culvert with an appealing appearance

BF 2157 Rosebud River near Didsbury

BF 73920E Two Creeks Culvert on Hwy 43

Culverts

Concrete Headwalls

- 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

BF 73920E Two Creek Culvert on Hwy 43
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)

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.
8. Costs

- Structural modifications made for aesthetic reasons, excluding increases in span length

- Spans slightly longer than economical minimum to improve appearance

- Less than 2% of construction cost

- Up to 7% of construction cost

(Menn, 1990)

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
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)

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?
References