Bridge Aesthetics Sourcebook

Practical Ideas for Short and Medium Span Bridges

Draft, March 2006
Bridge Aesthetics Sourcebook

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- www.bridgeaesthetics.org/
Our Goal

- As of 2008 there were 601,470 bridges in the National Bridge Inventory (NBI).
- Of these, approximately 98% or 590,000 have spans < 300 feet.
- Our goal is to address these “Workhorse” bridges.
“Ugliness is not consciously designed into a project. It creeps in when decisions are made without considering visual consequences.”

Public Agency Official
Aesthetics shouldn’t be:
• An afterthought
• Dismissed as an inconvenience
• Intimidating

Aesthetics should be:
• Integral to the design of our bridges
• Determined through a collaborative process with all relevant stakeholders

“Efficiency, economy and elegance, all considered equally”

David Billington
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Why Consider Aesthetics?

The public is becoming ever more aware of the appearance of bridges and the effects they have in their communities. We need to respond to that concern. We can't just worry about the structure and leave the aesthetics to someone else. Every structural decision is an aesthetic decision. If a decision affects the size, shape, color or surface texture of a visible part of the bridge, it affects how people will feel about the bridge. For the same reason we would not build a bridge that is unsafe, we should not build one that is ugly. To ignore aesthetics is irresponsible.

Frequent Objections to Considering Aesthetics:

It automatically adds cost.

Most agency planners immediately associate bridge aesthetics with increased design and construction costs and additional construction time. While this is frequently the case, it is not always so. Whether it is so and the degree to which it is so varies widely depending on region of the country, owner preferences and practices, contractor capabilities, span length, size of project, community aspirations and other project specifics. If increased cost is involved, the relevant question is, does the aesthetic improvement justify the additional cost? The designer's obligation, as always, is to seek the best combination of efficiency, economy and elegance.

See Section D, Background Information, for more on costs.

Keys to Success

The shapes and sizes of the structural members themselves dominate people's impressions of a bridge. They are the largest elements of the bridge, therefore the first elements people see as they approach and the most strongly remembered. It is impossible to correct the appearance of a poorly proportioned or detailed structure by the application of "aesthetic treatments," though many have tried. There is no substitute for correctly proportioning and sizing structural members. With that in mind, the consensus on bridge aesthetics over the last century and a half can be boiled down to these basic criteria:

- Simplicity
- Good proportions with an emphasis on thinness
- Clear demonstration of how the structure works
- Fits its context/surroundings
How to Consider Aesthetics

Bridges have more than just transportation functions. They also function socially, visually, and symbolically as significant elements in their communities and environments. Every project will be different and will possess its own unique characteristics. Nevertheless, there will be some commonality in the steps the engineer can apply in considering aesthetic bridge design. Following these steps will help ensure a successful bridge that its owner and community will be proud of.

1. **Understand the Goals and the Site**

   Before a designer can start on the bridge itself, he or she must understand what the bridge is expected to accomplish, functionally as part of a transportation system and socially, visually and symbolically as part of a living community and environment. The designer must have an idea of all of the criteria that the structure must meet and all of the concerns that will act on the structure. In recent years, the Federal Highway Administration (FHWA) and many other transportation agencies have recognized that this is a broad task, requiring the coordination of many, often competing, interests. This process has been given the name **Context Sensitive Design**.

   See the Background Information section for how to use Context Sensitive Design techniques to address all of the concerns involved in a project.

The Site

The bridge site is the most important feature that will influence the configuration and hence the aesthetic design of a bridge. Bridges designed to work with and complement a site will be both functionally and aesthetically successful.

**Tip:** Go to the site at different times of day, at night and in as many different seasons as possible. There is no substitute for first-hand familiarity with the bridge site.

- What features does the bridge traverse? Bridges over canyons or deep cuts will require a structural type that may be inappropriate for a highway crossing.
Design Guidelines

The Ten Determinants of Appearance
How people react to an object depends on what they see and the order in which they see it. This means the largest parts of the bridge—the superstructure, piers and abutments—have the greatest impact. Surface characteristics (color/texture) come next, then details. Therefore, design decisions should be approached in the following order of importance.

1. Horizontal and Vertical Geometry
Before there is a concept for a bridge, the roadway geometry creates a ribbon in space that can be either attractive or unattractive. The geometry establishes the basic lines of the structure, to which all else must react. A graceful geometry will go a long way toward fostering a successful bridge, while an awkward or kinked geometry will be very difficult to overcome.

The structural engineer must work interactively with the project highway engineers during development of the project geometry to make a suitable allowance for structure depth and define features that would enhance or detract from the overall bridge appearance. A proactive approach is highly recommended since it is extremely difficult to change the project geometry during later stages.

As a guideline, the more visually challenging geometrics are also more difficult and expensive to construct, and they may result in a questionable product.

Pier placement establishes not only the points at which the structure contacts the topography but also the size and shape of the openings framed by piers and superstructure. The success of the visual relationship between the structure and its surrounding topography will depend heavily on the apparent logic of the pier placement.

The visual character of the bridge site has an influence on the structure layout and span arrangement. In rural landscapes with little visual evidence of development, the bridge design may respond to the site by one of the following approaches:

- Strong long-span sculptural elements that contrast with, but do not dominate, the landscape.

Figure C.5 – This deck arch completely spans the canyon floor and is highly transparent. The bridge and the site are complementary. State Highway 83 Bridge over Castlewood Canyon, Colorado.

- Slender elements that minimize the silhouette and are as transparent as possible may be preferable to reduce the visual impact of the project.

Figure C.6 – The substructure for this high level crossing with slender piers is virtually transparent. Meadows Parkway over Plum Creek, Castle Rock, Colorado.

While each bridge site is unique, many guidelines have been developed to consider the relationship of the span layout to the site:

- Examine the ratio of the span to vertical clearance or height. It may be appropriate to hold this ratio constant throughout the bridge. As the vertical clearance diminishes going away from the main span of the bridge, smaller side spans may be warranted. In general, the span should be greater than the height.
The Ten Determinants of Appearance

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#1 Horizontal and Vertical Geometry

- Bridge geometry is often very complex.
- Few bridges
  - Are located on straight alignments
  - Have flat horizontal deck surfaces
  - Have supports oriented at right angles to the superstructure
  - Have constant cross section widths
  - Are located on a flat site
• Multiple variations in structure geometry may result in visually unappealing bridges
• Rigid frames and slant leg frames can create gateways and portals

http://www.hpcbridgeviews.com/images/colorado-RichmondHill.jpg
Combining multiple superstructure types can result in visual discord and a lack of integrity.

Combination of cast in place concrete, steel and precast concrete superstructures on one elevated interchange.
#3 Pier and Span Arrangement

- Structure depths are proportional to spans
- Shorter spans have thinner superstructures with the visual emphasis on the substructure
#3 Pier and Span Arrangement

- Longer girder spans have deeper superstructures, which become dominant visual features.

Deep structure relative to height above grade results in a massive superstructure appearance.
#6 Pier Shape

- Single column hammerhead piers provide for visual transparency on narrow bridges

Post tensioned pier caps result in reduced cap dimensions and slender appearance
Combining pier types and shapes results in visual discord.
• Short abutments combined with terracing and landscaping visually soften the connection between a bridge and its site
Color

- Is relatively inexpensive
- Is subjective
- Is much more complex than most people realize
Color Options

- Reflecting local culture
Texture

- Material selection can add both texture and color to the bridge.
Lighting

• Practical Considerations
  – Maintenance
  – Lamping and Energy
  – Physical Constraints
  – Color Rendering
  – Wildlife Concerns
  – Light Pollution
Lighting – Aesthetic Considerations

• Color rendering – HPS and MH
Background Information

1. Fundamentals
Aesthetic reactions are created by the eye and brain at the moment an entity is seen. The aesthetic value of a bridge is realized subconsciously—it is not created by words. Thus words cannot completely reflect the phenomena that we are trying to describe and evaluate. Nevertheless, words are a necessary part of our communication and are often used to describe or explain an aesthetic reaction after it has occurred. In order to use words to communicate about aesthetics, we need a commonly understood terminology. The following terms are borrowed from other visual design fields and applied to bridge and highway design.

a. Visual Characteristics
To be able to talk about an object, it is helpful to have names to describe its visual characteristics.

or other nearby objects can also help illuminate the underside of a bridge and influence our impression of it.

b. Visual Qualities
Visual qualities result from the arrangement of the visible elements of an object and are used to evaluate a visual composition. Visual qualities are intangible; they are perceived characteristics that exist only in the mind of the evaluator.

Order
Order is the arrangement of design elements so that each element has a clear place and function with no visual confusion.

This bridge is a confusion of girders and piers—it is hard to tell what supports what.

The repetitive plan shapes and continuous girder depth give this bridge a sense of order.

Proportion
Proportion is a method of creating a sense of order by assigning appropriate relative sizes to the various elements. The goal is appropriate proportions.
Background Information

1. Fundamentals (*Aesthetics 101*)
2. Achieving Context Sensitive Designs
3. Community and Stakeholder Involvement
4. Practical Tips for Historic Bridges and Settings
5. Working with Architects, Landscape Architects and Artists
6. Aesthetics and Cost
## Bridge Aesthetics Sourcebook

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<td>Frederick Gottmooalor, Joseph Showars, Eric Yarmack</td>
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<td><strong>Design Guidelines</strong></td>
<td>Joseph Showars, David Traini, Faith Baum, Eric Yarmack</td>
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<td>Frederick Gottmooalor, Mary McCahon, Robert Shulock, Dean Van Landuyt, Eric Yarmack</td>
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<td><strong>Example Bridges</strong></td>
<td>Dean Van Landuyt</td>
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<td><strong>Bibliography</strong></td>
<td>Tom Morraala</td>
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<tr>
<td><strong>Review and Comment</strong></td>
<td>Faith Baum, Alan Matajowsky, Mary McCahon, Mary Ann Nabor, Robert Shulock, Bryan Spanglar, Dale Thomas</td>
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Bridge Aesthetics Workshop
Practical Ideas for Short and Medium Span Bridges

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Manager, Structural Engineering

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Consulting Engineers
• **Past Workshops**
  IBC – June 2009, Pittsburgh, PA
  Rutgers – April 2010, Piscataway, NJ
  PENNDOT – April 2010, Harrisburg, PA

• **Upcoming Workshops**
  IBC – June 2010, Pittsburgh, PA
  TRB – January 2011, Washington, D.C.
Workshop Agenda

- Introduction
- Economy, Efficiency and Elegance
- Sourcebook Design Guidelines
- Break
- Color, Texture, and Lighting
- Historic Considerations
- Design Context
- Lunch
- Design Exercise
- Break
- Closing Remarks
Design Groups at Work
Bridge Aesthetics

It so happens that the work which is likely to be our most durable monument, and to convey some knowledge of us to the most remote posterity, is a work of bare utility; not a shrine, not a fortress, not a palace but a bridge.
— Montgomery Schuyler, 1883, writing about John Roebling's Brooklyn Bridge

This is the home of the Bridge Aesthetics Subcommittee of the Transportation Research Board.

The Subcommittee on Bridge Aesthetics is a subcommittee of the Committee on General Structures (AFF10) of the Transportation Research Board, which is part of the National Academies, "advisors to the nation on Science, Engineering and Medicine". The site has two target audiences, transportation agencies and their consultants, and members of the general public who would like to see better looking bridges in their own locales.

Purpose and Goals

The aesthetics of large bridges often receive much attention because of their size and prominence in the landscape. However, the numerous "everyday" bridges, such as highway overpasses and small river crossings are usually approached as purely technical problems, with little thought given to their appearance. The public has begun to realize that these bridges, taken together, can have a greater influence on the visual quality of the transportation environment than the landmark bridges. They are insisting that transportation agencies improve the appearance of their everyday bridges.

In response to this interest the General Structures Committee of the Transportation Research Board (TRB) and the Subcommittee on Bridges and Structures of the American Association of State Highway and Transportation Officials (AASHTO) created the Subcommittee on Bridge Aesthetics.
Bridge Aesthetics Presentations

2009

The Federal Role in Highway Design and Aesthetics: A Historical Perspective
Bruce E. Seeley, Michigan Technological University

Cost of Bridge Aesthetics from a Department of Transportation Perspective
Dean Van Landuyt, Texas Department of Transportation

Context-Sensitive Sustainable Solutions Meet Economy, Efficiency, and Elegance in Bridge Design
Robert J. Shulock, Hatch Mott MacDonald

Route 52 Viaduct: Ribbon in the Sky
Robert Bevilacqua, Michael Baker Jr., Inc.

Defining Subjective Context of Bridge Designs
Igor Tognoli, T V I in International

Connective Sensibilities: Pedestrian Bridge Design Concepts
Tom Scherbo, HNTB Architecture

Bridge Architecture of the 21st Century: A Bridge Architect’s Perspective
Paul D. Kindermann, Washington State Department of Transportation

Contextual Bridge Design
Thomas Pietrowski, AIA, SARP, H2L2 Architects | Planners LLC

2008