



bridge aesthetics

sourcebook

Practical Ideas
for Short- and
Medium-Span
Bridges

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Credits for Sourcebook on Bridge Aesthetics

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Sourcebook

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► Preface

This Sourcebook presents guidelines for improving the appearance of short- to medium-span bridges (those with spans up to about 300 feet). These structures constitute the great majority of bridges and are often referred to as “workhorse” bridges. The intended audience includes all of those engaged in advancing transportation projects: engineers, administrators, planners, environmentalists, and the general public. The goal is to encourage a common understanding of and terminology for bridge aesthetics that will encourage interaction among these individuals and result in more attractive and context sensitive bridges throughout the United States.

The Sourcebook begins by explaining why it is necessary to consider bridge aesthetics. It then provides practical, easy-to-apply ideas for design engineers and other professionals to use in developing elegant designs for the typical bridges on which they work every day.

This Sourcebook has been prepared by the Subcommittee on Bridge Aesthetics (AFF10(2)) of the Transportation Research Board (TRB). Full credits may be found at the end of the Sourcebook. The Sourcebook was approved by the subcommittee’s parent committee, TRB’s General Structures Committee (AFF10), at the January 2010 meeting of TRB.

The Sourcebook was presented for comment to the Subcommittee on Bridges and Structures (SCOBS) of the American Association of State Highway and Transportation Officials (AASHTO) at its May 2008 meeting. No comments were received from SCOBS members, so the Sourcebook was placed on the agenda of the May 2010 meeting for approval by SCOBS. Prior to the meeting, during preliminary consideration of the Sourcebook by the T-9 committee of SCOBS, one SCOBS member presented comments. This final version of this Sourcebook reflects responses to those comments. SCOBS approved it for AASHTO publication by electronic ballot in September 2010.

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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

Chapter 1

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 cannot 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. Of course, the first obligation is to build a bridge that is safe and meets the client's functional requirements. The designer's obligation then is to satisfy those requirements with the best combination of efficiency, economy, and elegance.

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, then the relevant question is does the aesthetic improvement justify the additional cost? We make such judgments every day when buying a car or a suit. We can make them about bridges, too. If the affected community is involved, we can take advantage of their guidance as well. See Chapter 4, Background Information, for more on costs.



Figure 1-1 Often simply paying attention to proportions and details can result in an attractive bridge with no increase in cost. Canyon Creek Bridge, Anchorage, Alaska.

People cannot agree on what looks better

This is also not true. People have agreed for centuries on which paintings look better, which symphonies sound better, and which buildings are more attractive. A consensus has existed since the nineteenth century on which bridges look better and why. That consensus is embodied in this Sourcebook.



Figure 1-2 The aesthetic quality of Robert Maillert's Salginatobel Bridge was recognized by New York's Museum of Modern Art in 1949 and by many others since. Shiers, Switzerland.

My client/boss won't let me This Sourcebook presents a strong case that you may share.

I don't know how This Sourcebook will provide you with the knowledge and tools that you need.

What's the goal here?

The purpose of this Sourcebook is to make designers and all others involved in transportation development more knowledgeable about bridge aesthetics by providing a clear description of principles and terminology, supported by practical and easy-to-apply examples. The ultimate goal is to make every bridge an efficient, economical, and elegant feature in its community and environment by giving meaningful visual expression to loads, equilibrium, and forces.



Figure 1-3 An elegant feature in its environment. Brainerd Bypass over the Mississippi River, Brainerd, Minnesota.

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 past 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, and
- ▶ Fitting its context/surroundings.



Figure 1-4 Simplicity and thinness are often enough. I-95 over Pulaski Highway, Baltimore, Maryland.

Only after all of that is right, think about surface textures and ornamentation.

The final step is to look back over the entire design to ensure that choices made at later stages are still consistent with earlier decisions.

Aesthetics, like every other field of endeavor, has its own terminology. See Section 4.1, Fundamentals, for more on the use of words.

TIP

Chapter 2

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.

2.1. 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, not only functionally as part of a transportation system but also socially, visually, and symbolically as part of a living community and environment. The designer must have an idea of all the criteria that the structure must meet and all 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 Section 4.2 for how to use Context Sensitive Design techniques to address all of the concerns of those involved in a project.



Figure 2-1 Community uses under a bridge may be more important than transportation uses. 17th Street Causeway, Ft. Lauderdale, Florida.

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.



Figure 2-2 Sometimes the appearance at night is as important as during the daytime. Broadway Bridge, Miami, Florida.

- 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.



Figure 2-3 Rock foundations permit arch bridges. Reichenau Bridge, Switzerland.

- ▶ What are the widths and design speeds of the roadways being carried or traversed by the bridge?
- ▶ What types of traffic will the bridge be expected to carry or traverse? Bridges that carry pedestrian traffic will require appurtenances scaled to people more than a bridge that carries only interstate highway traffic.



Figure 2-4 Having pedestrians on a bridge suggests the addition of overlooks. Upper Middle Road over 16 Mile Creek, Oakville, Ontario.

- ▶ Are there clearance envelope requirements that can affect the layout of the bridge?



Figure 2-5 Marine channels and riverbank uses often affect bridge clearance requirements. Deutsch Bahn Railroad over Humbolthaven, Berlin, Germany.

- ▶ Is there a type of geology or in-situ soil conditions that will favor a certain type of foundation or substructure layout?
- ▶ Are you replacing an existing bridge? Is it historic? If so, is a formal historic review process in place? What are its results?

See Chapter 4, Background Information, for more information about historic review processes.

The Context

A structure in an urban setting will have different requirements than one in more rural locations, especially if there will be pedestrians nearby or below. The bridge should fit into its surroundings.

What is the nature of nearby land uses? Buildings? A bridge in an industrial area may warrant a different level of aesthetic design than a bridge located in a park or public place. Adjacent buildings and structures might lend existing architectural features that can be echoed in the bridge.



Figure 2-6 Nearby land uses must be considered. Clearwater Memorial Causeway, Clearwater, Florida.

- Are nearby land uses historic or is the area historic? Is a formal historic review process in place? What are its results?
- What are nearby environmental features? Will they affect the bridge in some way?
- What is the visual environment? From which viewpoints will the bridge be seen? By whom? How will any of this change with the season or time of day? Because of their size and conspicuous placement, bridges are often seen as structures that define a community. They can even be centerpieces around which a community will be built. The viewpoints from which the bridge will be seen and the view sheds that are affected by the bridge will be important.

TIP

Take lots of photos and study them.

- How will the topography influence the bridge layout? Some examples are:
 - A high profile crossing a canyon or deep valley or a side hill alignment that is visible from a distance.



Figure 2-7 The roadway profile for this bridge needed to provide for clearance over a railroad track and made the bridge prominent in relation to the tops of buildings in the surrounding town. Skillful use of color blended this bridge into its surroundings. Perry Street Bridge, Castle Rock, Colorado.

- A depressed highway section passing under a bridge.



Figure 2-8 This community entry is in a depressed roadway section and passes under a bridge. The use of massive abutments combines with the roadway side slopes to form a gateway. Meadows Parkway Railroad Overpass, Castle Rock, Colorado.

- A bridge located at the top of a crest curve on a ridgeline which frames views of the distant landscape.
 - A flat coastal plane with minimal ground relief or open water. Bridges in this environment are often seen from a distance and in silhouette. The overall composition of forms may be the most defining visual image.
- Is the bridge part of a larger project, an interchange or corridor? Will the bridge have to follow a previously established theme?



Figure 2-9 Albuquerque's Big I interchange has a theme covering MSE walls, standard details, and colors, developed with community input.



The Community and Other Stakeholders

In every project, there are influences outside the control of the engineer which may affect the design and configuration of a bridge. Potential stakeholders include communities, elected officials, businesses, public agencies, and the people that will live with the bridge after it is constructed.



Involve all concerned parties from the very beginning, before putting pencil to paper. The process will run more smoothly and the final result will address the most strongly held desires of the community and meet with their approval. See Section 4.3 for more on effective community involvement.

- Are there communities, businesses, or individuals nearby who are concerned about the bridge? What are their concerns?
- What is the community's attitude toward the bridge? Some communities see themselves as historic enclaves and view a bridge as a chance to restate local architectural traditions. Other communities present themselves as forward-looking, stepping confidently into the future. These communities will be interested in a state-of-the-art bridge that embodies their aspirations.
- Are there other agencies that will review or comment on the bridge? What are their roles and opinions?
- Will an artist, architect, or landscape architect be involved in the project?

See Section 4.5 for tips on working with these professionals.

Owner Requirements

Owner requirements are most commonly applied by way of the owner's design standards and policies. The designer needs to recognize that, because every bridge is unique, some of the standards and policies may not completely apply to this particular project, and the owner should be made aware of that.

- Is there a previous feasibility study, Environmental Assessment, Environmental Impact Study, or other document that will direct the design? What commitments have been made pursuant to those studies?
- Is there a formal project need statement that defines what the intended result of the project is?



Tip: The project need statement should be referred to periodically so that scope creep is avoided and the design remains focused.

- ▶ Does the owner have existing aesthetic design guidelines? Are they appropriate for this bridge?
- ▶ Does the client have a department or bureau that deals with landscape, urban design, and bridge aesthetic design issues? Will they be involved in this project? What are their opinions?
- ▶ What are the cost limitations that have to be considered when developing the bridge aesthetic design recommendations?

An aesthetically successful bridge design will most often result when the engineer produces an economical design that expresses the function of the bridge and does not put the primary emphasis on ornamentation.



2.2. Develop a Design Intention/Vision

Make a written list of all of the factors that will influence the design of the bridge in their order of importance. Get comments from all involved parties and make appropriate revisions. Get it approved by the owner. This will be the basis of all future design work.

2.3. Complete a Conceptual Engineering Study

Conceptual Engineering is the stage when all of the plausible options (and some not so plausible) are examined at a rough level of precision with consideration of the design intent, various materials, size and form of major members, constructability, project cost, life cycle economics, and appearance. The most promising ideas are then taken to greater levels of refinement. Solutions will emerge that fit the requirements of the site and that are roughly equivalent in terms of structural efficiency and economics. These solutions can then be worked to best appeal to the aesthetic sensibilities of the designer, the owner, and the public.

This phase is too often short-circuited by an assumption that a standard bridge that has worked well at another location will work well here. That often means hammering a square peg into a round hole, resulting in a suboptimal bridge and unnecessary construction cost that far outweighs the cost of Conceptual Engineering. Every bridge deserves a design; smaller bridges require the application of engineering arts to the same level as do large bridges. Settling on a standard bridge type before fully understanding its requirements and opportunities shortchanges both the bridge and the public.



Figure 2-10 A Conceptual Engineering Study for the Seattle LRT Viaduct produced a design that both reduced cost and improved appearance compared to a standard design.

Involve All Stakeholders in Identifying Options

Communities and review agencies will have opinions about what types of bridges are appropriate. Testing their ideas in the Conceptual Engineering phase will avoid the need to go back and look at their options later when they object that their ideas are not being considered. It will also encourage their support of the final decision. It may even result in the adoption of a superior but previously unconsidered bridge type.

Make sure all involved stakeholders know all of the implications of the alternatives, including comparative costs. That will facilitate their support of the final decision.

TIP



Figure 2-11 Sometimes the best response to an unconventional problem is an unconventional solution. Interchange on Route A35 near Basel, Switzerland.

Test Promising Options with 3D Views Taken from the Important Viewpoints

Even seasoned design professionals have a hard time anticipating all of the visual implications of a design from 2D engineering drawings. Nonprofessionals sometimes have an even harder time.

Include drawings made at night and in various seasons, especially in northern locations where snow is on the ground for a large part of the year.

Most CAD software has 3D modules that make this quick and easy to do. The best approach is to place 3D drawings developed in CAD over photos taken from the most important vantage points.

TIP



Figure 2-12 A photo simulation showing how a proposed bridge will affect an existing marina. Proposed crossing of the St. Croix River, Stillwater, Minnesota.

Evaluate Promising Options for Constructability, Maintainability, and Costs

Through the generation and review of multiple alternatives, the process will narrow down to the concept that best satisfies efficiency, economy, and elegance while still achieving the design vision. The evaluation of efficiency and economy of the various alternates can be approached through normal engineering techniques, with the added provisos that 1) the evaluation of efficiency must include both the efficiency of the structural type for the site conditions and the efficiency of the structural form itself and, 2) the evaluation of economy must include consideration of life-cycle costs. The evaluation of elegance can be approached by reference to the aesthetic design guidelines contained in Chapter 3. Once these evaluations are made, the alternative that best satisfies all of the design criteria can be identified. The product of Conceptual Engineering is the Type, Size, and Location report.

Select the concept that best integrates efficiency, economy, and elegance while achieving the design vision.

TIP