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9 Bridge Aesthetics

9.1 General

Aesthetics is an important consideration in the design and construction of highway systems. The public's interest in promoting their local communities through the use of aesthetics has grown over the years. In response, the Iowa Department of Transportation has taken a more proactive approach in designing structures that enhance or blend in with their environment. Because bridges play an important role in our visual environment, designers must be aware that bridge details have visual consequences. Additionally, addressing aesthetic considerations at the front end of the design process will produce a better result than adding them at the end.

Two states have taken the lead in the area of bridge aesthetics and have prepared highly detailed design manuals. In 1993, the Maryland DOT released the "Aesthetic Bridges Users Guide". This guide and a similar one published by the Minnesota DOT in 1995 entitled "Aesthetic Guidelines for Bridge Design" present detailed information about the how, where, and when of aesthetic bridge design. The guides are good resources that illustrate how to determine proper structural form and proportions for bridges in both urban and rural settings.

9.1.1 Policy overview

Not all structures will warrant aesthetic details. District personnel will make the final determination of the extent of aesthetic enhancement for projects under their jurisdiction. Consultant designers shall contact the Aesthetic Bridge Specialist at the Office of Bridges & Structures for direction on the level of aesthetics required on a structure before beginning design.

When a structure has been identified for aesthetic treatments, the Office of Bridges & Structures will recommend a level of treatment based on a percentage of the project costs that is acceptable to the District Office responsible for the project. Typically, aesthetic costs have been 1 to 7 percent of the overall project costs depending on the visibility and special design requirements of the structure.

The Office of Bridges & Structures will direct the application of all aesthetic bridge designs.

9.1.2 Design information

Reserved

9.1.3 Definitions

Articulation is the shaping of a bridge or bridge component.

Baseline refers to the appropriate least cost solution given normal project parameters.

Concrete Stain is a semi-opaque penetrating medium for coloring cured concrete.

Concrete Colored Sealer Coating is an opaque, high silicone content pigmentable sealer.

Concrete Integral Colorant is a coloring pigment added to concrete mix prior to placement.

Context refers to the physical, social, historical, economic and political environment.

Context Sensitive Design is a design process that acknowledges project constraints and design opportunities that go beyond the normal scope of project planning and development, including consideration of the social, environmental and cultural environments.

Form Liner is a foam, plastic or rubber form insert used to create texture.

Mitigation is an improvement intended to offset or alleviate negative project impacts.

Reveals refer to narrow and usually shallow rustication lines.

Rustication refers to shallow surface features in concrete, such as grooves and recesses.

Texturing refers to a varied concrete surface treatment over broad areas.

Theme is the basic design premise or principle applied to a group of elements.

9.1.4 Abbreviations and notation

CSD/CSS, context sensitive design/context sensitive solutions
FHWA, Federal Highway Administration
Iowa DOT, Iowa Department of Transportation
OBS, Office of Bridges and Structures
OD, Office of Design
OLE, Office of Location and Environment
SHPO, state historical preservation office
TS&L, type, size, and location

9.1.5 References

Committee on General Structures, Subcommittee on Bridge Aesthetics, Transportation Research Board (TRB) and the National Research Council. *Bridge Aesthetics Around the World*. Washington, 1991.

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Gottemoeller, F. *"Bridgescape: The Art of Designing Bridges"*. John Wiley & Sons, 1998.

Federal Highway Administration (FHWA). *Flexibility in Highway Design*. Washington: 1997

Texas Transportation Institute Research Report 2113-3. *Guidelines for Aesthetic Design in Highway Corridors: Tools and Treatments for Texas Highways*. Texas: Texas Transportation Institute and the Texas Department of Transportation, 2001.

9.2 Public Involvement

When aesthetics are planned for a structure in or near a defined community, local community members are encouraged to participate in an aesthetics advisory group to aid the Iowa DOT in the course of aesthetic concept development. The Iowa DOT retains final decision-making authority on any aesthetic projects. Any questions about implementation of this policy shall be directed to the OBS.

The extent of public involvement is tied to the Aesthetic Level Classification of the project [BDM 9.4] and is managed by District Office staff. Aesthetic advisory groups should generally be formed for Level "A" and "B" bridges, may sometimes be appropriate for Level "C" bridges, but should not be used for Level "D" bridges. Except for significant corridor projects or for signature bridge projects, local community advisory or beautification groups should be limited to ten (10) non-DOT staff participants or fewer. District

Office staff shall be relied upon to ensure that interested, representative individuals are offered the opportunity to participate in such groups.

Oftentimes, local public interest in a bridge construction project will generate the inclusion of aesthetic enhancement during the planning and budgeting process [BDM 9.3]. Evidence of this is usually found in the project description within the project envelope. (The project envelope contains a complete collection of project-related information, and is kept in the OBS. Consultants may request copies of items from the project envelope for use as reference material. Consultants are advised to send pertinent information and correspondence regarding the project to the OBS for inclusion in the project envelope). On occasion the inclusion of aesthetic treatments can occur later in the process of developing plans for the project. In these cases, the designer is advised to make inquiries into the possibility that the project could eventually include enhancements. Consultant designers shall contact the OBS. In-house designers should contact the Aesthetic Bridge Specialist or the Assistant District Engineer to confirm the intention of including aesthetic enhancements in the design plans. All correspondence regarding aesthetics in relation to the project should be entered into the project record by the designer.

Projects that include a public involvement component will often have a public process which may parallel the project's engineering design effort for a time. This will usually occur during the preliminary and early final design phases of the project. It is important for the designer to remember that there may be periodic approvals to be gained from a local advisory group. Certain milestones may be achieved, beyond which the designer may not be able to continue without first receiving word from District personnel that approvals have been granted for the current design concept. Design work may be held up for some time before being allowed to proceed. The designer shall avoid getting ahead of the public involvement review and approval process, since the risk of rework or redesign is increased.

9.3 Establishment of an aesthetic project

Only selected projects will receive aesthetic enhancement. There are a number of different ways by which a project is identified for enhancement. The following sub-articles list some typical examples of this process, but should not be considered a complete list of the possible mechanisms for including aesthetics.

9.3.1 Initiation by district office

The initiation of an aesthetic project by the District office will be documented in the project description. This documentation can be found in the project envelope. When the addition of aesthetic enhancements occurs after the project description is written, the information governing the proposed enhancements may arrive in the OBS through other channels, such as directly from the District office to bridge office personnel. The designer shall consult with the Section Leader to verify the inclusion of aesthetic enhancements before beginning any design work on the project.

District personnel will make the final determination of the extent of aesthetic enhancement for projects under their jurisdiction.

9.3.2 Identification by Office of Bridges and Structures

In some cases, the designer or other personnel in the OBS may propose that a project be considered for aesthetic enhancement. This can occur when it becomes apparent to OBS personnel that the project is likely to attract significant public attention, or is subject to the parameters established by the Aesthetic Level Classification system used by OBS [BDM 9.4].

Even a type, size and location (TS&L) plan can present clues to the designer that a project may be a candidate for enhancements. The bridge’s location in or near an urban area would be readily apparent in the information provided on the TS&L, and may indicate that aesthetics could be warranted. A field exam may raise the preliminary bridge designer’s awareness of important indicators immediate to the project site, such as unique contextual issues [BDM 9.5.1 and 9.5.2].

The District office should be contacted as soon as possible after the project has been identified by OBS as a candidate for aesthetic treatment. District personnel will make the final determination of the extent of aesthetic enhancement for projects under their jurisdiction.

9.3.3 Projects involving signature and historic bridges

In most cases, replacement or rehabilitation of a signature or historic bridge will result in some consideration of aesthetic or other enhancement of the new bridge. A “signature” bridge could include any bridge with a unique structure type, either in an urban or non-urban area. Regardless of whether or not an historic bridge is listed on the National Register of Historic Places/Structures, its replacement will likely draw attention from public citizens or groups concerned about its loss. Bridges listed on the Historic Register will need to be addressed by the Office of Location and Environment (OLE), which will make the necessary contacts of personnel at the State Historical Preservation Office (SHPO). Keep in mind that aesthetic enhancements can become important contributions to mitigate the loss of the historic structure.

9.4 Aesthetic level classifications and cost guidelines

Although all bridges deserve a minimum level of aesthetic consideration, some structures will warrant additional attention. With this in mind, our office has developed a classification system, designed to relate the visibility and importance of a structure to an appropriate level and cost of aesthetic enhancement.

Bridges will be classified into one of four enhancement categories: A, B, C, or D level bridges.

9.4.1 Level “D” bridges

Level “D” bridges are designated as lower visibility structures. For example, this category includes rural bridges over ditches or small streams. Because of their lower visibility, the need for aesthetic details may be limited, as may be the budgetary commitment made to fund any included enhancements. There will typically be no public involvement in the design of Level “D” bridges.

9.4.2 Level “C” bridges

Level “C” bridges may include typical overhead standard bridges and the need for aesthetic details shall be determined on a case-by-case basis by the District Office. Project budget increases for enhancements in this category will generally be between 1 and 5 percent of bridge construction costs. There will typically be little or no public involvement in the design of Level “C” bridges except at the discretion of the District Office.

Figure 9.4.2. Level "C" bridge examples in Iowa

Consultants shall contact the Aesthetic Bridge Specialist at the OBS for direction on aesthetic design details to be included in the design plans.

9.4.3 Level "B" bridges

Level "B" bridges may include bridges located in or near urban environments, along heavily traveled corridors, in resort/recreation areas, and in commercial areas where there is a high degree of exposure and/or there have been public requests for enhancements. Project budget increases for enhancements in this category will generally range from 3 to 10 percent of anticipated bridge construction costs. The usual target increase for aesthetics in this category is 5 percent of overall bridge cost.

If aesthetic details are to be incorporated then public involvement considerations will likely need to be taken into account early in the planning process if there is enough public interest. Public involvement may continue into the preliminary design phase in some cases.

Figure 9.4.3. Level "B" bridge examples in Iowa

Level "B" bridges will always be considered for additional aesthetic details. Occasionally, it will be appropriate to use an existing design precedent as a starting point for the development of aesthetic concepts. Nevertheless, it is likely that the development of new, unique details will be required.

Consultants shall contact the Aesthetic Bridge Specialist at the OBS for direction on aesthetic design details to be included in the design plans.

9.4.4 Level "A" bridges

Level "A" structures include bridges with unique structure types, some major river crossings or other highly visible structures, and any historic bridge replacement project. Structures may also be designated as Level "A" when they are located in specific portions of interstate corridors such as I-74 in the Quad cities or I-235 in Des Moines.

Examples of level "A" bridges are the Des Moines River bridge at Keosauqua, the cable stay bridge over the Mississippi river in Burlington, Iowa, the new pedestrian bridges over I-235 and the unique Lake Okoboji Bridge in northwest Iowa. Virtually any pedestrian-only or bicycle trail bridge, regardless of location, should be considered a Level "A" structure. Project budget increases for enhancements in this category will generally be between 5 and 15 percent of anticipated bridge construction costs.

Figure 9.4.4. Level "A" bridge examples in Iowa

There will likely be significant public involvement both early in the planning phase and throughout the preliminary design phase. Several review meetings with a community advisory group are also likely to occur, with the expectation that feedback and input received will noticeably affect the course of the project's design.

Level "A" bridges will always be considered for additional aesthetic details. Development of unique features and details is very likely to be required for Level "A" bridges. Consultants shall contact the Aesthetic Bridge Specialist at the OBS for direction on aesthetic design details that will be developed and included in the design plans.

9.4.5 Cost

Enhancement cost is figured as a percentage of structure construction costs beyond what is necessary to build a bridge that meets the project requirements in terms of roadway geometry, structural capacity and other functional needs. Do not include special or unusual cost items such as staging cost increases in the basic bridge cost estimate, as these items will artificially decrease the cost of the enhancements when figured as a percentage of bridge cost. Generally, a prestressed beam type bridge with standard barriers and railings will be considered the basis for estimating the cost of a conventional or baseline bridge.

Exceptions should be made in the case of replacements of existing bridges that have unique features. Unusual or unique features on such bridges will, in most cases, increase the baseline bridge cost estimate for the replacement. For example, when replacing an existing bridge which has a painted steel picket railing, a chain link fence should not be used as a baseline pedestrian railing cost item.

When a local community requests project enhancements that go beyond the Iowa DOT's budgetary commitments to the enhancements, a cost participation agreement may be executed for the local government to pay the excess costs. In such cases the District will initiate agreements with the appropriate local government agencies. These agreements can be used for aesthetic treatments such as city street lighting, shared use path lighting, and other shared use path features such as benches or lookouts, aesthetic railings, and community identity features. The Iowa DOT may also assist the local municipality in locating other funding sources for the enhancements. District personnel will make the final determination of the acceptable cost of aesthetic enhancement for projects under their jurisdiction.

9.5 Aesthetic design guidelines

9.5.1 Aesthetic and context sensitive design

The final built form of an aesthetic bridge may be determined by an overriding design concept, theme or organizing idea. The background principles affecting the design of the various components of the bridge

will likely be different for each unique bridge location. It is therefore impossible to enumerate all the possible concepts or themes in this manual, as they are unlimited in number and description. It is possible, however to list some of the likely influences that may help to establish the design concept for the project. A thorough investigation into each of these influences is a task that can prove rewarding for virtually any project, regardless of its location. This is also a task that can be made much easier by relying on local participants for their uniquely regional insight.

Some possible influences on design concept/theme include:

- Architectural context
- Historical context or events
- Natural environment
- Geographic location
- Existing aesthetic guidelines for interstate corridors
- Nearby infrastructure
- Presence of pedestrians
- Viewing opportunities (or lack thereof)
- Community identity and/or goals
- Tourism opportunities
- Commercial interests
- Future development planned

9.5.2 Context sensitive design/context sensitive solution

The surroundings of the bridge should be taken into thorough account before attempting to incorporate any kind of enhancement treatment into the design. The general character of the surroundings - scenic, rural, semi-urban, urban - are a good starting point. The aesthetic treatment of an urban bridge will usually be quite different from that of a rural structure. The number and position of potential observers of the bridge is a related area of inquiry that can begin to inform the designer about the kinds of treatments that can be effective once built. If the bridge is built over a roadway, the speed of traffic will be an important factor in determining which enhancements are appropriate. For example, color can have great effect for both slow- and fast-moving traffic, but fine rustication or texturing of concrete surfaces may be lost on the freeway motorist and may be more effectively employed on bridges observed by slow-moving traffic and pedestrians.

Consult the References article [BDM 9.1.5] for more information and guidance about the analysis of project context.

“Placemaking” is a term used by architects and urban designers to describe the effort to make a memorable place within an urban landscape. Bridges in both urban and rural settings can aspire to establish a sense of place in the same way as a building, a public art installation, a park or an urban square. Place can be established through special accommodation of pedestrian or bicycle traffic, and then incorporating design elements that only those slow-moving observers can fully appreciate. It can be done through architectural manipulation of the piers, abutments and railings of the structure to create a unique vision that reflects the aspirations of the community. It can also be done by making great effort to fit the structure into its immediate context, blending it seamlessly with surrounding streetscape or thoroughfare. One cannot create a sense of place by ignoring the context and designing a standard bridge, or even a standard aesthetic bridge. Aesthetic design should not be begun without thought about where the bridge is to be built, what is nearby, and who will use and observe it upon its completion.

9.5.3 Basic aesthetic guidelines (preliminary and early final design)

There are some features of visually pleasing bridge structures that have been repeatedly identified by numerous publications on bridge aesthetics. The following are discussions of each, but should not be considered complete documentation of the subject matter. The References article [BDM 9.1.5] contains several good sources of detailed information on these topics.

9.5.3.1 Long, slender appearance

It is almost always best to enhance the appearance of the basic bridge structure by ensuring that its details allow for the longest and most slender appearance. This can be achieved through careful span arrangement, reduction in the number of supports, maximizing the distance between supports, and using the shallowest beam possible for the span. The designer may even consider using shorter barriers, when allowed.

Changes in depths of beams on adjacent spans should be avoided, when possible. Concrete bridges should employ the same depth of beam for all spans. Steel bridges should be carefully designed so that changes in girder depth are logical in appearance, and haunched depth changes should generally be favored over abrupt changes in girder depth.

See BDM 9.5.4.1 for a discussion of recommended span to depth ratio targets. Keep in mind that structural guidelines and available beam depths may ultimately control superstructure depth.

Note in Figure 9.5.3.1 how the extension of slab lines through the wing, rustication on the barrier, and elimination of the pier end diaphragm help the bridge to appear longer.

Figure 9.5.3.1. Bridges with long, slender appearance

Horizontal lines of structure should be made continuous or to appear continuous. Details that break the superstructure's long horizontal lines - such as pier end diaphragms - should be avoided. Carrying the slab edge lines through the abutment wing extension and wing is another effective technique toward maximizing the bridge's apparent length.

9.5.3.2 Equal and/or balanced span arrangement

When laying out a structure's span arrangement, it is important to consider the overall visual effect of the spans, and to avoid thinking only about each span individually without regard to the whole.

When a single structure contains spans of different lengths, care should be taken to achieve symmetry in the elevation of the bridge if it is to be viewed from below. If symmetry is not achievable, the layout should be studied carefully for other logical organizing principles. Visual balance can be achieved in an asymmetrical span arrangement. Consult References [BDM 9.1.5] for more detailed information on asymmetrical and other atypical span layouts.

9.5.3.3 Wide overhangs

Wide overhangs cast deep shadows on bridge beams, which can exaggerate the apparent slenderness of the structure. A 3'-0 slab overhang dimension (from the centerline of fascia beam to edge of slab) should be considered a minimum.

9.5.3.4 Reduced column count for multiple-pier structures

Unless the column count is somehow dictated by the pier's aesthetic design concept, it is generally best to design piers with the least number of columns. T-pier or wall pier configurations may be considered on some over-land bridges with multiple spans, in order to decrease the total column count.

Figure 9.5.3.4 illustrates how T-piers may be used to reduce total column count on a ramp interchange.

Figure 9.5.3.4. Bridges with minimal column count

9.5.3.5 Member sizes

On some structures, it is advisable to use larger, thicker members where the forces are the greatest and thinner elsewhere. Proper proportioning of pier columns to span depth is also an important consideration. Consult the References article [BDM 9.1.5] for more detailed information.

9.5.3.6 Static vs. dynamic lines

Straight, plumb vertical lines, such as those at piers and abutment faces and mask walls, generally convey a static image. Sloping or angled verticals can generate a more dynamic appearance in the bridge. Mask walls in particular, can serve to lengthen or decrease the apparent length of the bridge, depending on which direction they are angled (e.g. toward or away from the span). Be careful to include enough slope so that the observer is convinced that the slope was intentional, not merely a mistake by the builder. A minimum of 10 degrees is a good starting point.

Figure 9.5.3.6 demonstrates how a sloping mask wall can create a dynamic appearance.

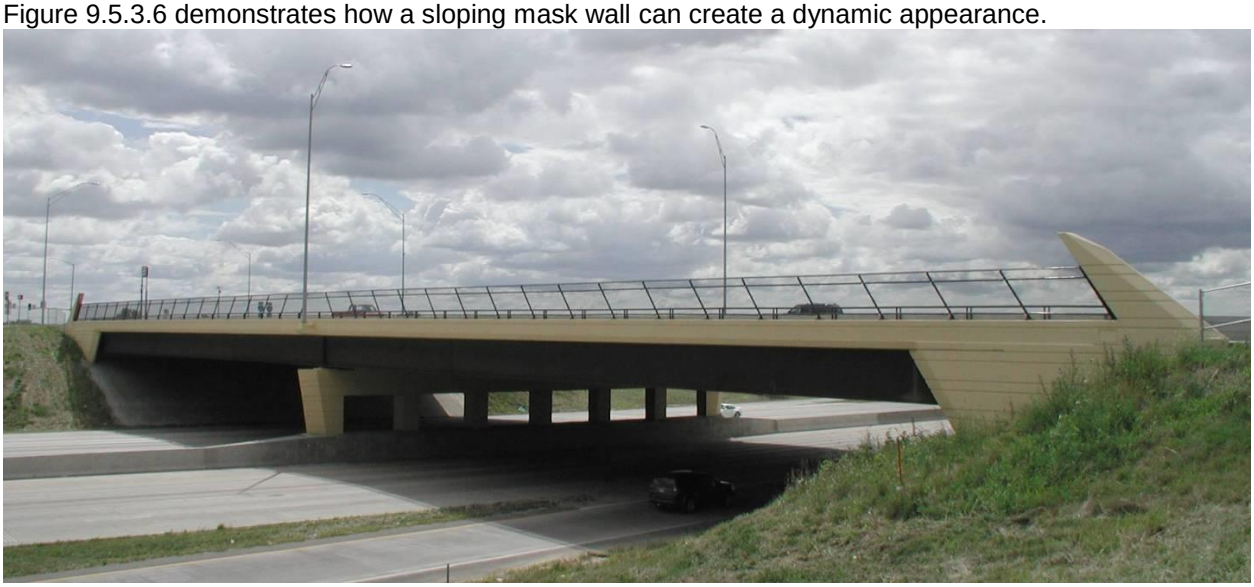

Figure 9.5.3.6. Bridge with sloping mask wall

9.5.3.7 Ornamentation

It is always best to try to find ways of enhancing the necessary components of the bridge, rather than bolting on aesthetic treatments at the end.

Figure 9.5.3.7-1 display bridge examples with ineffective bolt-on aesthetic details. Figure 9.5.3.7-2 gives examples of complementary bolt-on aesthetic details.

Figure 9.5.3.7-1. Bridges with ineffective bolt-on aesthetic details

Some elements, such as railings or fences, do create fine opportunities for enhancements that can be built off-site and installed to complete the appearance of the bridge. In general, however, a bridge's appearance is not greatly enhanced by the addition of an extravagant railing or other add-on. The entire structure must be thought of as a visual composition, incomplete without any of its parts. The designer should attempt to articulate, rather than merely ornament, the bridge's necessary components to create that composition. The shaping of piers, abutments, barriers, etc. will be more effective in creating architectural character than can be achieved by most bolted-on details.

Figure 9.5.3.7-2. Bridges with complementary bolt-on aesthetic details

9.5.3.8 Individual structures

The designer should be advised that single structures that have been identified for aesthetic enhancement in or near communities may be considered to be community gateways by the local residents and municipal leaders. This may bring the following considerations into play:

- Local constituents may seek to have the bridge express community identity through its design, including through its basic shape, colors, or through the addition of signage or emblems.
- There may be other enhancements planned for the area surrounding the bridge, which may be a freeway interchange or part of a city streetscape. Improvements may include landscaping, signage, special paving, ornamental street lighting, artwork, trails, or other amenities. The design of the bridge should be coordinated with the characteristics of these adjacent features. The color scheme associated with surrounding work will be of particular importance if the bridge will include any colored coatings for steel or concrete components.

9.5.3.9 Multiple structures/corridors

If there are multiple aesthetic structures within the same area or corridor, a unified design theme is strongly advised. This is especially applicable to new bypasses and renovations of existing freeway corridors. Sometimes new underpass structures or other amenities are located near an aesthetic bridge, and it may be appropriate to develop aesthetic treatments for them that match or complement treatments used on the bridge.

The designer should become familiar with any aesthetic theme that has already been established and ensure its applicability to the structure being designed. Adjustments of the concept may have to be made at individual sites due to differing functional design parameters, but the theme chosen for the grouping must be translated effectively at each structure. Likewise, if the designer is working an aesthetic theme into the first of several affected structures, he/she should become familiar with all of the structures to be enhanced by the aesthetic theme. This will help to ensure that all structures are able to accommodate the concept in a reasonable way, and prevent single structures from deviating unacceptably from the theme.

9.5.3.10 Bridge widenings

Bridge widening projects rarely include aesthetic enhancement unless the existing structure has unusual and identifiable characteristics that can be carried into the new addition. When exceptions occur, it should be generally understood that, due to the typically lower overall costs of such projects relative to total bridge deck area, the enhancement cost premium can be higher than for a completely new bridge. If the work planned for the existing structure is more substantial, for example replacing the entire bridge deck, then the enhancement percentage could be in compliance with the usual cost guidelines.

Figure 9.5.3.10 is a widened bridge with work that included existing pier repairs, replacement of the entire bridge deck and existing slope protection. Note in the figure how the new pier shape was derived from the existing pier shape.

Figure 9.5.3.10. Example of handling aesthetics on a bridge widening

9.5.3.11 Sidewalks and trails

Sidewalks or trail accommodations on bridges invariably bring requirements for pedestrian fences or railings. Standard chain link fence will almost never fulfill the aesthetic vision for an enhanced project. The final railing or fence appearing in the plan for an aesthetic bridge will usually be of a custom design with significant complexity in its detailing and construction.

By the nature of the inclusion of sidewalks, the bridge and the physical execution of its component parts will be assumed to be under greater visual scrutiny. Slow-moving pedestrians and bicyclists have the opportunity to stop and linger. Details (and oversights) that are invisible to the freeway motorist come

plainly into view for these observers. The designer should keep this in mind while assembling the parts of the bridge, including custom fences or railings, abutment features, concrete barriers, trail paving, and even piers.

Figure 9.5.3.11 contains some examples of aesthetics that are easily viewed by pedestrians and are therefore subject to more visual scrutiny.

Figure 9.5.3.11. Example of handling aesthetics on a bridge widening

The designer should be well-versed in the specification requirements that are in effect when pedestrian and/or bicycle accommodations are part of the project. See BDM 9.5.6 and 9.5.7 for further information.

9.5.4 Superstructure

9.5.4.1 Span to depth ratio

A span to depth ratio of 30 or higher is considered excellent; between 20 and 30 is considered good; 15 to 20 is acceptable, though not ideal; under 15 is undesirable, except in short end spans of bridges with constant beam depths for all spans. Keep in mind that structural guidelines and available beam depths may ultimately control superstructure depth.

9.5.4.2 Girder bridges: steel and concrete

Many bridges can be aesthetically successful with either concrete beams or steel girders. The Iowa DOT's BT series beams exhibit desirable span to depth ratios, and yield a highly articulated fascia surface with strong shadow lines. If desired, concrete beams can be coated with pigmented stains or sealers to differentiate them from other surfaces on the bridge elevation, which can exaggerate the

horizontal lines of the bridge and increase the appearance of slenderness. Concrete beam depth should remain consistent throughout contiguous spans, if possible.

Because of the opportunity to add color to a bridge without the use of coatings by employing weathering steel, steel can be a more aesthetic choice for a girder bridge. However, it is important to gauge the opinion of interested public groups relative to the subjective aesthetic qualities of weathering steel. Some constituents have expressed negative views of weathering steel's visual characteristics, especially during the initial period after installation when areas of contrasting color or construction-related staining may be present.

Higher span to depth ratios can also be achieved with steel, which is aesthetically desirable. Steel also allows haunched and curved girders, which can lend intrinsic aesthetic quality to the structure.

Steel girder bridges are generally considered to have higher cost per square unit deck area. In many cases, the final choice of girder type is driven by this cost assumption. However, consideration should be given to the associated reduction in substructure component costs when longer steel girders are used. When fewer piers are required, as is the case in some steel girder span layouts, cost differences with a normal concrete beam bridge may be significantly reduced. This is especially important when the conditions make the construction of piers more expensive than average, as is the case when building in a difficult river environment.

For horizontally curved bridges, steel will almost always be aesthetically preferable. Chorded concrete beam bridges yield undesirable results due to their varying soffit widths, inconsistent shadows cast on the fascia beam, and their generally stilted appearance. Pier end diaphragms are often impossible to eliminate, which results in broken or discontinuous superstructure lines.

9.5.4.3 Span arrangement

Refer to BDM 9.5.3.2 of this manual for specific recommendations on span arrangement.

9.5.4.4 Continuous structure lines

Horizontal lines of structure should be made continuous or to appear continuous. Details that break the superstructure's long horizontal lines - such as pier end diaphragms - should be avoided. Carrying the slab edge lines through the abutment wing extension and wing is another technique effective in maximizing the bridge's apparent length.

9.5.4.5 Haunched steel girders

Care should be taken in configuring the precise geometry of haunched girders. Haunches should always be formed by smooth curves, never by straight lines. The length of the haunched section of the girder should be neither too long (which may eliminate any sense of curvature in the haunch) nor too short (which can lead to poor visual proportions). Generally, haunches that reach a third of the span are considered superior, but in some cases the haunch may extend over the entire span. The depth of the haunch should be between 1.3X and 2X the mid-span girder depth. Consult References [BDM 9.1.5] for more detailed information.

9.5.5 Substructure

Reserved

9.5.6 Barriers

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9.5.7 Pedestrian and bicycle railing/fence

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9.8 Commentary on aesthetics and policy in the United States and Iowa

Roadway enhancement efforts have been a legislated part of the American highway culture for the last five decades. Beginning with The Highway Beautification Act of 1965, funding earmarked for enhancements has been included in every major highway bill passed by Congress. In 1968, the Federal Highway Administration (FHWA) began an annual program to award projects with scenic enhancement features. An accompanying FHWA document made a list of recommendations, among them was the following: “Encourage a high level of visual quality in every proposed freeway”, and “adopt the systems concept of an interdisciplinary team approach to urban freeway planning on every level”. The interdisciplinary team almost invariably included additional specialist designers to assist freeway and bridge engineers when aesthetic value was incorporated into project planning and design.

The National Environmental Policy Act (NEPA) of 1969 established environmental goals that directly affected federally-funded highway projects. Included in the Policy’s directives were the following: “Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings”, and “preserve important historic, cultural, and natural aspects of our national heritage.” It is important to remember that due to the limited staffing of federal and state agencies charged with overseeing NEPA, local community participants are often enlisted by those agencies to assess the performance of state DOTs against NEPA standards. Memoranda of Agreement with local municipalities are often the vehicles by which NEPA compliance is assured.

The National Highway System Designation Act of 1995 declared that “design for new construction… of a highway on the National Highway System may take into account… the constructed and natural environment of the area (and) the environmental, scenic, aesthetic, historic, community, and preservation impacts of the activity…”. This Act officially moved design considerations already in place for bridges on the Interstate Highway System onto virtually all bridges on the NHS.

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 set aside ten percent, or $3.6 billion, of its transportation program for enhancements that increase the environmental, historic or aesthetic value of a project. It was also at this time that the National Scenic Byways program was implemented. More recently, the Transportation Equity Act for the 21st Century (TEA-21) continued the Transportation Enhancements (TE) program when signed into law in 1998. The FHWA describes the TE program’s purpose as “to strengthen the cultural, aesthetic and environmental aspects of the Nation’s intermodal transportation system”.

Other nation-wide agency activities related to enhancements of transportation infrastructure have paralleled the FHWA and legislative lead. The Transportation Research Board (TRB) established a Subcommittee for Bridge Aesthetics as part of its structures group. TRB also published the seminal guidebook, "Bridge Aesthetics Around the World" in 1991 as a designer's reference. The American Association of State Highway and Transportation Officials (AASHTO) has incorporated aesthetics into its guide publications for roadway and bridge designers since the 1980s. The current edition of the AASHTO LRFD Bridge Design Specifications includes a section entitled "2.5.5 Bridge Aesthetics" in its "Section 2: General Design and Location Features", which states that "bridges should complement their surroundings, be graceful in form, and present an appearance of adequate strength", "Engineers should seek more pleasant appearance by improving the shapes and relationships of the structural components…", "… engineers should seek excellent appearance in bridge parts…", and "The bridge as a whole has a clear and logical relationship to its surroundings". Incidentally, the Iowa DOT had two prominent names appear on the AASHTO LRFD document: former DOT Director Mark Wandro, who served on the Executive Committee for 2003-2004 as Regional Representative in Region III, and; DOT Research and Technology Bureau Director Sandra Larson, who was Vice Chair of the AASHTO Subcommittee on Bridges and Structures.

With the recent introduction of Context Sensitive Design/Context Sensitive Solutions (CSD/CSS), the FHWA has infused the transportation enhancement effort with new directives for state agencies. The Iowa DOT has trained many of its supervisory engineers in the basics of CSD/CSS through FHWA-sponsored "Thinking Beyond the Pavement" seminars. FHWA has recognized that CSD/CSS can ease public involvement efforts on controversial projects, and can help to streamline the often-problematic NEPA process that must be followed on many new works. Aesthetics can even be considered as mitigation for other negative project impacts. The FHWA has also launched a new website to showcase CSD/CSS projects from around the country. Iowa's first posting to this website was the Sioux City Gateway "Prairie Bridge" project.