Bridges Produced by an Architectural Engineering Team

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ABSTRACT

In this paper, the aesthetic qualities of bridges are defined, the methods and principles employed to achieve these qualities are described, and seven award-winning bridges are presented to demonstrate the effect of public opinion on bridge appearance.

The purpose of this paper is to document (a) the reasons for producing bridges with aesthetic qualities and (b) the methods utilized to accomplish this task. The goal of the author's architectural engineering team is to comply with legislative direction for producing bridges built with public funds. These bridges must also satisfy the public's concern for quality while operating within strict fiscal limitations.

Many beautiful bridges were built before 1950, most of them depending on the arch for their beauty. Some were spectacular in their accomplishments but could only be considered beautiful by engineers. Before the age of formal calculations, bridge designers were generally intuitive in their design plans--they were more artist than engineer. The age of formal calculations produced a spectacular and plentiful array of bridges that did not collapse.

The midpoint of our century appears to have been the starting point in California for a formal blending of intuitive bridge design with formal calculations on a normal, continuous basis. The scientific method has been expanded to include more than the object to be produced. This object, a bridge, is subjected to close scrutiny from every conceivable direction. Decisions concerning its appearance are no longer the values of one man, but the values of the recipient community as a whole. Within the California Bridge Department, the methods and principles used in assessing these values have been passed from one "bridge architect" to the next for approximately the last 60 years.

DISCUSSION

The Team Approach

Before 1956, bridges in California were produced by an informal working relationship between engineers and one engineer-architect. After 1956, federal legislation that defined routes and provided funds for the Interstate Highway System led the California Department of Transportation to select the team approach as the most desirable method for obtaining high production and good quality.

Every bridge designed for California's highway system must receive an aesthetic review by a design team composed of a bridge architect and engineers of appropriate disciplines before it enters the final structural design stage. The area surrounding a bridge site must first be examined to determine the effect the structure might have on natural or man-made landscapes, existing or future cultures, and inhabitants. A harmonious relationship between all elements of the complete problem must exist for the project to be successful.

Consideration is given to any existing bridges in the vicinity that may have special architectural treatment. Finally, the bridge itself is architecturally designed so that it is aesthetically compatible with its route. Special safety measures, new bridge rails, median, rails, approach rails, or pedestrian protection, are also given aesthetic consideration at this time. In order to allow all concerned interests to perceive the finished relationships, artists prepare architectural renderings, photo retouches, and models for display at public hearings. The public is treated as a paying client.

Total Design

The cooperative effort between engineer and architect begins at the earliest possible time. Open discussion of the site and possible solutions can save time and money. Bridges have been moved to shorten them or place supporting systems in areas removed from positions originally planned.

The engineer is in charge of producing contract plans. The architect is the engineer's consultant. Advanced planning studies prepared by the engineers are reviewed by bridge architects. These reviews consist of selecting column type, girder edge treatment, and surface treatment. A preliminary architectural sketch is drawn consisting of section, elevation, and a rough perspective. Cost estimates are prepared and the suitability of structural design to architectural features and cost are determined before work progresses. A separate evaluation for each bridge in a group is not carried out until a type selection meeting is attended by representatives from the Specifications, Structural Design, and Architectural Design departments; and the appropriate supervisors. After discussion, these general plans become the basis for drawings and models produced as needed to satisfy the public's demand for information. Sometimes, the public demands a particular style of architecture. However, the general policy is to produce the most efficient bridge by incorporating aesthetics into the structural requirements.

Ornamentation

Ornamentation is limited to surface textures and does not interfere with the visually exhibited, overall purpose of providing structure from one point to another. The ornament shown in Figure 1 was generated by a request from the community to acknowledge the path of the Oregon Trail. A bridge architect produced a preliminary drawing for community approval. Figure 2 shows a drawing similar to

FIGURE 1 Bridge with integral ornamentation.

the contract drawing details. The design was produced by laminating plywood and inserting it in the forms before placing concrete. Additional concrete to produce the design was minimal. The lowest point in the design represents the normal surface of concrete without the design. The design was presented as line drawings within a grid pattern to be enlarged by the contractor.

Ornamentation on steel structures has been limited to color. Girders must be painted or fabricated from Cor-Ten steel. Color applied as a parallel arrangement of different color can produce the impression of a thinner girder. Cor-Ten steel must be carefully used to avoid the oxide-drip staining of other structural parts. It is possible to consider vertical stiffeners on the exterior girder to be ornamentation. This type of clutter has been removed and replaced by a horizontal stiffener on new steel bridges.

Philosophy

An overall philosophy concerned with bridge and site must also contain a plan for dealing with the bridge as a unique item. Total design described the relationship between engineers and architects. The architect must have a method to solve the subjective portion of the problem. A philosophy involving good design was developed by integrating (1) sound structural design, (2) function, and (3) appropriate aesthetic treatment; and decisions regarding priority are normally assigned in this order.

Of the three elements, appropriate aesthetic design is the most difficult to achieve because it is conceived by intuition, emotion, and experience. Because a structure primarily affects the visual senses of man, the aesthetic designer must proportion and shape his creation so that it is in harmony with its site, as well as being a pleasing entity in itself. The component parts must show unity or order, and should have some variety or contrast to relieve monotony. The overall view of the structure in its setting should appear to be in balance; it should look like it belonged there.

Harmony refers to the basic shape and impression the completed composition imparts to the viewer. A simple example consists of placing a structure within a low-rolling-hills, rural setting. A harmonious structure would contain some of the visual qualities of low, rolling hills. The structure would have a definite horizontal character, as opposed to a vertical character, and would have a smooth surface texture with curved edges.

Harmony, unity, variety, and balance are the basic elements of creative composition common to all the fine arts as well as bridge architecture. These elements are physically produced in a bridge by the proper shaping and treating of the structure's component parts to give form, line, space, light and shadow, texture, and color. These are the technical means for creating all visual artistic expression.

There is general agreement on these broad concepts of what constitutes good design but the transition from theory to a design on paper is often difficult. The principles and techniques of aesthetics as applied to bridge design rely on the definition of a beautiful bridge. The following definition reflects the observed results achieved by engineers and architects employed by the California Department of Transportation Bridge Department's Division of Structural Design and Construction.

Beautiful Bridge Defined

A beautiful bridge makes a minimal impression on the environment, has good proportions both in its integral parts and in the space outlined by its parts. It is composed of one dominant structural system using a minimum number of bents with a minimum number of columns per bent. Size, shape, color, and texture on superstructure, columns, and abutments are utilized to either call attention to, or play down, the role of these structural parts.

The relationship of transparency to mass must also be considered, however. Structural systems such as trusses, stayed girders, and suspension are more

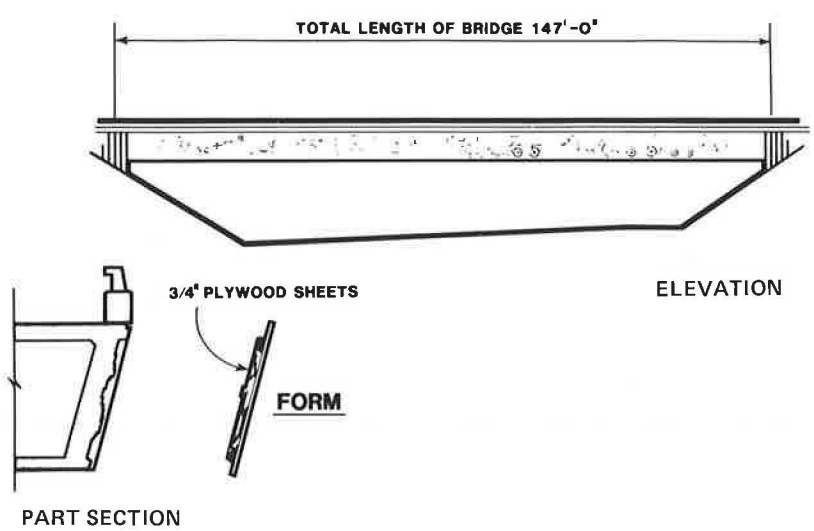

FIGURE 2 Detail of ornamentation.

transparent than box girders or plate girders. The ability to see through a structure can convey an air of mystery or magical quality to the viewer.

Aesthetic Qualities of Span Layouts

The span layout fixed by structural considerations can be changed by extending the limits of structure required. Prestressing a concrete structure illustrates this principle. A different type of structural system can also be used to retain economy even though the span or spans is lengthened or shortened. The following situations illustrate aesthetic qualities fixed by the structural layout:

1. A single span represents the ultimate bridge provided it can be thin enough, and sufficient camber can be applied to present the appearance of a straight line without a sag.
2. Two spans cause a split-composition effect in a natural setting but appear to belong to a freeway environment (Figure 3).
3. A multiple, even number of spans places a column in the center splitting the composition and causing the expected space in the center to be blocked by a column.
4. A multiple number of odd spans avoids the problem--there is no column in the center.
5. A three-span, arched girder with haunches produced by long curves appears especially graceful (Figure 4).
6. Multiple-span, arched girders appear busy and tend to disturb structure flow.

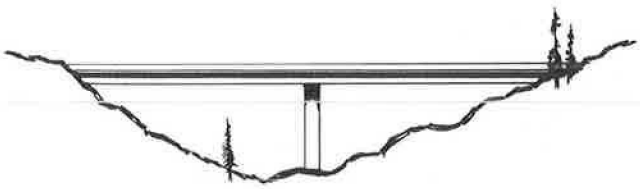

FIGURE 3 Two equal spans.

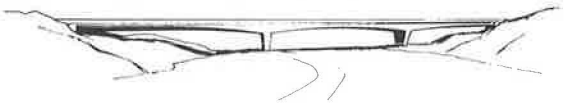

FIGURE 4 Three-span arched girder.

Standard Design

Standard designs have been employed to cope with the large number of bridges required. Standard refers to a general design in either concrete or steel reflecting the philosophy stated without ornamental embellishment. The details are standard, not the bridge. These designs are modified to satisfy various site conditions. Unusual conditions are dealt with by producing custom designs. Crossings over large bodies of water, deep ravines, and pedestrian structures are representative of custom design. Versatility in design along with low maintenance and competitive cost has resulted in the majority of bridges being constructed of concrete, with the box girder as the dominant structural type.

Abutment

The apparent bridge length (slenderness) is increased when viewed by using the shortest wing wall length. From an aesthetic viewpoint, an abutment reflecting the features of the mass connecting it to the bridge should be used. Abutments connecting to earth are usually concrete with a rough texture. The wing walls are made as small as possible, and are set back from the deck to continue part of the shadow of the deck on the wing wall. Abutments connecting to man-made structures can often be hidden within the structure causing the bridge to simply end at the man-made structure. This basic design of producing minimal apparent size in abutments enhances the feeling of lightness in a bridge. Abutments of large apparent size would only be used to stop visual movement along the bridge. (The building of defensive constructions at bridge terminations is not generally practiced.) Abutments with vertical faces appear static and stop visual continuity along the length of the bridge. Bridge length effectively stops at the abutment (Figure 5).

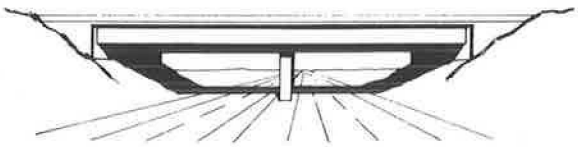

FIGURE 5 Static lines.

Abutments with sloping faces continue the line of the deck and rail downward into the ground. The apparent length of the bridge can be increased and a feeling of ground integrated with bridge established (Figure 6).

Columns

Many types of columns have been used throughout history, but present-day bridges promote movement. The historic use of elaborate columns has been to restrict movement.

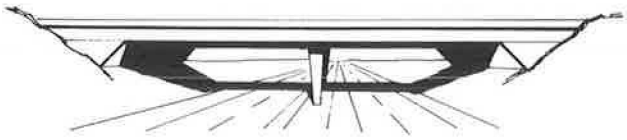

FIGURE 6 Dynamic lines.

Standard architectural columns have been designed as a series of modular shapes. Cross sections are available in round, octagonal, and hexagonal forms. These forms can be expanded to include a rectangle between the basic form. A round cross section can become a cross section that is semicircular at the edge with flat sides joining another semicircular edge. This system is used for all the geometrical forms to increase the load bearing ability of a single column. Therefore, a minimum number of columns can be used. The edge column directly adjacent to the viewer provides the impression of column width that the viewer normally perceives. This impression is controlled by light reflecting from the column edge. Octagonal columns appear slimmest as a result of the greater number of surfaces. The viewer sees a large area broken up by several planes. Round columns are affected less and square or rectangular columns are not affected. The architect can take advantage of this light reflection by using the principles to slim down a massive column or increase the apparent

size of a column to offset a massive superstructure. Column proportions therefore have a large effect on the aesthetics of bridges.

Columns that appear larger than necessary to support the superstructure are not desirable because attention is directed away from the primary purpose of a bridge, which is to provide free movement. Columns that are obviously needed to support the superstructure should appear to be of sufficient size to perform their function. Columns that appear thinner than the visual requirement impart the feeling of possible collapse to the viewer.

The upper part of standard architectural columns is curved, arched, or flared to visually integrate the column with the superstructure. This spreading outward of the standard architectural column is designed to be compatible with the sloped exterior girder of a trapezoidal box girder. Standard, flared architectural columns are not compatible with vertical exterior girder shapes. A transition between the column and the superstructure similar to the capital on classic style columns must be introduced. This "capital" usually takes a simplified form involving straight lines tapering in the opposite direction of the flare for a distance less than the girder depth. The capital actually becomes an exposed column cap, or part of an exposed column cap. This treatment is effective only when the extremities of the flare are wider than the superstructure.

Flared columns as described previously are designated as one-way-flare columns (Figure 7). They promote flow perpendicular to the bridge, under the bridge; therefore, they are directional.

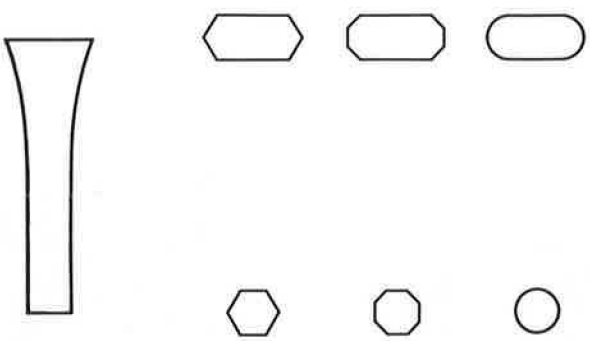

FIGURE 7 Standard architectural columns with one-way flare.

Standard architectural columns have also been designed with two-way flare (Figure 8). These columns are nondirectional (they do not direct flow in a particular direction) and are particularly appropriate in situations involving more than one bridge, such as in an interchange. Two-way-flare columns are more effective from a visual judgment because the flare is evident from any viewing position.

The lower portion of a column must connect with earth, man-made material, or water. Standard architectural columns all have vertical lower portions. while although this may not provide the best solution aesthetically, it is the only practical solution for a column that must cope with great changes in height while retaining the same width at the top.

Columns with their lower portions in water rely on the structural conditions for their shape. Columns resting on spread footings or in drilled holes can appear to disappear into the water. This is a distinct advantage with fluctuating water levels. Columns in water supported on pile caps must consider the pile cap as an element in their overall design. Pile bents exposed as columns are used only when low clearance dictates the use of thin superstructure.

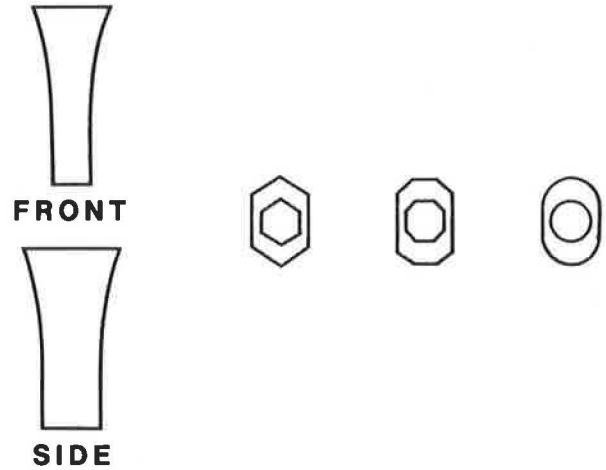

FIGURE 8 Standard architectural columns with two-way flare.

These situations usually occur in areas where restricted passage and aesthetic concerns are minimal.

The standard architectural columns are the result of many nonstandard or custom designed columns. Typical undercrossing, overcrossing, and connector bridges can use similarly sized columns. The current series of standard architectural columns is the second attempt to produce standards to simplify design and lower construction costs by repetition.

There will always be a need for nonstandard columns. Special site conditions, such as Figure 9, require an overcrossing to span a divided highway with a depression in the center for mass transit. Inadequate space for one large column presented the problem of two thin columns resulting in a three-span structure. The structure depth would have visually overpowered the columns. The result was a massive-looking superstructure. Combining all the problems produced a unique solution with columns and superstructure in proportion.

FIGURE 9 Nonstandard architectural column.

Superstructure

Profile View

The profile view describes the structural type such as arch, post, and lintel, or combined variations of these types. Sound structural design (1), function (2), and appropriate aesthetic treatment (3) have been established as the order of priority. The first priority must begin with geology to determine where supports may reasonably be located. The structural type is therefore dependent on possible support in order to determine the span lengths. Technology has made it possible to have single-span lengths of 200 ft in concrete. This base can be expanded by using steel and adapting continuous span procedure to

extend the limit. Increasing the apparent height of the structural type by constructing a truss, combining a truss with an arch, building towers, and suspending the deck by stays or suspension cables are other forms of increasing span lengths.

The problem of economically producing large numbers of bridges necessitates the implementation of a repetitive process. Basic methods and procedures must remain as simple as possible; therefore, the least complicated method and procedure must be the starting point for selecting structural type. Actual physical and monetary conditions modify this beginning toward an increasingly complicated problem.

A parallel exists in aesthetics. The second and third priority may modify the choice of structural system. Bridges constructed to serve transportation functions are large structures. Small, complicated, structural systems are not in harmony with large size. Therefore, the appropriateness of the structural system is the most important factor in bridge aesthetics. This factor can be seen from any distance from which the bridge can be seen. It is the bridge. The architect can bring out the aesthetic qualities of the structural system, but can never change its basic impression.

Cross-Sectional View

The cross-sectional view is never directly apparent, except in the case of towers. The depth and edge shape of the superstructure exert an influence on the profile view in the way an overhang produces a shadow from sunlight. A glimpse of the cross section can be viewed directly when the abutment is as wide or wider than the superstructure. The trace of the superstructure will appear on the abutment wall. This trace is normally in deep shadow and is not readily apparent. Bridge orientation regarding sunlight is important. Without direct sunlight on a profile view, a silhouette--the structural type--is all the viewer will perceive. The real depth of the superstructure can be designed to appear less than it is by using methods appropriate to the orientation of the bridge. Sunlight can be reflected by sloping the usually vertical railing face or girder face as shown in Figure 10. The apparent depth perceived by

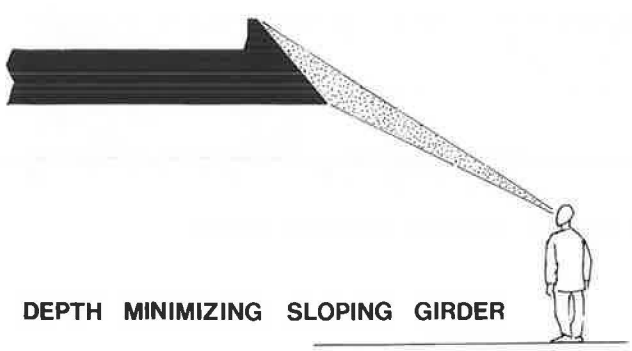

FIGURE 10 Depth-minimizing sloping girder.

a viewer passing below the bridge is less than the vertical projection of the real vertical depth. Catching sunlight with a vertical face can also produce the effect of thinning a deep structure facing in a southerly direction as shown in Figure 11. This structure, Kettleman Lane Overhead, relies on sloping the girder, abutment, and the wing wall. This type of slope puts the girder face in shadow making it difficult to tell where girder and soffit

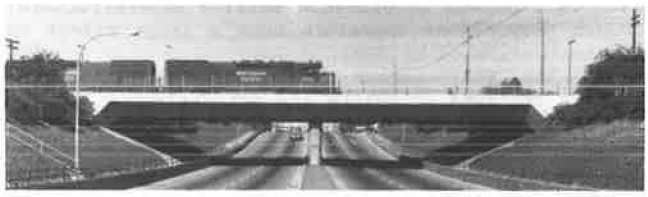

FIGURE 11 Kettleman Lane overhead.

intersect (Figure 12). The perceived depth is actually greater than the real depth. This principle carried to its maximum produces a curved girder face-soffit where there is no line defining girder depth. Coupled with the depth minimizing slope on the railing and deck, a sculpture is produced (Figure 13).

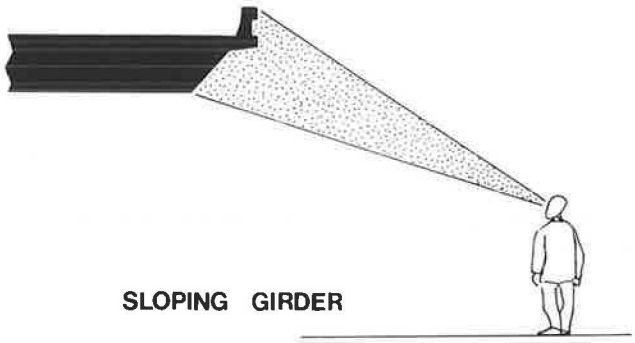

FIGURE 12 Sloping girder.

FIGURE 13 Curved Soffit girder.

The contrast between sloping the exterior girder face and simply relying on shadows cast by an overhang on a vertical girder is apparent (Figure 14). The vertical projection of the girder depth is approximately equal to the real depth. This type of girder presents the greatest obstacle to visual flow under the bridge by presenting the greatest apparent depth. A shadow on the girder produced by the overhang can break up the depth, but the bottom of the girder will produce a sunlight stripe until the entire girder is out of the sun. A sun stripe at the rail and at the bottom of the girder clearly defines the bridge depth.

Multiple Bridges

Interchanges pose the same problems for superstructures as for columns. Simplicity and shapes promoting flow are required elements. Structural types, cross sections, standard columns, and minimum size abutments are required to avoid greater confusion. Simple

FIGURE 14 Typical standard bridge.

ornamentation is required to avoid the monotony inherent in the ascetic scene described previously.

This ornament can be made an integral part of concrete structures. Depressions and bumps within an area framed with smooth concrete produce dramatic visual contrasts (Figure 15). Color can add to this contrast.

FIGURE 15 Ornament relieves sterility.

APPLIED PHILOSOPHY

Tuolumne River Bridge

This bridge was built in a canyon. The canyon became a reservoir (Figure 16 and Table 1). The span and clearance requirements dictated a multi-span structure. The structure was designed to carry only one-half of the projected traffic initially. Provision for widening was required. This bridge improved an existing entry to Yosemite National Park. The existing two-lane road contained tight radius curves that restricted the choice of structural systems. Steel plate girders were chosen and a wide overhang provided the method for producing shadow to relieve the girder depth. Both the concrete deck and the steel girders are curved in the plan view, allowing the shadow produced by the overhang to be parallel to the top and bottom flanges. A scalloped shadow would have resulted from using a curved deck and straight girders.

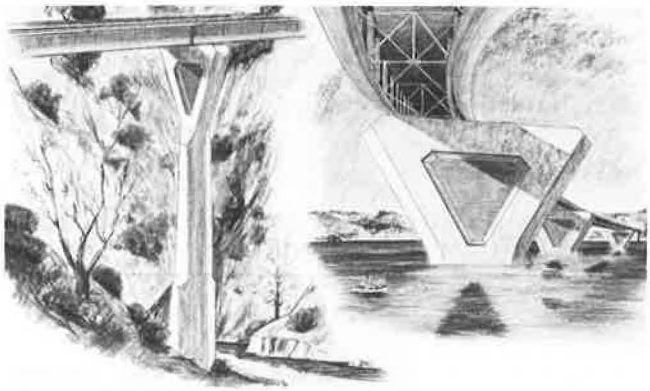

FIGURE 16 Design drawings for Tuolumne River Bridge.

The concrete columns were specially shaped to provide resistance to water accelerated by earthquake forces. The transition from superstructure to column conforms to the requirement for the suggestion of a capital when using flared columns with vertical girders. The necessity of providing for a method of anchoring future girders to widen the structure produced the flared column. The mass of this column at the top was designed to be open in the dark area. Structural conditions did not allow for an opening; therefore, a depression painted the color of the surrounding landscape was substituted to promote the effect of an open area. Girders were painted the same color to minimize the impact of the structure on the surrounding landscape.

Award Received

1972 American Institute of Steel Construction Prize Bridge--Medium Span High Clearance.

Archie Stevenot Bridge

A deeper, wider canyon in approximately the same geographical area as the Tuolumne River Bridge produced a bridge with an entirely different appearance (Figure 17 and Table 1). This bridge was also constructed in a canyon that later became a reservoir.

Longer spans were required. Therefore steel box girders or concrete box girders were presented to contractors as options. The steel box girder was opted for and constructed with a provision for widening by increasing the overhang. The necessity of a wide overhang to provide shadow was not as evident when a large clearance condition was in effect. Filling the reservoir, and reducing the clearance increased the need to reduce the apparent height of the girders (Figure 17 and Table 1). The concrete columns were designed as rectangular, cross-section pyramids. This design recognized the forces produced by earthquakes and the increasing water level produced by the reservoir. Column size was proportional to the exposed height. Renderings were used to obtain a document to allow all team members to reach a point of understanding. Photo retouches produced from the design renderings communicated the team's intent to all outside parties, and models were constructed to clarify design decisions.

Awards Received

1978 American Institute of Steel Construction--First Place; 1977 U.S. Department of Transportation--First Place in Outstanding Structure Category, Award for Best Entry; and 1981 Design for Transportation Awards--National Award for Design Excellence.

Adams Avenue Overcrossing

The site for this bridge (Figures 18 and 19, and Table 1) was an unexcavated depression within the San Diego city limits. The possibility of building the bridge in a hole allowed the exterior girder to be a warped surface due to the relative ease of constructing formwork.

TABLE 1 Physical Data

Bridge	Year Completed	Span Length (ft)	Total Length (ft)	Girder Depth (ft)	Column Height (ft)
Tuolumne River	1971	132, 195, 260 350, 260 197	1,394	15	220
Archie Stevenot	1976	200, 250, 500 550, 500, 250	2,250	11-26 Varies	380
Adams Avenue	1970	110, 218, 110	439	6-15	50
East Fork of the Chowchilla	1972	232, 300, 188	720	8.5 min	100
Napa River	1977	150, 175, 230, 250 230, 175, 6@150, 120	2,230	7.75-12 Varies	100
Montana Pedestrian Overcrossing	1979	111, 118, 68	298	4	16
Broadway Pedestrian Overcrossing	1979	143	143	5 min	None
California Incline Pedestrian Overcrossing	1979	164, 141, 42	348	5	Varies
Castellamare Pedestrian Overcrossing	1979	112	112	4	20
West Lilac Road Overcrossing	1978	504 arch	695	7-14	135 (arch above road)
County Road 8 Overcrossing	1968	101, 101	202	6	17

FIGURE 17 Archie Stevenot Bridge over the completed reservoir.

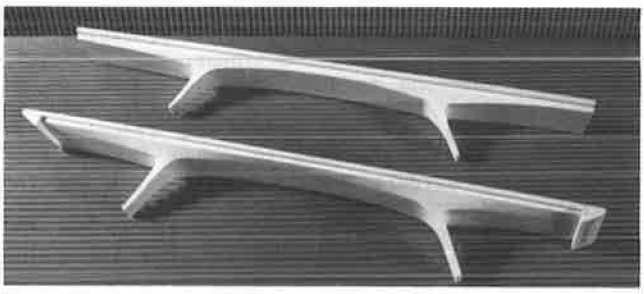

FIGURE 18 Adams Avenue Overcrossing—model.

FIGURE 19 Adams Avenue Overcrossing—actual.

Bridges with a curved soffit profile change the point of intersection between soffit and exterior girder when the exterior girder is not perpendicular to the soffit. If the slope remains constant, the soffitt width varies from maximum width at thinnest girder depth section to minimum width at maximum depth girder section. The constant slope girder produces a flat exterior girder surface. No light-diffusing break-up occurs. If the girder slope varied to cause the soffit width to become a vertical projection of the horizontal soffit width at the point of least girder depth, soffit width would be constant and a warped, sloped, exterior girder surface would occur. A light reflecting surface different from previous constant slope surfaces would have been created. This surface combined with sloping columns could produce a structure with greater visual continuity than previous sloped exterior structures without paying the price of large, flat, reflective surfaces.

Models were constructed to work out the actual details. Calculating the volume of concrete proved to be difficult, so a scale model was constructed and filled with grout. The grout was measured as it was poured.

Award Received

1969 Portland Cement Association Award of Excellence.

East Fork of the Chowchilla River

Located on the western slope of the Sierra Nevada Mountains, this three-span structure (Figure 20 and Table 1) is the southernmost member of the Tuolumne River, Archie Stevenot Bridge group. A reservoir was not involved in this project. The isolated location provides space to allow the large, flat, reflective surface of the constant slope box girder to relate to the environment. A large site does not require as much surface break-up as a small site to allow a harmonious relationship between structure and site. The deck overhang produces a shadow to accentuate the slim girder depth and create a cap or a top for the superstructure. Columns form a logical extension of the superstructure. Renderings and models were used to develop the design.

Award Received

1972 Fifth Annual National Scenic Highways Competition--First Place in Outstanding Structures Category.

Napa River Bridge

The southern extremity of the Napa Valley provides the site for this multi-span concrete bridge using box girders arched over the longest spans to present

FIGURE 20 East Fork of the Chowchilla River.

the thinnest profile (Figure 21 and Table 1). Arched or curved soffit girders add interest and variety to an otherwise repetitive bridge. These forms also help the structure to relate to the adjacent rounded hills. The integral column treatment used at the East Fork of the Chowchilla River would have increased the perceived size of the total structure, due to the relatively larger bridge at Napa River.

FIGURE 21 Napa River Bridge.

Single column bents relate by virtue of their flared, lozenge, cross sections to the curved soffits and sloped sides of the exterior girder faces. Textured detail provides relief from the expanse of concrete at the top center of all columns. (Renderings were the only visual aids used to prepare this design.)

Awards Received

1978 Prestressed Concrete Institute Award, and 1982 U.S. Department of Transportation--Second Place in Major Highway Structure Category.

Pedestrian Overcrossings in Santa Monica

Bridges of different architectural design demonstrate the effect of public influence on bridges designed to solve a common functional problem. These structures provide pedestrian access from Santa Monica to the beach over busy Route 1. Space along Route 1 is at a premium, which dictated stairs instead of ramps.

The California Coastal Commission was concerned about these structures. This concern provided the opportunity to deviate from completely standard design. Pedestrian structures have an additional element to consider in their design: the direct users of these structures are people. Therefore, the scale and detail should make people feel comfortable. The experience of using the facility should be pleasant.

Photo retouches were used extensively in public meetings held to obtain general approval from the public. This background helped to obtain approval from the Coastal Commission.

Montana Pedestrian Overcrossing

The Montana Pedestrian Overcrossing is an example of a different type of integral column combined with the height-reducing, sloped girder to create an integrated structure that reflects light and adds to the beach atmosphere (Figure 22 and Table 1).

FIGURE 22 Montana Pedestrian Overcrossing.

Broadway Pedestrian Overcrossing

Broadway intercepts an old brick stairway part way up the hillside. Brick was used as a design element to carry the stairway theme over Route 1 and tie it to the beach side. This structure is located less than 1 mi south of Montana (Figure 23 and Table 1). Montana has an appearance unlike Broadway yet both structures are compatible and serve as landmarks due to their difference.

FIGURE 23 Broadway Pedestrian Overcrossing rendering.

California Incline Pedestrian Overcrossing

A variation on the theme set by Montana. This structure is located within sight of Montana (Figure 24 and Table 1).

Award Received

1982 U.S. Department of Transportation--Third Place in Intermodal Facilities Category.

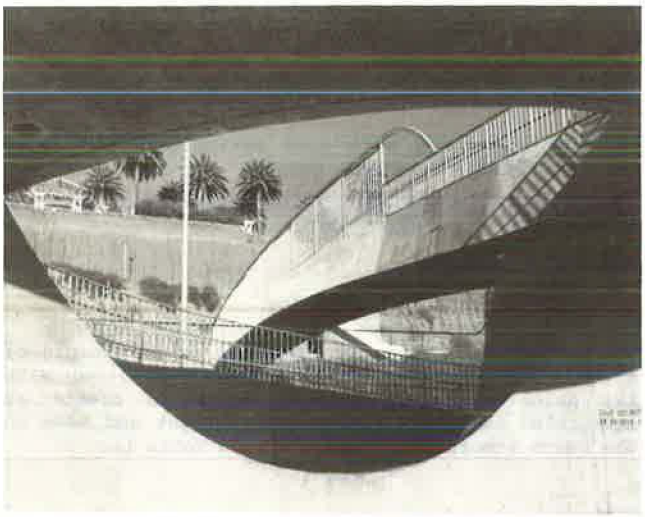

FIGURE 24 California Incline Pedestrian Overcrossing.

Castellamare Pedestrian Overcrossing

The Castellamare Pedestrian Overcrossing, located approximately 1 mi north of Montana, bears no resemblance to the Montana or Broadway overcrossings, even though the designer was the same for all three overcrossings (Figure 25 and Table 1). The Los Angeles County Parks Department had definite design requirements. The structure replaced a 1920-vintage arch tied directly to a building of historical importance. The basic design for this structure resulted from grade school competitions. The exposed aggregate rocks are from a particular beach in Mexico specified by the Parks Department.

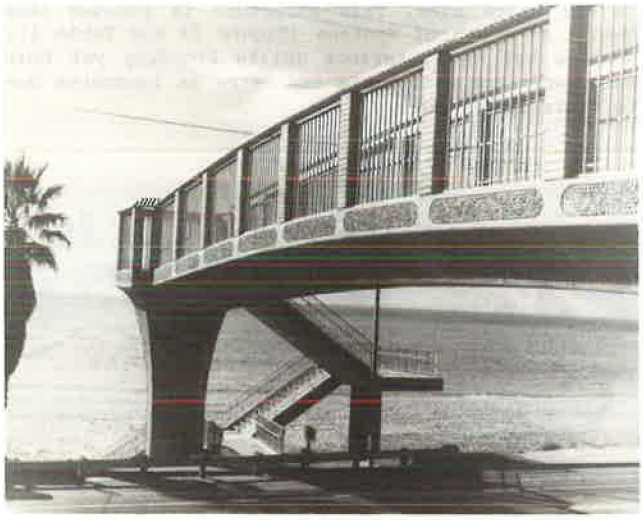

FIGURE 25 Castellamare Pedestrian Overcrossing.

West Lilac Road Overcrossing

West Lilac Overcrossing (Figure 26 and Table 1), which is located north of San Diego was designed without input from committees. It was designed by an architect and an engineer to be built within a cut section. Before the section was cut, however, every aspect of aesthetics had to be visualized because the site did not physically exist during design. A similar situation existed at Adams Avenue. Models were used extensively to find and solve the problems of integrating an arch with a sloping box girder. Complete integration of column and superstructure produces a structure more like a gateway than a bridge.

FIGURE 26 West Lilac Road Overcrossing.

Awards Received

1978 Portland Cement Association Award of Excellence, and 1979 Prestressed Concrete Institute Award.

Typical Standard Bridge

County Road 8 Overcrossing is the type of bridge built to pure engineering considerations (Figure 14 and Table 1). Bridges built according to this formula could probably be successful today in award competitions provided they were stretched to their structural limits by displaying the last word in technical efficiency. The point is that something must be added to the basic standard formula to raise the structure out of its absolutely standard situation. That something is a quality that is achieved by incorporating either the public's will or engineering genius. Ideally, it would be a blend of both.

CONCLUSION

Bridges designed to fulfill engineering requirements without regard for their appearance may be without aesthetic qualities. Public opinion demands these qualities. Engineering and aesthetic concerns can successfully be combined by a team of specialists working on a large number of bridges with varying requirements. The team must combine structural, functional, and aesthetic values using rational methods. The degree of success depends on the ability of all concerned parties to accurately perceive the completed project. Drawings and models provide the tools to create an accurate perception.

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