METHODOLOGY FOR EVALUATING THE AESTHETIC APPEAL OF BRIDGE DESIGNS

William Zuk, Virginia Highway Research Council

Presented is a systematic methodology for rationally determining the aesthetic appeal of bridge designs by the use of paired line drawings where one visual factor at a time is varied. These paired drawings are then judged by either a preselected or randomly selected group of people. An example (using a standard bridge overpass) is selected as a vehicle to explain the method. The method is such that conclusions can be clearly drawn from the judgments of the example. The results show that aesthetic preference is generally given to such factors as simplicity, slimness, symmetry, conformity to the site, and expression of out-of-the-ordinary characteristics. Other more detailed conclusions are also determined and presented in the body of the report.

•THE APPEARANCE of bridges has always commanded the interest of not only bridge builders but also most people who see them.. In designing bridges for safety, engineers are guided by precise codes, yet in their designs few of them are guided by any sort of aesthetic rationale. In some recent references (1 through 10) a number of characteristics and illustrations are given to depict bridges that are said to be pleasing in appearance. Unfortunately, the authors offer no validation of their statements concerning aesthetic content except the force of their own convictions. This is not to question their conclusions but to suggest that there might be an alternate way to evaluate the appearance of bridges more systematically, a way that puts aesthetic judgments on a broad base and is supported by rational data.

The testing procedure presented is dependent on the fact that in bridges relatively few elements are involved (supports, span, end abutments, and railings) in contrast to other works of art (as architecture, painting, and sculpture) where the constraints are few and the elements are many. However, even with only four basic visual elements of bridges, countless variations and combinations are possible. But, once again, the economic and technological constraints imposed on bridges reduce the number of variations to a manageable level.

It is known that decisions can most easily be made by comparing one situation or object with another. In the case of bridges, if the difference between two relates to one particular feature, that feature can be isolated (relative to the whole) and evaluated on its effect on appearance. In this way, preferences for different features and combinations of features can be systematically evaluated, always in a set of two.

It is also well known that decisions on the appearance of an object depend on who is doing the judging. One person may like an object, whereas another may dislike it. For this study two groups were used. Group I included people such as artists, architects, and landscape architects who have been formally trained in aesthetics. The second group included a random assortment of people, professional and nonprofessional, young and old, who have not had formal training in the arts. The majority opinion of each group is used to establish the preference position.

Sponsored by Committee on Bridge Design.

METHODOLOGY AND EXAMPLE

The specifics of the methodology described will be illustrated by example. The example is a short-span overpass highway bridge as might be seen on many of today's Interstate highways. The view is that of one driving at highway speeds, such that detail cannot be observed. All bridges shown are simple line drawings so that only the essential elements can be presented (avoiding distractions) and the controlled features can be easily varied. Line drawings are also useful to a bridge designer in that he does not have to construct models or build the actual bridge before an aesthetic evaluation can be made. Certain computers equipped with "light-pens" can be used to make line drawings that can be quickly changed.

Features that are varied include the piers, the spanning element, the end aubtments, and the rail. The proportions of these elements are varied along with their interrelationships with one another, as pier to span, abutment to span, or rail to span. The relation of the bridge form to the site and the color of the bridge as related to its environment are other factors varied.

All possible proportions or relationships have not been included in this example; however, should need arise to include other variables, no change in the basic methodology is needed.

In application, a copy of a brochure was given to a subject with instructions to compare the two diagrams on each page and indicate which one he found more pleasing visually at a quick glance. The subject was asked to disregard as much as possible any concern about the functionality of the bridge. The reasons for choices were not asked, although in some cases the subject volunteered such information.

Due to lack of space, only a few of the figures are included. Figure 1 shows the control bridge and some of the variations presented. The subject was presented with the control and a variation of the control and was asked to indicate of the two which he found more aesthetically pleasing. Figure 2 shows the control and a variation of it as they were presented. In regard to variations, six basic categories are believed to have relevance to aesthetic bridge design: (a) proportion of elements, (b) relation of elements, (c) degree of visual complexity, (d) site compatibility, (e) color, and (f) expression of out-of-the-ordinary characteristics. Expression of functionality and safety was omitted inasmuch as it was not considered a basis for aesthetic appeal.

In most of the comparative figures, one of the categories predominated as the variant, although in a few cases two categories may be suggested. For purposes of analysis, however, only one was listed for each pair. Table 1 gives the results of the survey. The reasons for choices were not asked, but in some cases the subjects volunteered such information.

The population interviewed in Group I included 29 architects, two landscape architects, and one artist (30 males and two females) ranging in age from 19 to 47. The population in Group II included 18 nonprofessional females, seven professional females, seven nonprofessional males, and 12 professional males, ranging in age from 16 to 55. The nonprofessional category included occupations such as homemaker, secretary, and laborer, and the professional category included occupations such as teacher, engineer, and medical doctor.

ANALYSIS AND CONCLUSIONS

The conclusions for the entire set of figures, derived from data given in Table 1, are as follows:

1. Groups I and II both like simplicity of form and simple relationships of elements.
2. Groups I and II both like slimly proportioned elements as piers, abutment, span, and rail.
3. Groups I and II both overwhelmingly favor symmetrical relationships of elements over unsymmetrical relationships.
4. Groups I and II both like bridges with some out of the ordinary characteristics, in particular, forms such as arches or those suggesting arches.
5. Groups I and II both like bridge forms that conform to the dominant features of the site.

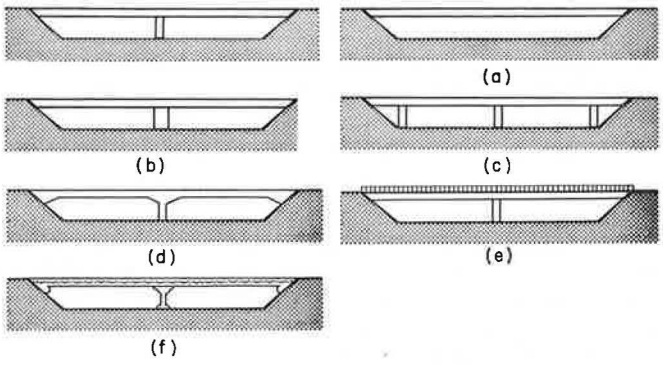

Figure 1. Control bridge (a) without pier, (b) with widened pier, (c) with two additional piers, (d) with haunches, (e) with open rail, and (f) with decorative embellishments.

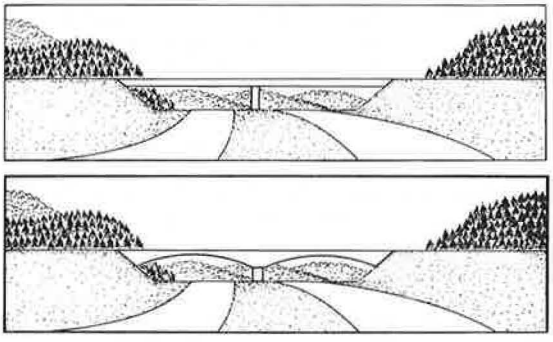

Figure 2. Control bridge and control bridge with arch variation both set in rural environment.

Table 1. Survey results.

Principal Variant[a]	Percentage for Control and Variable		Comments
	Group I	Group II	
c	6-94	54-46	Group I prefers extreme simplicity of no piers, whereas Group II is about evenly divided
a	69-31	75-25	Preference toward slim spanning element
a	69-31	61-39	Preference toward slim pier
b	69-31	61-39	Preference toward overall slim proportions
b	75-25	72-28	Preference toward simple relation of piers to span (few piers)
b	75-25	82-18	Preference for few piers
c	72-28	75-25	Preference toward simply shaped piers (no visible base)
c	47-53	70-30	Group II prefers simply shaped piers (no capitals), whereas Group I is about evenly divided
f	44-56	28-72	Preference toward simple pier but with special character
f	35-65	43-57	Preference toward span with special character
b	88-12	95-5	Overwhelming preference for symmetry
c	53-47	84-16	Group II strongly prefers simple lines of span, whereas Group I is about evenly divided
b	50-50	57-43	Generally evenly divided, but somewhat in favor of no exposed end abutment
a	41-59	34-66	Preference toward modest-sized abutment
b	78-22	57-43	Preference for "invisible rail"
a	38-62	43-57	Preference for slim rail appearance
f	4-94	23-77	Preference for bridge form of special character
b	60-40	52-48	Preference for simple relation between pier and span (arch form)
c	66-34	70-30	Dislike of superficial decorative elements
d	31-69	32-68	Preference for bridge form in harmony with site
e	44-56	48-52	Slight preference for bridge color (gray) contrasting with concrete pavement (white)
e	53-47	45-55	About evenly divided on bridge color contrasting or blending with bituminous (gray) pavement
e	19-81	77-23	Group I strongly prefers bridge color contrasting with environment, whereas Group II prefers blending color

[a]a = proportion of elements; b = relation of elements; c = degree of visual complexity; d = site compatibility; e = color; f = expression of out-of-the-ordinary characteristics.

6. Group I strongly prefers a bridge color that contrasts with the environment, whereas Group II strongly prefers a bridge color that blends with the environment.

7. Group I is somewhat influenced in aesthetic judgment by the preference for a clear expression of functionality, and Group II is similarly influenced by an appearance of structural adequacy or safety. (Both factors are related, but because of eductional and training differences they are seen and expressed differently.)

Considered as an example of the methodology, the described procedure and results are believed to have accomplished the goal intended: that of systematically evaluating the aesthetic appeal of different bridge designs and rationally determining patterns of preference. The example used was not designed to arrive at one specific most pleasing bridge form, although by the same technique of comparative designs one form could have been so determined. However, by inference, it appears that arch related forms are generally preferred over all others presented, including the control bridge form.

Interestingly, the results of Groups I and II are dissimilar on only one point, that of color contrast or harmony. On points of form, the two groups are generally in agreement. The latter conclusion is reassuring in that the position of "taste-makers" and that of the general public are essentially the same on most issues, provided a large enough sampling is made. (It is to be noted that there was no figure in the brochure that was unanimously selected or rejected by all.)

ACKNOWLEDGMENTS

Appreciation is extended to all those who participated in this survey and generously gave of their time for discussion of their opinions on bridge aesthetics in general.

REFERENCES

1. Wegenroth, R. H. Bridge Engineer Looks at Esthetics of Structures. Jour. Structural Div., Proc. ASCE, Vol. 97, No. ST4, Proc. Paper 8074, April 1971, pp. 1227-1237.
2. Prize Bridges of 1971. AISC, New York, 1971.
3. Visual Values for Highways. Graduate School of Design, Harvard Univ., Sept. 1970.
4. The Highway and Its Environment. Third Annual Awards Competition, Federal Highway Administration, U.S. Dept. of Transportation, 1970.
5. Prize Bridges of 1970. AISC, New York, 1970.
6. Concrete Bridge Design. ACI, SP-23, 1969, pp. 1-18.
7. The Appearance of Bridges. Ministry of Transport, Great Britain, 1969.
8. Leonhardt, F. Aesthetics of Bridge Design. PCI Jour., Feb. 1968, pp. 14-31.
9. The Freeway in the City. U.S. Govt. Print. Office, Washington, D.C., 1968.
10. Appleyard, D., et al. View From the Road. M.I.T. Press, Cambridge, 1966.