

it would be expected that the simple beam or girder with constant depth, the earliest form of construction with which we are acquainted, would be the most beautiful of all forms for a bridge. On the other hand, the least pleasing of all plate girder bridges is that made up of a succession of spans of considerable length and of the same construction. The lack of contrast gives rise to pronounced monotony. By reason of greater constructional complication, the simple truss or cantilever span is in general less pleasing than a girder bridge. Articulation, which is the distinctive feature of the truss, conveys the impression of complication, and renders the layman less capable of appreciating the strength and sufficiency than in the case of a girder, arch or suspension span, each of which, in addition, has many centuries of use behind it in which the race has grown familiar with its form. The steel arch is generally regarded as more beautiful than the suspension bridge, certainly not from superior grace of line, but simply because of the age-long association with stone.

Must Retain Proper Balance

The fourth of Mr. Young's axioms is that proper balance or relation of parts to each other and to the whole must be maintained. No part of the construction should contain a suggestion of undue strength or undue weakness in comparison with any other part, but all should be equally efficient. This lack of balance is frequently seen in structures composed of widely different materials, in which, perhaps a light steel truss is supported upon heavy stone abutments. The mind of the observer is forced suddenly to change its standards for estimating the sufficiency of adjoining spans. A steel arch bridge without apparent sufficient abutments shows the same defect and excites wonder even in the lay mind as to the means by which the enormous rib thrust is resisted.

The fifth axiom is that the design which is structurally the most efficient for the amount of material employed will at the same time be the most pleasing. The author claims the correctness of the principle that the most pleasing outlines or general forms arise when the maximum economy of material is secured, and shows that nature performs her work along the lines of least resistance. In fashioning a straw, reed, or stalk, nature seeks only to obtain the greatest strength and rigidity with a minimum of weight, and by her own mathematics has arrived at the annular cross-section as the most efficient.

A type of structure which illustrates the principle that economy of material and æsthetic quality go hand in hand is the simple truss span with the curved top chord, which by this means shows both a saving of material and an improvement in appearance. Quite as significant is the fact that the saving is greatest and the appearance best when the curvature of the chords is the most regular. The coincidence of æsthetic correctness with scientific efficiency is also illustrated in the relative slope of the diagonals of trusses with curved top chords. A wide variation in the slope of these members is æsthetically objectionable from the lack of satisfaction with the general outlines, and probably from a breach of orderliness. This dislike of large variation in the slope of diagonals has a scientific basis, for there is an economic inclination of such diagonals—about 45 deg.—and this inclination of the members is the one most pleasing to the eye.

Shams are Æsthetic Failures

Again, the most pleasing axial curve for an arch ring is the one which corresponds most nearly with the dead-load line of pressures. The use of curves which are noticeably flat on the haunches is particularly objectionable for arches of low rise, the reason being that apparently full advantage has not been taken of the possible rise. The form of arch ring which involves the greatest security for the piers in case of the development of an unbalanced thrust is also at the same time the most pleasing to the eye.

The sixth axiom is that there should be no attempt to conceal the true nature of the material of the bridge or the structural principles involved. Not alone in the realm of

ethics is deliberate deception and falsehood to be condemned, but also quite promptly in art. Any structure in which the real nature of the material or the structural principle employed is purposely disguised is a sham, and, therefore, a failure æsthetically.

Ornamentation Only an Aid

The effort to make monolithic concrete look like masonry by the use of joint lines is unsatisfactory to the eye, because the lines of the structure at once give the lie to the surface treatment from the fact that the arch is much flatter than it would be if constructed in masonry. The same reasoning holds good if rock-faced or cut stone masonry has been employed only to produce a pleasing surface finish. It may, however, be said that when the lines of the structure would be the same as if a masonry construction had been adopted, and that the apparent masonry is, to all intents and purposes, strong enough to take the loads, there is no more æsthetical objection than there is to the use of marble or mosaic facing to a concrete backing. The eye at once realizes that a facing only is intended, and that there has been no attempt at gross premeditated deception.

The seventh standard enunciated by Mr. Young is that the chief beauty of a structure arises from its general form. The truth of this axiom may be proved from many examples of structures which obviously possess beautiful lines, but which are quite devoid of ornament; and from many other examples which have been much ornamented, but which possess no charm, showing the total inability of decoration to compensate for lack of beauty in form.

This last standard has its corollary in the eighth axiom, that ornamentation should be employed only as an aid to the display of general lines and proportions. The author states that ornamentation may be legitimately and properly used to accentuate or contrast the structural functions and characteristics of the parts, to emphasize the magnitude or strength of the structure, or to afford relief to long unbroken straight lines or large blank spaces. It should never be applied thoughtlessly to the first clear space which occurs to the designer as in need of beautification, but only where it can serve as handmaiden to the chief element of beauty, the general form. Careful use should be made of the column, which should always have the function of supporting loads. The insertion of large columns over the piers of a bridge without any apparent load upon them is not permissible.

Massive Load-Bearing Parts

Decoration should always be applied to the lighter and frailer portions of a structure rather than to massive load bearing parts. We do not usually find great strength and great delicacy as co-existent attributes of the same object. The application of ornament to the chords or end posts of a truss is, therefore, incompatible with the character of these members. In masonry, the necessity for the radial arrangement of the voussoirs involves the desired accentuation of the ring, but no such condition exists in concrete construction. If the ring is accentuated, the true structural dimensions should be preserved, since noticeable deviations from such true dimensions are highly objectionable. Often faulty panelling will suggest a constant thickness of arch ring where such is not existent. The springings should be clearly defined, the abutting of the ring accentuated, and the arch ring should not appear to have no support and so to be liable to slip vertically down between the abutments.

Emphasis of the lateral stability of piers and abutments adds to our appreciation of their functions. Counterforts running from the tops of the piers to the top of the coping give the effect of security against side-wise displacement of the structure, and, at the same time, break the monotony of a plain spandrel wall above the piers. A batter of the face of the abutments is essential to obviate the appearance of a liability to move forwards. Skillful contrasts of color may be employed, but only to accentuate the main structural lines and to assist the eye to trace the functions of the various parts. Emphasis of strength, either directly,

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