Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht

Band: 14 (1992)

Artikel: Sense and quality of engineering design

Autor: Arenas, Juan J. / Pantaleón, Marcos J.

DOI: https://doi.org/10.5169/seals-853176

Sense and Quality of Engineering Design

Sens et qualité des ouvrages de génie civil

Sinn und Schönheit im Ingenieurentwurf

Juan J. ARENAS
Chairman
APIA XXI
Santander, Spain

J.J. Arenas, born in 1940, is since 1976 professor of structures at Santander University, where he has been engaged in the study of nonlinear behaviour of reinforced and prestressed concrete structures, as well as in the history of bridges. In 1987 he founded, with M.J. Pantaleón, APIA XXI, a civil engineering design firm.

Marcos J. PANTALEÓN
Vice-Chairman
APIA XXI
Santander, Spain

M.J. Pantaleón, born in 1955, is since 1985 professor of structures at Santander University where he has worked on the study of buckling of stiffened steel plates and cable structures. Co-founder of APIA XXI in 1987

SUMMARY
In this paper, we emphasise the increasing need for the aesthetic aspect of civil engineering works to be considered, as opposed to the purely functional criteria which were formerly used by engineers to assess these works. The aesthetic side of civil engineering should not be seen merely as something separate from the functional merits of the work, but rather as the external expression of the inner structural design. We conclude with the idea that beauty should feature in the list of the engineer's priorities.

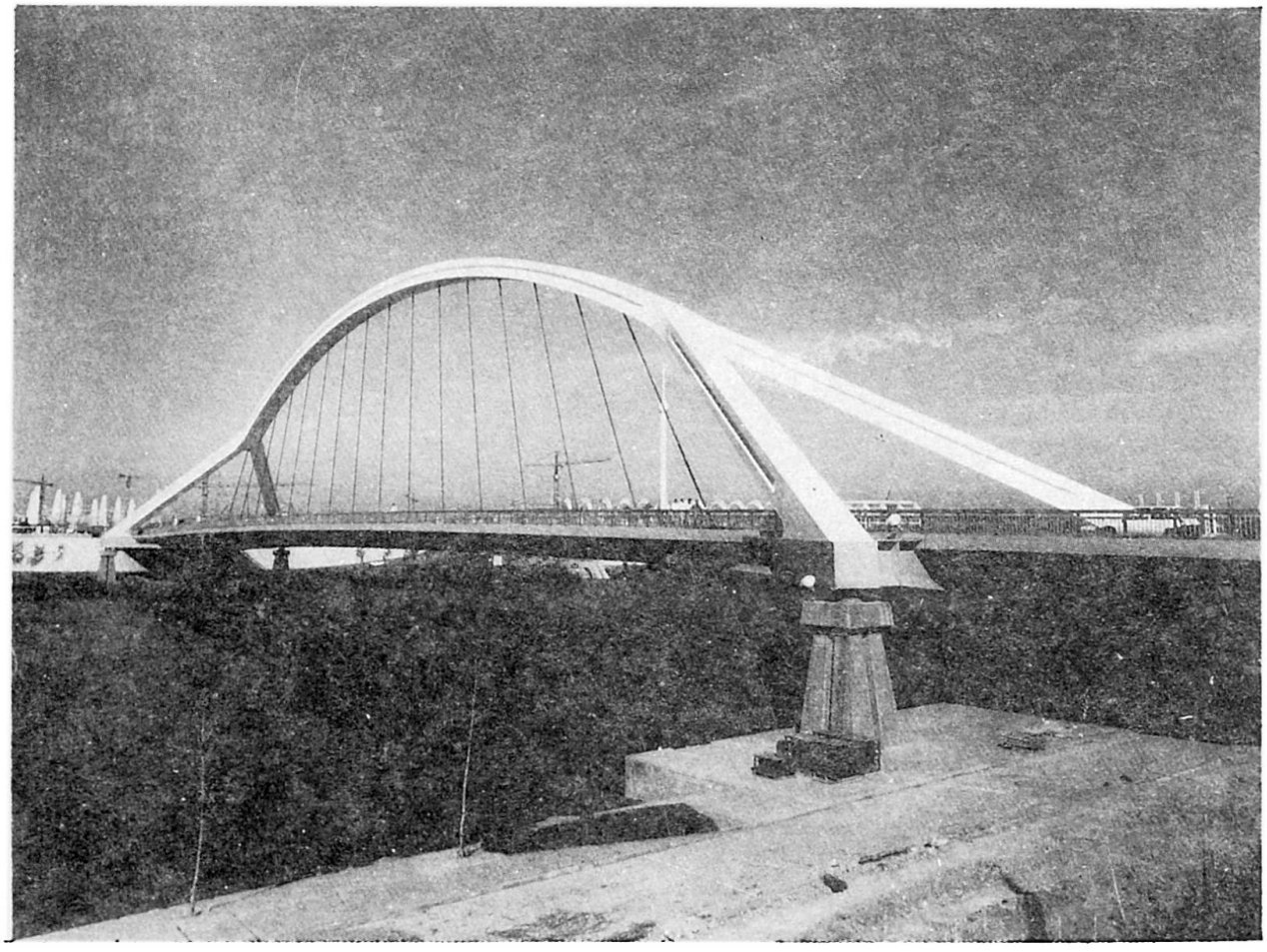
RÉSUMÉ
Face à une valorisation prédominante des valeurs fonctionnelles, cette contribution souligne l'importance croissante de la qualité esthétique des ouvrages de génie civil, dont la beauté doit venir non des interventions décoratives mais plutôt d'une bonne expression externe des valeurs internes dérivées de la conception et l'ordre du projet.

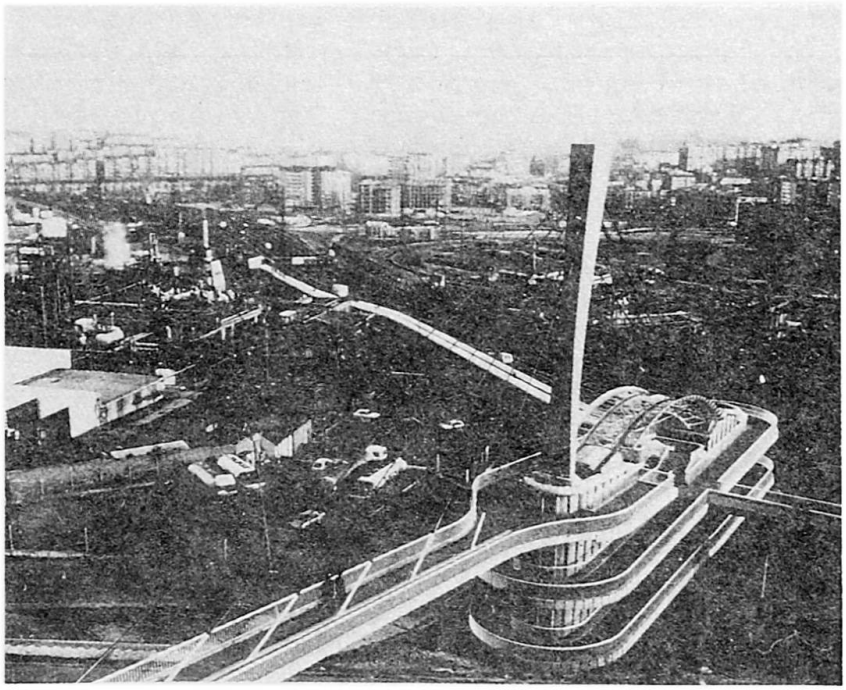
ZUSAMMENFASSUNG
Bei diesen Ausführungen möchten wir auf die wachsende Notwendigkeit hinweisen, den ästhetischen Aspekt bei Hochbauarbeiten zu berücksichtigen, anstatt wie früher üblich nur dem rein Praktischen Bedeutung beizumessen. Die ästhetische Seite des Hochbaus sollte nicht getrennt vom praktischen Wert der Arbeit betrachtet werden, sondern vielmehr als die äußere Form des inneren Baumusters. Zusammenfassend sei gesagt, daß die Schönheit unbedingt eines der Anliegen bei der Ausführung von Hochbauarbeiten sein sollte.

Civil engineering, as an academic and professional degree, was created in France, about 1750, with the foundation of the Ecole des Ponts et Chaussées. Historically, this was a turning point where engineers branched out from architects. Up to this time, the word engineer was only asigned to military, planning fortresses. The only known profession dealing with construction, houses, roads or bridges, was architecture. For example, the beautiful bridge over the Loire river at Blois, was built by Gabriel, whose position was "The King's First Architect".

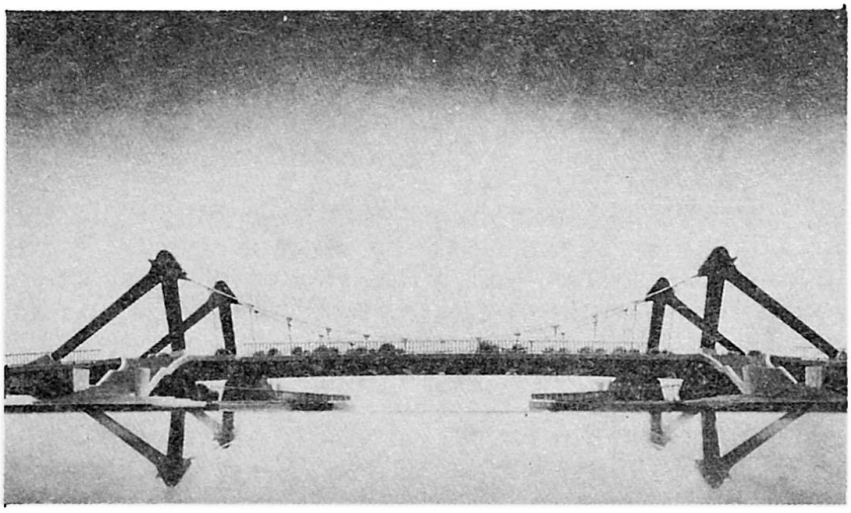
Architecture at that moment was mainly characterized by the use of decorative arts. Civil engineering arose then as a search of scientific knowledge that would lead to rationalist design as opposed to the empirical rules used up to that moment.

We should remember that at this time massive stone bridges, not very far from the Roman arches were still built. It was Perronet, first Dean of the French school, who undertook an experimental research that allowed him to build very slender vaults. He understood, for the first time, the mechanism of distribution of the trust force among the pier head and the two vaults springing from it. Almost heretically, he could conclude that "a more slender pier means more safety for the bridge". Those were technical advances but, for example, the neutral fiber of a plan cross section was not to be known until about 1815, when Navier, professor of the Paris School, brought it into being.





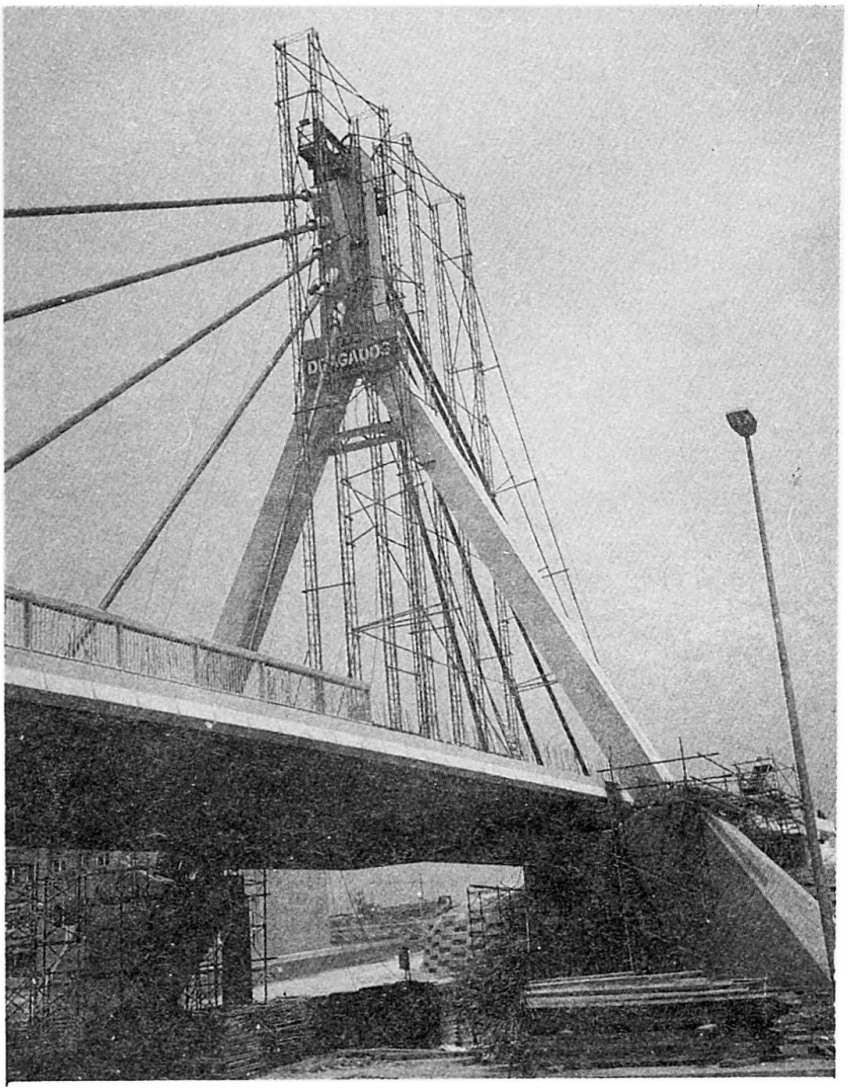
So, one may well understand the climate of scientific discovering and the pionners atmosphere where civil engineering grown up. Either there is no difficulty to imagine the overall indifference with which old engineers looked at the architects and their decorative arts. Faced to the challenge of crossing a ravine for a new railway with a lattice iron bridge, with serious difficulties until Castigliano assessing its internal forces, who should care about shapes and proportions? Was not the bridge, because resisting the load of heavy trains, beautiful enough by itself? Of course, it was, and this was an accurate assesment by that time.



No longer. We face now a completely different situation. At present time, modern societies ask for something more than resisting and lasting structures. The increasing environmental consciousness leads to require that civil engineering designs are not harmful for the landscape values. But, an step further, it should lead to ask for designs that embellish by themselves their environment.

Civil engineers were and continue to be nurtured with mathematical and physical knowledge as the basis of its science. However, since its birth-day, they have been educated in a certain disregard for the values of drawing and design. If they were

engineers they should not be confused with architects, worried only with aesthetic and decorative values!. Such situation has not changed very much until now, where the same basic gap between both professions appears. Civil engineers seem in general more able to calculate and even to build than architects. But, in spite of many really achieved engineer's designs, in not few cases we actuate under high economic preassure and with not much care about the cultural and aesthetic consequences of our work. In a historic moment where a certain search for art and beauty is spreading we should not be surprised to see architects being summoned to participate in, if not to conduct, important bridge designs.

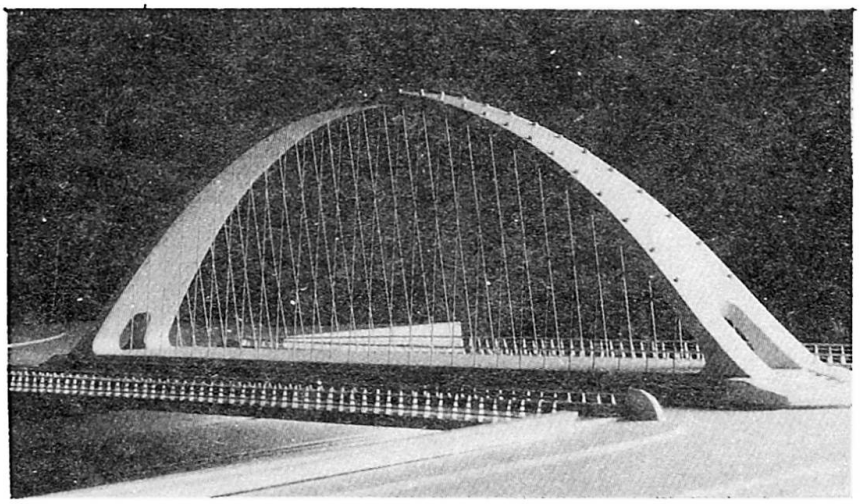


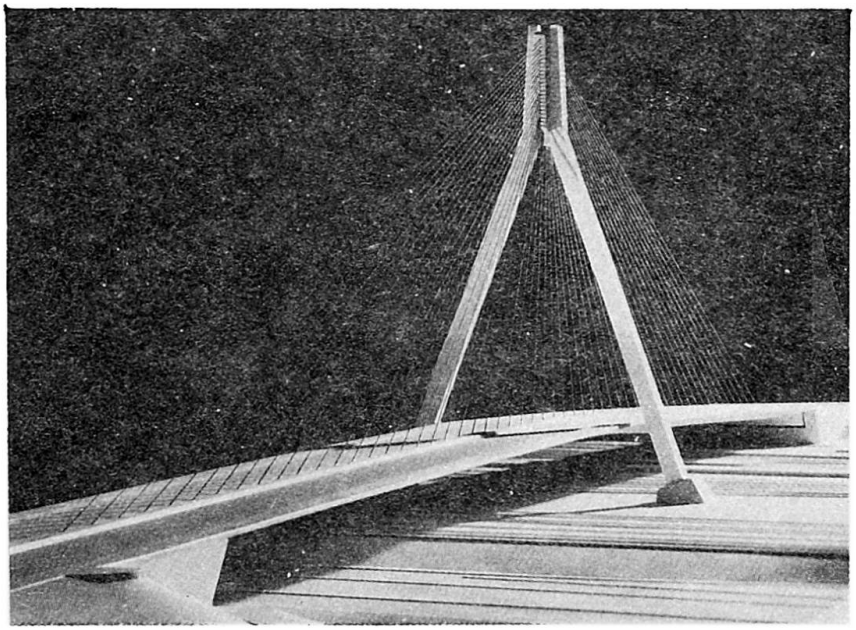
This fact may produce some anxiety among engineers. Looking in the long run, perhaps it should be good for us to think about the following points:

a).- The civil engineer should adopt a more open attitude towards cultural values, beauty and art. He should understand that aesthetic values are going to become functional in the sense that beauty is increasingly becoming one of the functions that a bridge must perform. A function, we think, as necessary in the near future as its resistance or durability.

b).- The aesthetic of an engineer's design should never be based on decoration. We should stress the importante, even ethical, that things appear to be what they really are. So, as the engineer job consists in knowing in depth the physical behaviour of the structural materials, he is best prepared to design shapes that fit the best the adresssed problem. We should avoid to feed the "look" culture, where anything may find social appraisal if its external aspect is nice or spectacular, however its internal lack of real values.

c).- The aesthetic values of an engineering work will always be grounded on the best external expression of a good internal design. We think that one must always flee from artificial decorations, that are those that do not arise from the essence of the construction. But, at the same time, we must try to found our work on a basic order, chosen in such a way that the functional requirements are satisfied, but which, in a nearly authomatic mode, will allow us to develop rithms, proportions and relations that, since Palladio (architect and engineer), we know constitute the basis of the very idea of beauty in a construction.





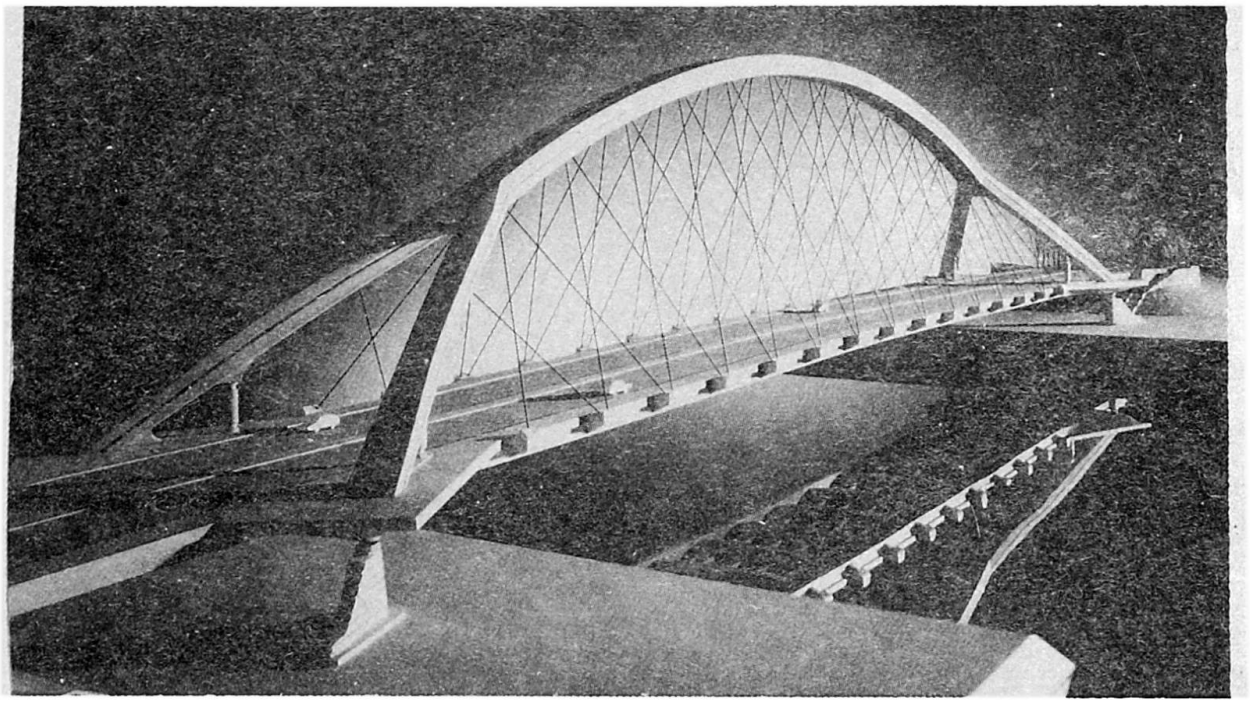
Principles like "less is more" and "form follows function", expressed by great architects with an engineer's mind, are to be strictly followed as a guarantee against errors of quiting the permanent engineering values.

d).- Of course, the basic engineering skills should be maintained. But we think that mathematics and poetry are well compatible. Further, the understanding of the performance of a structure is the only ground for achieving a good external expression of its values. Similarly, the engineer that allows his poetic impulses to arise is in the best position for materializing them. Even, trough some misterious cross-fertilization, the resistant feeling may insufflate poetical sense and the creative tension may lead to a more clear vision of the resistant phenomenon, offering solutions that otherwise perhaps would not appear in the engineer's mind.

e).- We are convinced that this is the right time to look for a more integral education program for the engineerig students. Where, inspired in the architects education, Strengh of Materials is learnt not over shapeless beams but rather working on beautiful volumes, whose beauty is partly derived from its good adecua-

tion to the resistant problem. Where the cultural and aesthetic values are present from the beginning and where the students are told that we look for the the stress and strains of the material but relating them in a permanent way with the quality of these shapes, as adequate to such a resistant performance. This is perhaps the right time to end with the rather artificial division between architects and engineers, arisen in 1750.

Of course, this is not an easy task: Being educated as good engineer and, at the same time, as a nearly architect. Neither it was for Perronet to decide to narrow his bridge piers or for Navier to find the neutral fiber of a cross section. Probably we are faced again with a big challenge: Putting up an educative system with such clear objectives is perhaps the Castigliano theorem to be solved by the engineers profession at the end of this century.



Photos included in this paper are bridges designed by APIA XXI in the last four years, in different Spanish cities:

(1): Barqueta steel bow-string bridge over Guadalquivir river, 168 m span, at Sevilla. Owner: EXPO'92. Contractor: AUXINI-ENSIDESA.

(2): Cruces concrete structure and cable-stayed footbridge, in Bilbao. Owner: Vizcaya Council. Contractor: EKONE.

(3): Model of Lago suspended bridge over the Channel of EXPO'92, Sevilla. Deck in composite construction. Contractor: AUXINI.

(4): Concrete cable-stayed bridge built in Valencia. Main span: 65 ms. Owner: SEPEs. Contractor: DRAGADOS.

(5): Model of Oblatas concrete arch bridge, with 50 m span, in Pamplona. Owner. Pamplona City Council.

(6): Model of stayed steel-concrete bridge at Zaragoza: Two equal spans of each 168 meters. Owner: Zaragoza City Council.

(7): Model of tied arch concrete bridge over Ebro river, at Zaragoza. Main span: 216 ms. Owner: Zaragoza City Council.