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

Band: 11 (1980)

Artikel: On aesthetics in structural engineering

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DOI: https://doi.org/10.5169/seals-11232

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On Aesthetics in Structural Engineering

Sur l'esthétique dans le génie civil

Über die Aesthetik im Ingenieurkonstruktionsbau

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SUMMARY
The item treats the subject, object, setting, solution etc. of the problem. It finds its solution by formulated aesthetical components, through structural forming and detailing, based on two functions of the structures – carrying purpose and aesthetical effect, under definite ,,requirements, unavoidability and riteria''.

RESUME
L'article examine l'objet, la matière et la solution du problème. Il trouve sa solution dans la présence des composants esthétiques formulés, par une forme structurale et des détails constructifs sur la base des deux fonctions d'une construction: fonction structurale et fonction esthétique.

ZUSAMMENFASSUNG
Der Aufsatz betrachtet das Objekt, den Gegenstand, die Grundlagen, die Lösung und andere Komponenten dieses Problems. Das Problem kann gelöst werden mit Hilfe formulierter ästhetischer Komponenten, konstruktiver Formgestaltung und Detailierung und aufgrund der zwei Funktionen des Bauwerks: Tragverhalten und Aesthetik.

All material things with a definite form and appearance in space have become possible and function reliably due to their immutable and moulding carrying structure. This comprises the global basic and material conditions and media for life and work of people, for the existance and development of society (all buildings, bridges and other building and architectural equipment,all equipment and installations of technologies, all machines and products of the industry, all modes of transportation, etc. The structures ensure (1) their own spaces and forms - according to the functions and purposes, (2) their rationality and effectivity - according to the requirements and conditions and (3) their availability and reliability - in general. The structures (in the conditions of limited stresses and deformations) carry and balance all loads and influences (on the buildings, equipment, etc) which arise due to their functional purposes and external conditions. With all this the structures represent themselves the highest form of functional organization of the structural materials. Their creation is on of the most supreme manifestation of the human creativity - the structural creativity.

Besides their utilitarian purpose the material things also have aesthetical effect and perception with their (1) volumetric-spaced form and (2) externally detailed appearance. This form and appearance are their fundamental visual "aesthetic components"[1]

The Aesthetics in Structural Engineering presupposes: consicusly set up requirements for aesthetical effect and perception of that which (1) is created by man, (2) possesses the aesthetical components form and appearance, (3) moulds these aesthetical components with the participation of the structure.

The matter of the problem Aesthetics in Structural Engineering is valid especially for the buildings, bridges and structural equipment, which possess an exceptional diversity and individuality and which have the mark of uniqueness and creativity as a product of architects and structural engineers.

For all of them the volumetric-spaced form, as first aesthetical component, is formed up always and immutably with the participation of their carrying structure. As regards bridges, other structural equipment, buildings, etc., by and large whenever and wherever the structure is visible, this also refers to the second

aesthetical component - externally detailed appearance. [1],[2]

The treatment of the problem Aesthetics in Structural Engineering obtains, therefore, not some independent "Aesthetics of Structures", but "Aesthetics of Buildings, Bridges, etc.", which aesthetical components Form and Appearance are the result of their immutable structure. Any structure is determined objectively on the basis of some form, corresponding to certain function, complying with the relevent technical and economic possibilites, etc. Of course, the opposite is also taken into consideration, particularly the strong and even determinative influence of the structure on the form. [3]

In a historic aspect, the development of the structures (and structural materials) has determined (to one or another degree), the forms and the appearance of the buildings, bridges, etc. - not only with their utilitarian purpose, but also with their aesthetical effect and perception. Naturally, this development has always been based on a dynamic and constantly perfecting unity of "function - form - structure", of "architecture - structure - industrialization", of "settlement - buildings - building szstems - structural szstems", etc.

The structures are product of structural creativity and creative structuring on the basis of the constantly developing science and theory of the structures. We shall note in this respect the analogy to the musical creativity, which is also based on the theory of music (for harmony, counterpoint, rhythm, etc. [3]

The Science and the Theory of the Structures reveal the regularites and create knowledge for organizing and structuring of the structural materials in carrying-structural forms and szstems - structures. They are vast and complex science and theory, because the creation of one structure requires knowledge and experience (science and theory) in many scientific and technical fields and directions. [3]

It is easy to understand, when it is a question of Form and Appearance of the structures, that they are product and result mainly of the creative processes and activites: "structural forming" and "structural detailing". These are complicated complex

multicyclic creative processes, starting from "primary functionally-technological form", going through the "possibilites of the structural cross-sections", in order to obtain the "final structural form and appearance", with their two functions: (1) primary carrying purpose and (2) secondary aesthetical effect. /3/

In the process of actualizing the first function (the primary carrying purpose) two basic objective criteria are acting simultaneously. The first one is the "material criterion" - for minimum expenditure of material. It is a permanent one in the sense, that for all times and under all conditions it leads to respectively determined structural forms and detailing of the structures. The second one is the "technological criterion" - for minimum expenditure of labour and energy. It is a dynamic one in the sense, that for all times and even for each separate case it leads to respectively different forms and detailing of the structures.

Here we would like to note that the technologies are developing towards satisfying the "material criterion". In this way the structural engineering is approaching a structural perfection: creation of structures with minimum expenditure of material,labour and energy. Many actualizations and achievements are well known, when the "final structure", subordinated exactly to the requirements for minimum expenditure of material, labour and energy, has determined the "final forms and appearance" of the buildings, bridges, etc. with indisputable and aesthetical qualites that have stood the test of time.

It can be also definitely claimed, that the architectural and structural styles of the buildings, bridges, etc. of each epoch are the result exactly of such structural forms and detailing./1/

Up to this point we have outlined everything in order to justify the position: that after the optimum actualization (on the basis of the above mentioned objective criteria) of the first function of the structures (primary carrying purpose) it follows that their second function (secondary aesthetical effect) should be actualised, too.

We are on this position because we take the liberty to see that the structural knowledge and feelings (theory and creativeness)

which leads towards form and appearance of the structures, subordinated to the above mentioned objective criteria, have always formed and are forming man's basic criteria for an aesthetical effect and perception. [4]

We shall take the nature as an objective example. Everything in nature, which has immutable carrying and forming structure is created, in general, as a result of unavoidable objective (1) "necessity" - for some function and purpose, (2) "requirements" - for some balance and stability, (3) "criteria" - for some optimum expenditure of material and energy. And in this case, man is well aware of the "beauty in general" of nature, which has been created not on the basis of some "preliminary" human aesthetical criteria for its effect, but which, in fact, has created "resultant" human aesthetical criteria for its perception. We do underline "beauty in general", because from man's aesthetical point of view in the world are existing not only beautiful, but also unpleasant things, but they will be an unavoidable result of some objective "necessity", "requirements" and "criteria".

We do underline also the "resultant human aesthetical criteria", because a man's unavoidable objective "aesthetical adaptation" to nature is available too.

On the other hand, every thing that is man's product, which again has immutable carrying and forming structure, is a result of the same unavoidable objective "necessity", "requirements" and "criteria". And here, from a man's aesthetical point of view will exist also and unpleasant material human works, but they must be result also of the same unavoidable objective "necessity", "requirements" and "criteria". Towards them the man behaves himself with the respective "aesthetical tolerance" or "aesthetical adoptability".

It is exactly on this point that the cardinal question has to be put: what should man's subjective aesthetical estimation be?

A supplementary one to the above mentioned unavoidable objective "necessity", "requirements" and "criteria", or such that should be established mainly on their basis? And our answer is: man's aesthetical estimation is formed (or should be formed) following

the forms and appearance, according to the mentioned objective "necessity", "requirements" and "criteria". This opinion of ours becomes, however, difficult to be contradicted, if in the function (purpose) we include not only "objective utilitarian", but also "subjective aesthetical" requirements. But in this case the aesthetical requirements must have some established and durable determination and justification with a character of social objective categories and criteria, such as have not been determinated up to now.

Evidently, there will be things not beautiful from the point of view of man's subjective aesthetical criteria. But they should be the result also only of a respective "established (immutable) necessity", in the presence of a respective "objective (explicit) unavoidability". But it is possible also, that they are simply an expression of one subjective estimation from the positions of old (of the past) aesthetical criteria, etc. [1]

Asserting that, we have in mind the historical dynamic formation of man s aesthetical criteria for perception: from antique columns to modern space-ships, from old arc bridges to contemporary hanging bridges, from the first domes to the modern hanging roof structures, etc. [4]

We would like to refer to two well known truisms.

The first one is - "beauty must be also justified". And we shall add: in what other way, than by the unavoidable objective "necessity", "requirements" and "criteria"?

The second one is - "man is something great, because is something adaptable". And here too we shall add: to what should man adapt his aesthetical criteria, if not again to those forms and appearance, resulting from the same unavoidable objective "necessity", "requirements" and "criteria".

In this respect it is necessary to have in mind that man's emotional and rational nature are always in some unity, having in mind, that every "emotional effect" is always accompanied by a "rational perception", which on its part is based (historically and naturally) also on the forementioned objective "necessity", "requirements" and "criteria".

The Aesthetics in Structural Engineering has its objective dynamically developing laws and regularites, which do not depend on some "preliminary" emotional notions and postulates but are the result of some rational structural logics and approach. Following this structural logics and approach the structural engineers are creatively looking for new structural decisions - forms and appearance - thus provoking and affirming new understandings and criteria for beauty and aesthetics. [3],[4]

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