

AESTHETIC ASPECTS OF THE DESIGN OF ENGINEERING STRUCTURES IN THE EDUCATION

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Abstract

Aesthetic aspects of engineering structures can expediently be taught to civil engineering students by formulating principles of aesthetics, which can be immediately applied in design. The paper enumerates such principles and visualizes them on photos.

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In the university education of students in civil engineering, the triplicity: function-structure-form must be considered. However, traditionally, teaching of structures dominates. Function is rather neglected, partly justified by the simplicity of the function of engineering objects. The aesthetic appearance of engineering structures is hardly mentioned, although it is the determining characteristic of their exterior.

The lecture 'Design of Engineering Structures' intends to overcome this shortcoming. In the frame of this lecture our Department also teaches basic principles of esthetics. However, teaching aesthetics meets some obstacles. The not wholly exact world of thoughts of aesthetics is alien to the whole way of thinking of civil engineering students. Thus was necessary to try to formulate the main thoughts of aesthetics in clear principles and rules, easily to survey, which the civil engineering students can understand, learn, and apply in their design work. We can reach this goal only if the message of aesthetics is considerably simplified. We think that this is still better than overwhelming students with profound aesthetic lucubration, they cannot apply to specific structures, and try to forget in the shortest possible time. The main principles of aesthetics can be summarized as follows:

- order;
- proportions, rhythm, symmetry-asymmetry;
- shaping, completion;
- character;
- form as expression of static behaviour;
- the structure should fit to its environment.



Photo 1a.



Photo 1b.

Further points to be taken into account:

- surface forming, colors;
- light appearance or suggesting stability;
- phantasy, playfulness;
- aesthetic problems of outside arranged load-bearing structures.

Taking these aspects one by one we can state the following:

- Order must be visible. Objects arranged seemingly at random (e.g. parabolic antennas arranged for telecommunications reasons) should be 'put in order' by round mounting balconies which give an impression of order even if the antennas continue to be arranged 'at random' (*Photos 1a* and *1b*).



Photo 2a.



Photo 2b.



Photo 3a.

- The requirement of good proportions can be often fulfilled by applying the rules of golden section. Let us compare e.g. the posts carrying flood-lights shown in *Photos 2a* and *Photo 2b*. The post in *Photo 2b* yields – just due to the application of the golden section – an agreeable view, while looking at *Photo 2a* we expect the post to overturn.
- The shaping, completion also belong to the agreeable appearance. When looking at the chimney in *Photo 3a* we do not really understand why it is



Photo 3b.

discontinued just where it ends, while with the (somewhat old-fashioned) chimney of *Photo 2b* we do not have such doubts.

- Character means that the structure or the structural element should clearly show how it is. If it is curved, there should be no doubt about its shape, i.e. it should be not 'almost straight'. For example we cannot decide for sure whether the lower edge of the main girder of the bridge of *Photo 4a* is straight or curved. The answer can be given only by the shadow of the ledge cast by the sun shining at an appropriate angle (*Photo 4b*).
- It is always advantageous if the shape of the structure corresponds to its static behavior and expresses it. The shape of the famous Sydney Harbour Bridge (*Photo 5a*) suggests that it works as an arch clamped at both ends, but at closer examination it turns out that it is a two-hinged arch. On the other hand, the shape of the pedestrian bridge shown in *Photo 5b* completely corresponds to the bending moment diagram of the continuous beam, i.e. of the real structure.
- An engineering structure, due to its dimensions, cannot merge with its environment, it can only fit to it. This means that – as it concerns its style, its appearance – it should be in harmony with its environment. Thus the water tower of *Photo 6a* fits very well into the elegant resort environment of the Margaret Island, while that of *Photo 6b* fits to the much more puritan industrial surroundings.
- The application of colors can greatly enhance the apparition of an engineering structure. Glaring colors are generally avoided. It is advantageous to paint



Photo 4a.



Photo 4b.

- the load-bearing elements of higher order (e.g. main girders) with a darker color than those of lower order (*Photo 7*). Membrane structures almost require glaring colors: let us compare, as an example, the 'dirty' color of the pneumatic tent of *Photo 8a* with the white and red colors of that of *Photo 8b*.
- Both the light appearance and the form suggesting stability can be aesthetic. The light appearance is elegant (*Photo 9a*), the form suggesting stability indicates reliability (*Photo 9b*).
 - With some phantasy (which can lead to playfulness) otherwise monotonic engineering structures can be made interesting. As examples *Photo 10a* shows a Dutch road sign girder, and in *Photo 10b* a Spanish pylon can be seen.
 - Outside arranged load-bearing structures can also enhance variety. The Dutch bus garage of *Photo 11* would be very monotonic if its load-bearing structure had been placed in the inside. The space trusses painted red lended an agreeable variety to the otherwise monotonic aluminium sheeting.



Photo 5a.



Photo 5b.

The above brief summary shows how it is possible to present the basic principles of aesthetics in a form which civil engineering students can understand and learn. In any case, appropriate photos are needed to illustrate the above principles. (It should be remarked that – surprisingly - the great monographies on aesthetics mostly do not contain pictures, only general principles and, consequently, they are not suitable to be used in engineering education.)

References

- [1] Kollár, L.–Vámosy, F.: Mérnöki alkotások esztétikája, Akadémiai Kiadó, Budapest. 1996.



Photo 6a.



Photo 6b.



Photo 7.



Photo 8a.



Photo 8b.



Photo 9a.



Photo 9b.



Photo 10a.



Photo 10b.



Photo 11.