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Objekttyp: **Article**

Zeitschrift: **IABSE reports = Rapports AIPC = IVBH Berichte**

Band (Jahr): **79 (1998)**

PDF erstellt am: **22.06.2024**

Persistenter Link: https://doi.org/10.5169/seals-59943

Structural Impact on the Environment: Aesthetics

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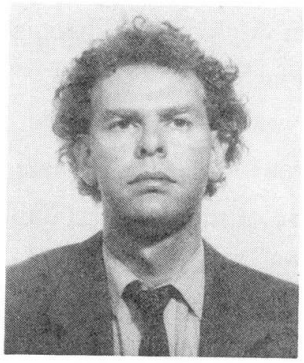

Mark Lenczner, born 1961, graduated from Imperial College in civil engineering with 1st class honours, and obtained a post-graduate DEA from the ENPC, Paris. After working in London with SOM, in 1990 he joined the structural design section of Taisei. He has worked on numerous major international and domestic projects and is also a qualified Licensed Architect.

Summary

Of the various ways that a structure can affect the surrounding environment, it is perhaps aesthetics that has the greatest impact on society. Whilst bridge engineers have recently paid increased attention to this aspect, the aesthetic aspects of building structures has generally been left to the domain of architects. Yet the role of the structure in determining the appearance of buildings can be significant, and merits increased input from engineers. This applies to all types of buildings. As most people live and work in a built environment, society has much to gain from any improvement that can be made. This paper attempts, albeit briefly, to highlight some points on how the structural engineer can readily make a difference on various types of projects, and improve both the building aesthetics and the surrounding environment.

1. The challenge to improve aesthetics

Improving the aesthetics of buildings directly enhances the built environment in which we live. It also increases the public acceptance of buildings and other structural works. The creation of technically proficient yet often dull or jarring and 'impersonal' buildings means we are not succeeding in creating a pleasant environment, albeit safe, convenient and technically advanced.

Many modern constructions are not held in high regard by society. Indeed, when the public are asked to name their preferred buildings, they will often refer to those built many years ago and considered as 'traditional'. This will typically be buildings made from 'traditional' materials in 'traditional' styles. The materials would typically be those available locally, whether in stone, wood, bamboo, brick or even dried earth. The 'style' was often a development of

function and a response to the local conditions and environment; good aesthetics often 'fell into place' in meeting these requisites, making adjustments to suit cultural styles and in providing interest to avoid monotony. The result was often buildings and a built environment in which people felt 'comfortable', an idyll which people still appreciate, despite the shortcomings of some of these constructions.

Admittedly, one common theme is, of course, the use of natural materials, and the empathy humans tend to have to them. Yet the use of modern structural materials is not necessarily a preclusion to creating 'aesthetic' structures. The recreation of new buildings in old styles can often prove unsuccessful when we sense that the materials are not being used in the same original conditions. It is more how we use them, and in particular the overall form or structure in which they form part, and how well the whole responds to the numerous needs that will determine their assessment.

Through interfacing with architects at a concept stage with and by a re-consideration of the appropriateness and potential of certain structural forms and materials, and their expression, the aesthetics of even the most mundane of buildings can be enlivened.

2. The roles structure can play

Although building aesthetics is often left to architects, they do not have a monopoly on the ability to judge aesthetics. Furthermore, the potential of structure is (usually) best understood by engineers. Structural engineers should thus not refrain from proposing solutions; most good architects would appreciate the possibilities that can result.

2.1 Form

Form, when derived from a sense of function, results in both variety in shape and a sense of aptness and belonging. The conditions which dictate the form and function depend on both the type of building and its location, and are also a response to the local environment (both human and natural). Such considerations rarely lead to the same solution, so there is rarely any standard 'right' solution. This in itself should discourage monotony, a major problem for improving the aesthetics in the built environment. This is also true for considering different parts of the same building. Time, construction and budget considerations aside, lack of inventiveness or imagination is a major impediment to attaining good solutions. The best solutions are likely to result from a holistic approach, viewing the building, its shape and surroundings, as a whole. A structural solution derived such will often produce a 3-D form that allows numerous possibilities for creative and aesthetic expression, even if only parts of

the structure are expressed.

The ability to create in 3-D is compounded somewhat by the 2-D or linear nature of most structural components (beams, slabs, etc.) that we use both in our analysis models and in actual construction. This contrasts with the 'micro-structure' elements , such as brick, used more frequently in the past. Yet think in 3-D we must. Indeed, the connection of the elements making a frame can in itself be part of the aesthetic concept, perhaps reflecting how the building is put together.

Addressing how the structural form is detailed and co-ordinated into the finished form is also important, hopefully avoiding the addition of unnecessary marring 'extras'. Similarly, the structure should not just appear 'clever' from an engineering point of view, but appear pleasant to the human eye.

2.2 Material

Expressing structure as an aesthetic thus also concerns us with exposed material. Steel and concrete have an industrial image. They are not typically viewed as 'aesthetic' materials and are usually covered by building finishes. Yet they are utilised widely in numerous other forms and media (e.g. cars, furnishings, large 'non-building' structures) with less objection.

Part of the problem lies in their mixed past-record as used in buildings. For steel, problems include providing corrosion protection, maintenance and the sometimes unsightly protrusions and 'complexity' of some members. There is also the challenge in ensuring their fire-resistance in the exposed state. For concrete, problems remain with staining, deterioration and cracking concerns. Yet we equally know that with greater attention paid to material behaviour, detailing and construction methods, most of these problems can be overcome, and appear in colours and textures to suit as required.

Indeed, with thorough investigation of possible design concepts, these materials can be expressed in attractive ways, as existing examples can testify. In Japan, exposed concrete is now accepted and frequently preferred to more 'artificial' paint-type finishes. Yet such examples are generally exceptions, rather than a standard to which we must regularly aim for. We can do more to express the numerous possibilities these, and other materials, have for aesthetic expression, and be structurally efficient. Working in tandem with architects, building service and lighting specialists etc., such structure can be made to be the 'feature' of the building design, a plus gained without the need for the additional cost of cladding, which itself can often have a pre-fabricated unnatural image. When this is combined with making not just the material but the structural form of the building the chief characteristic, then one is on the

way to creating an attractive and efficient building.

Mention should also be made of the still rather under-used structural properties of glass, timber, stone, non-ferrous metals and new composite materials. Although their potential is known, and used on occasion, it is usually as a response to an architect's requirement, and done on a case-by-case basis. Yet when we adopt their structural potential as a starting point in the concept design, we can readily produce complete 'aesthetic' structural forms, rather than as 'in-fills'.

3. SETTING

The fitting into the surrounding landscape, be it urban, rural or natural, is a major influencing factor of aesthetics, and will often be the critical factor in the success of a design. The following are just a few examples of how engineers can help address aesthetic issues.

3.1 Prime Nature

For projects in prime natural settings, it may often be preferable to blend/conceal or hide the works altogether by partly building underground or into the hillside, or create low-side walls of 'natural' structural materials. The creation of the exposed surface roof form will usually be the primary aesthetic consideration. Here the engineer can lead in designing long-span contoured structures to suit both external aesthetic and internal planning requirements, with the surface finish blending into (landscaped) or perhaps even complementing the surrounding scenery, perhaps using tensile net or contoured space trusses of wood or steel, with a translucent skin. Overtly 'regular' structures are unlikely to blend in.

3.2 Semi-rural, suburban outskirts.

In semi-rural or city outskirt-settings, the designers should similarly be expected to provide non-obtrusive solutions, though not to the same level of concealment. The track record of such developments is generally not so good; typically developers are primarily looking for commercially viable solutions to purely functional requirements. Apart from certain agricultural-related structures such as silos and the like, whose function demands tall structures, typical large developments would be low-rise commercial, warehouse or factory-type buildings. Here also the engineer can instigate improvements.

For example, the mono-pitch or low-angled flat roof is a fairly standard solution, but is often not a true expression of the actual structure inside supporting it, as they often have interior

columns, particularly where over one-storey high. Sloping roofs in three-dimensions could provide a visually more-interesting solution, with structural merit, and allow more natural daylight inside. For the case where a single clear-long span is required, exposing the spanning structure outside creates numerous possibilities for expressing a distinctive solution. The side-walls also, normally summarily clad in bland sheet-cladding, can be considered as a opportunistic mural to display geometrically attractive lateral resisting systems. Bracing need not always be concealed, nor X or V shaped. Geometric star shapes, even curves and non-rectangular solid-forms can provide vastly increased visual interest. An exposed structure of almost any form could be designed to improve upon most standard clad-solutions.

3.3 Urban

It is for urban settings, however, where the problems of improving aesthetics is most demanding. Not only can adjacent buildings distract from one's preferred objective, but the confinements imposed, be they functional, legal or technical, are stricter. One must also attend to the building as seen from a distance, and also at street level 'close-up', where the selection of material is more crucial. As such, the criteria for long or tall structures can be different to smaller structures which are less visible from afar.

For long-span, or in particular high-rise buildings, the structure is critical in defining the building's form. For very tall structures, utilisation of the whole depth of the building's volume, such as for tube or coupled perimeter frame and wall structures, is often a stability requirement. The result is often a fairly regular solid form. From a far distance, the outline of groups of such skyscrapers can give a city a 'dynamic' look. Closer-up, however, their simplistic shapes can sometimes appear harsh and dull. This problem can be addressed somewhat through the design of the cladding, or perhaps more efficiently with 'engineering expression'.

Some of the solutions used are the expression of perimeter framing and cross bracing, and the highlighting of 'megaframe' modules, belt-trusses and the like. Some of these have been successful in providing further visual interest, structural efficiency and freeing the architect to create more varied forms (or voids), to suit other requirements perhaps, between the critical structural members. The engineer is most influential in defining the 'megaframe' and can create pure and logical forms, which the public can appreciate, and preferably not muddled or concealed by the addition of less relevant elements. The structure need not always be literally 'on view' ; more subtle expressions of the 'muscular' form and shape of the structure projecting out but still enveloped by the cladding can also be effective.

The appearance at street level is also critical in creating a pleasant environment. Well-

engineered structures can often lose their potential appeal and clarity if the form of the overhead superstructure is masked at ground level, such as by ill-thought out cladding and in-fills, so losing the potential of forming a dramatic open-space framed within or around the structure. Transfer structures at lower levels can also similarly confuse the form of the main superstructure if not treated correctly. As the designers responsible for these elements, we should not passively accept inappropriate treatment.

For smaller buildings, the structure is typically less critical in moulding the form and expression of the building, yet the potential and improvements to be gained from the lack of attention to structural expression are perhaps even greater. The somewhat ubiquitous approach of designing a skeleton to support a predetermined layout normally leads to buildings of a rather 'two-dimensional' or 'hollow' character, apparently composed of facades of either overt simplicity, or featuring rather illogical ins-and-outs, belying the fact there is a structure, hidden from view, on which to develop the design. In many cases, when structure is expressed, it is too often disguised to look like something it is not.

This is partly a material problem, with reluctance to expose structural materials, and partly a lack of appreciation of the potential to be gained (including functional benefits) of encouraging expression of structural form. This is particularly so for 3-D forms, and their inherent structural efficiency and flexibility, but also for the part expression of wall or column/beam elements, and the interesting spaces they can form. Indeed, the interior expression of structure is another area where the interior environment can be similarly improved to create more inspiring living space.

Conclusions

The ways in which our built environment can be improved are many, yet attention to aesthetics is perhaps on of the most influential. The scope for structural engineers to play a leading role is significant and merits increased attention to be paid. The working relationship with architects also needs to be addressed so that this potential can be greater realised. The built environment is almost around us wherever we go. Indeed, the examples I will be taking for illustrating these points are all in the immediate vicinity of where I live, but the principles can be applicable anywhere. Attention to aesthetics does not require much additional effort, yet the rewards to be gained for society as a whole can be many.