THE ROLE OF STRUCTURE IN ARCHITECTURE

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Abstract: The article covers is concerned with the programmatic aspects of the relationship between architecture and structure. In particular, deals with the process by which the form and general arrangement of structures for buildings are determined - with the design of architectural structures. Moreover, several fundamental issues according to architecture were discussed.

Key words: philosophical preoccupation, armature, programmatic, resolution, architectural design, space-enclosing elements, subsequent, masonry, masonry.

The architect who considers him or herself to be an artist, dealing through the medium of built form with the philosophical preoccupations of the age in which he or she lives, is surely engaged in a titanic struggle. One aspect of that struggle is the need to determine building forms which are structurally viable. All artists must acquire mastery of the technology of their chosen medium but few face difficulties which are as formidable as those who choose buildings as their means of expression. The sculptor has to contend with similar structural problems but his or her difficulties are trivial by comparison with those of the architect. The difference is one of scale - the size of a building, compared to that of a work of sculpture, means that the technical hurdle which must be surmounted by the architect is of a different order of magnitude to those which are faced by most other artists. The structure of a building is the armature which preserves its integrity in response to load. It is a bulky object which is difficult to conceal and which must somehow be incorporated into the aesthetic programme. It must therefore be given a form, by the building's designer, which is compatible with other aspects of the building's design.

Several fundamental issues connected with the appearance of a building including its overall form, the pattern of its fenestration, the general articulation of solid and void within it and even, possibly, the range and juxtaposition of the textures of its visible surfaces are affected by the nature of its structure. The structure can also influence programmatic aspects of a building's design because the capability of the structure determines the pattern of internal spaces which is possible. Its span potential will deter mine the maximum sizes of the internal spaces and its type affects the extent to which the sizes and shapes of the spaces can be varied both within an individual storey and between storeys. The relationship between structure and architecture is therefore a fundamental aspect of the art of building. It sets up conflicts between the technical and aesthetic agendas which the architect must resolve. The manner in which the resolution is carried out is one of the most testing criteria of the success of a work of architecture. This book is concerned with structural design for architecture. It complements my previous volume, Structure and Architecture, and discusses the selection of structure type, the selection of structural material and the determination of structural form.

It deals primarily with the development of the idea of the structure for a building - that first stage in the structural design process which is concerned with the determination of the elementary form and arrangement of the structure, before any structural design calculations are made. It is intended primarily for architects and it is hoped that it will enable students and members of the profession to gain a better understanding of the relationship between structural design and architectural design. The final form which is adopted for a work of architecture is influenced by many factors ranging from the ideological to the severely practical. This book is concerned principally with the building as a physical object and, in particular, with the question of the structural support which must be provided for a building in order that it can maintain its shape and integrity in the physical world. The role of the building as an aesthetic object, often imbued with symbolic meaning, is, however, also central to the argument of the book; one strand of this argument considers that the contribution of the structure to the achievement of higher architectural objectives is always crucial.

Technical issues are accordingly considered here within a wider agenda which encompasses considerations other than those of practicality. The relationship between the structural and the non-structural parts of a building may vary widely. In some buildings the space-enclosing elements - the walls, floors and roof - are also structural elements, capable of resisting and conducting load In others, such as buildings with large areas of glazing on the exterior walls, the structure can be entirely separate from the space-enclosing elements . In all cases the structure forms the basic carcass of the building - the armature to which all non-structural elements are attached.

The visual treatment of structure can be subject to much variation. The structural system of a building can be given great prominence and be made to form an important part of the architectural vocabulary. At the other extreme, its presence can be visually played down with the structural elements contributing little to the appearance of the building. Between these extremes lies an infinite variety of possibilities. In all cases, however, the structure, by virtue of the significant volume which it occupies in a building, affects its visual character to some extent and it does so even if it is not directly visible. No matter how the structure is treated visually, however, the need for technical requirements to be satisfied must always be acknowledged. Structural constraints therefore exert a significant influence, overt or hidden, on the final planning of buildings. Information on basic forms of structure - the range of structural possibilities - is essential to the success of this process; this is provided in subsequent chapters which deal separately with the four principal structural materials of steel, reinforced concrete, masonry and masonry.

The principal forms of loading to which buildings are subjected are gravitational loads, wind pressure loads and inertial loads caused by seismic activity. Gravitational loads, which are caused by the weight of the building itself and of its contents, act vertically downwards; wind and seismic loads have significant horizontal components but can also act vertically. To perform satisfactorily a structure must be capable of achieving a stable state of static equilibrium in response to all of these loads - to load from any direction, in other words. This is the primary requirement; the form and general arrangement of a structure must be such as to make this possible. The distinction between the requirements for stability and equilibrium is an important one and the basic principles are illustrated in Fig. 1.5. Equilibrium occurs when the reactions at the foundations of a structure exactly balance and counteract the applied load; if it were not in equilibrium the structure would change its position in response

to the load. Stability is concerned with the ability of a structural arrangement which is in equilibrium to accommodate small disturbances without suffering a major change of shape.

The first of the beam/column frameworks in Fig. 1.5 is in a state of static equilibrium but is not stable and will collapse if subjected to a small lateral displacement. The insertion of a diagonal bracing element in the second framework prevents this and renders the system stable. Most structural arrangements require bracing for stability and the devising of bracing systems is an important aspect of structural design. As the simple diagrammatic structure in Fig. 1.6 illustrates, the structural elements of a building provide the link between the applied loads and the foundation reactions in order that equilibrium can be achieved. To be effective the elements must be of adequate strength. The strength of an element depends on the strength of the constituent material and the area and shape of its cross-section. The stronger the material and the larger the cros section the stronger will be the element.

To sum up, it should be noted that it is possible to produce a strong element even though the constituent material is weak by specifying a very large cross-section. In the case of a particular structure, once the requirements for stability and equilibrium have been met, the provision of elements with adequate strength is a matter firstly of determining the magnitudes of the internal forces which will occur in the elements when the peak load is applied to the structure. Secondly, a structural material of known strength must be selected and thirdly, the sizes and shapes of cross-sections must be chosen such that each element can safely carry the internal force which the load will generate.

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