Mega-structural concepts applied to special buildings

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Summary

Architectural design has experienced a radical change over the last years. The free and organic new forms have buried the geometrical and regular old ones. Because of that, the structural challenges have been greatly improved, being impossible to be achieved through conventional techniques. As an answer to this demand, the concept of "mega-structure" arises. Instead of trying to insert a structure inside the architectural shape, the structural engineer takes advantage of the potentiality that the shape provides to generate a structure that works as a whole.

The concept of "mega-structure" has been successfully applied in a large number of special buildings in recent times. In this paper, some of them are briefly reviewed and the newest one, the Orona Zero building, is more extensively developed.

Keywords: new architecture, free forms, mega-structure, façade truss, cantilever, box girder, diaphragm, staged construction.

1. The new architecture

Landmark buildings with special features, which are technically challenging, have at all times relied on innovative structures which require new structural types, new analytic procedures, new materials, or the conception and execution of unusual construction processes.

While this is still true nowadays, the omnipresence of computers in all stages of the life-cycle of a building –from design to construction– and more precisely, the development of very versatile design software applications, have triggered an outburst of architectures with unthinkable free forms which were only accessible to a select group of architects only a few years ago.

Contemporary engineering has to deal with these new designs, which often aren't realizable unless they have a previously conceived bearing structural scheme embedded in their form. The engineering of a free form requires an open minded approach in order to establish the most suitable archetypal structural system –or combination of systems- which best merges into its geometry, making use of its own form. This approach is only possible through a deep understanding of the inherent structural behaviour a shape may give rise to, a process greatly aided through the use of flexible computer software [1].

2. The concept of mega-structure

2.1 The way for optimizing the free form

The concept of mega-structure arises as a resource to be used by the engineer in order to solve the great structural challenges associated with the new architecture. It can be defined as the fitting of a large-scale structure into the architecture form (usually forcing or slightly modifying the proposed free form in order to try to approximate the architectural system towards an active-resistant arrangement), taken advantage of the building's entire dimension to work as a whole, frequently by form, minimizing the deformation energy of the system and, so that, its cost.

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