Structural Engineering in Tensile Structures Innovation. Past and Present

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Abstract

State of Art in structural engineering in the field of Light Structures and most concretely in Tensile Structures can't be understood without looking backwards, without learning from the Masters, all of them educated under the European mentality and social circumstances of changes.

The Big Masters in Light Structures developed his works from 1930 to 2000, being the father of all of them Eduardo Torroja, who also verbalized all the structural theory knowledge in his delicious book "Philosophy of Structures" (1958), a must reading book among structural engineers. Innovative book in which the behaviour of structures was explained in an intuitive way of understanding the flow of forces, but with of course, a strong knowledge of the physics and mathematical component of the structural engineering.

The plasticity of Torroja work has its continuity also in Europe, in concrete in Switzerland, by Heinz Isler and his famous physical models with iced fabrics in the Alps region winter. These models and his structural intuition allowed him to produce amazing concrete shells. Isler, in some manner, continued the tradition of physical models that half century before were performed by Spanish architect Antoni Gaudi for his vaults, but giving a step forward.

In this first-time line we also can find other outstanding European figures, some of them developing their career outside Europe, but exporting the European spirit. These well recognized figures are Félix Candela, Eero Saarinen (born in Europe, formed in Europe and under his father tutelage), Jørn Utzon, Frei Otto, and Jörg Schlaich, the last Master and last exponent of the Old School in Light Structures.

The inflection point in the world of the design of Light Structures is clearly marked by the Allianz Arena for Bayern München Stadium designed by Herzog and de Meuron architects, with its ETFE cushion skin and its dynamic look at night with the play of lights provided inside the pillows. This European innovation had its continuity in the world with the Ice Cube swimming pool facilities, Wembley Stadium for 2004 Olympics, airports and bus station canopies, and mainly Football Stadiums.

This boom in light structures, this new youth in structural engineering has only been possible thanks to the heritage of the Big Masters and the new tools in design under the umbrella of parametrization which has allowed to simplify the creative process and materialize concepts as fractality and apply them to architecture and the creations of spaces to make human life better.

Arenas&Asociados has tried, inspired in the Big Masters, following the present state-of-art in the field of light structures, and contributing with our knowledge in bridge engineering, to provide with our tensile-structures new spaces for humans.

And is that, as Bernard of Chartres said *"We are dwarfs standing of the shoulder of giants"*, and we have the responsibility of fusing Past, what we have learnt of our Masters and the new technologies, with Present, the parametrization, work digitalization and new materials 3d printing methods.

All of these provides us a promising and exciting future that we have to put in service of the society.