# Detailing masts

Josep Llorens

Barcelona School of Architecture (ETSAB), Universitat Politècnica de Catalunya
Diagonal, 649 - 1er, 08028 Barcelona, Spain
E-mail: *ignasi.llorens@upc.edu*
web page: *https://wwwgat.webs.upc.edu/portada.html*

## Abstract

Structural membranes need to be supported and tensioned by structural elements that condition the form and behaviour, affect the supposed lightweight appearance, and, in many cases, end up costing more than the membrane itself. As the most used supporting structural element is the mast, a research has been launched on its typology and detailing to improve efficiency and compatibility.

An extensive analysis of existing masts has been conducted to establish a typology, starting from the one mentioned on the "European design guide for tensile surface structures", together with the formulation of strategies aimed at optimizing the design. Both concepts are profusely illustrated with selected examples drawn from the own experience and the documentation kindly provided by the authors, including visits to the sites and literature.

Masts were not new when tensile structures were significantly developed starting from the middle of the twenty century. Many other applications such as sailboats, bridges, tents, cable suspended roofs and antennas had used and developed them considerably.

The typology is based on the position related to the membrane. Boundary masts support the edges at corner points. They are usually inclined to follow the resultant direction of the forces coming from the edge cables and going to the anchor ties. They can also be cantilevered when interferences coming from anchor ties are not permitted. Internal masts are surrounded by the membrane and rest directly on a base plate or float/fly on steel cables that push them upwards. A third alternative is the external mast located outside the enclosure, from which the membrane is suspended.

The three types of mast accept different strategies to cope with over-dimensioning imposed by buckling on such long elements. They include the use of circular hollow steel sections (because of their efficiency in compression and torsion, minimal surface area to be protected, minimal wind resistance and availability) improved by tapering, trussing, tying or coupling.

Apart from the section of the mast itself, its ends also have a considerable impact on cost, appearance and ease of installation. High points can be in the form of circular rings, humps, loops or scalloped cables, bearing in mind that the circular ring is a rigid connection hardly compatible with the flexibility of the membrane. Mast-base plates transmit compression (and shear) forces. They have to be designed carefully because they can easily result in a bulky element standing in the centre of the main visual field of the users.

With different combinations of the types, sections, profiles and details presented, more efficient solutions could be achieved.

## References

[1] B.Forster & M.Mollaert, 2004: "European design guide for tensile surface structures". TensiNet, Brussels.

[2] J.B.Harris & K.Pui-K Li, 1996: "Masted structures". Butterworth Architecture, Oxford.

[3] J.Llorens, 2015: “Detailing for fabric architectural structures” in “Fabric structures in architecture”. Woodhead Publishing Limited in association with The Textile Institute, Cambridge.