IN-PLANE DESIGN OF NON-CIRCULAR TRIANGULATED TENSILE SPOKE WHEELS

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ABSTRACT

This paper presents a new in-plane design of non-circular triangulated tensile spoke wheels with two perpendicular symmetry axes, like those used for roofing big sports stadiums, as well as a procedure to define such design. The proposed procedure describes how to define the in-plane shape and the necessary pre-stressing so that the outer ring behaves like a funicular polygon which has equal-length sides and is uniformly compressed. All in all, this procedure solves the problem of non-circularity of a triangulated spoke wheel by equalising the cross section sizing conditions of the outer ring to the sizing conditions that a circular structure would have.

Keywords: *Triangulated tensile spoke wheels, non-circular shape, homothetic deformation*

1. APPROACH

1.1. Introduction

Spoke-wheel-like roof structures are formed by pre-stressed spokes which are connected to inner tension rings and outer compression rings, where the supports are located. The spokes are usually organised into two layers: top and bottom. These two spoke layers are not parallel to each other, but usually converge at one of the rings. Thus, these structures can be classified into two subtypes: those which have two outer compression rings and one inner tension ring (Figure 1c), and those which have one outer compression ring and two tension inner rings (Figures 1a and 1b). In the former case, the two outer compression rings are separated by masts located at the outer end of the spokes. In the latter case, the masts are located between the two inner tension rings at the inner end of the spokes, and thus they are suspended in the air [1]. The profile of the spokes, biconcave (Figures 1b and 1c) or biconvex (Figure 1a), determines the use of intermediate ties or floating masts respectively between the inner and the outer ring. There is a third, less common subtype where the two spoke layers are crisscrossed between two outer compression rings and two inner tension rings (Figure 1d).

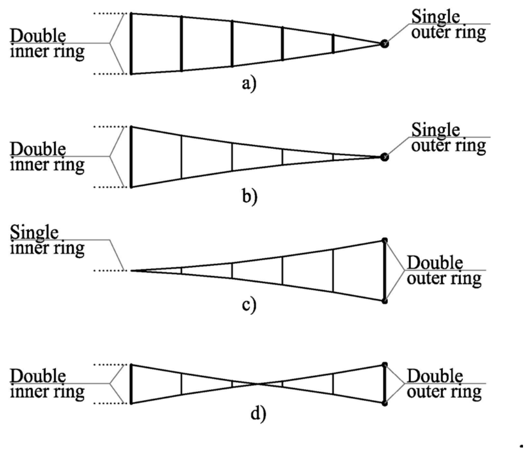

Figure 1: *Ring arrangements and spoke profiles*

If spans are long and live loads are small, the ratio between the self-weight and the whole of the loads of a spoke-wheel-like structure is usually much smaller than any other type of structure, especially with overhangs longer than 35 m [2].