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Wind Loading on Catenary Domes

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1 Abstract

Catenary domes are a less conventional, but structurally efficient, alternative to traditional circular-profile domes. Unlike the more common circular forms, there is a dearth of wind loading information for catenary structures. This paper aims to provide some insight in this regard. A series of wind tunnel tests were undertaken to investigate the effects of geometry and Reynolds number on the mean pressure coefficient distributions over catenary domes in a turbulent boundary layer flow. A hemispherical dome was also assessed, and the results compared with that for the catenary shapes. These parameters were evaluated to elucidate their influence on the loading on these structures. Only the results relating to mean pressure coefficients are reported in this paper. An important finding was that the height to base radius (H/R) of the catenary dome had a substantial influence on the mean pressure coefficient distributions over the structure. Finally, the results of the investigation and their implications on the design of catenary domes are discussed. This may be of value to designers because at present no wind loading information exists for catenary domes – at least to the author's knowledge.

Keywords: catenary dome; wind loading; pressure coefficients; wind-tunnel.

2 Introduction

Thin shell structures have been around for many years. A thin shell structure is one in which forces are transmitted primarily in-plane to the supports. Many shell forms, such as a hemispherical dome, also experience localized bending and shear forces toward the base (i.e. boundary effects). However, these forces may be diminished by adopting structurally efficient forms. One such shape is the catenary, which only experiences compressive stresses (i.e. no tension) under self-weight alone. A catenary is defined as the shape a chain makes when it hangs freely between two supports. The compressive forces are lowest at the highest point (i.e. apex) and increase towards the base of the structure. The form is particularly appealing when designing with materials that have an affinity for compressive stress, e.g. unreinforced masonry.

Although the catenary dome offers substantial structural benefits, no information could be found regarding wind pressures/loading on these structures. Most of the published wind loading information for curved roof structures corresponds to circular vaults and domes (e.g. Taylor 1992 [1]; Blessmann, 1996 [2]; Blackmore and Tsokri, 2006 [3]; Cheng and Fu, 2009 [4]). Due to a lack of relevant data in the literature, a wind-tunnel investigation was undertaken to better understand the wind effects on catenary domes. The study was

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