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# Fatigue reliability study of the high-mast lighting towers under vortex shedding action with Sri Lankan context

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ABSTRACT

The aim of this research is to study the fatigue performance of the high-mast lighting towers made up of steel under various thicknesses of the mast-arm wall subjected to along and vortex shedding wind action. For these kinds of wind sensitive structures, it is necessary to predict the total damage induced by the wind action. In order to estimate the vortex shedding induced forces on the high-mast steel arm, the fundamental basic wind velocity was obtained for zone 3 of wind zonation map of Sri Lanka. In this study, total damage was estimated, when the wind motions occur simultaneously in along-wind and vortex shedding wind mode. Fatigue study was carried out using S-N Curve with consideration of the stress acting at the base of the mast-arm which was obtained from the simple beam bending theory. Palmgren-Miner theory of cumulative fatigue damage method was used to study the cycles to failure for each band in the spectrum and the total damage due to wind action. It can be concluded that, the thickness of the mast-arm wall is a key parameter for the fatigue performance of the high-mast lighting towers and this method allows for the selection of the most cost-effective mast-arm wall thickness with consideration of fatigue life of the mast-arm system.

## 1. INTRODUCTION

Sri Lanka is an island in the Indian Ocean on its other sides. Generally, our country faces highly destructive wind actions during the North Indian cyclone and due to seasonal monsoons. So, this severe wind actions should be considered in the design of wind sensitive structures like high-mast lighting towers. The wind forces acting on the high-mast lighting towers depend on the basic wind speed of the particular location, terrain type, altitude and dynamic and cross wind effects. The wind induced fatigue occurs as a result of the along-wind and cross-wind response of the structures. In the code-based fatigue assessment, S (direct stress range) -N (number of cycles) curve is used for the estimation of load cycles with consideration of detail category for each structural part of high-mast steel arm as shown in Figure 2. In the S-N curves, reference value of fatigue strength is obtained at 2million load cycles as per provision given in the EN1993-1-9-2005.


**Figure 1 Wind Zone of Sri Lanka (Lewangamage & Jayasinghe 2012)**

Under different amplitude conditions, all stress ranges should be less than the constant