

Design and Modeling of High Mast Solar Light Pole

Ms. Dipali .C. Bhojar
Student
Department of Mechanical Engineering
K.D.K.C.E. Nagpur, India

Dr. A.V. Vanalkar
Professor
Department of Mechanical Engineering
K.D.K.C.E. Nagpur, India

Abstract

Along a major highway, luminaries pole structures may be seen every 101 of a mile. From documented cases, it appears that these structures started to experience fatigue problems in the last three decades. The general public might not be aware of the problem, because if such a failure occurs, the structure is replaced. Those working in the fatigue area realize that this issue is a serious matter. Clearly, the damage is costly, costing up to thousands of dollars per occurrence. For this purpose, a high mast lighting poles are fabricated using steel due to its high strength, ductility property and wear resistance. The high mast structure (HMS) has the characters of light weight and high cost efficiency. It possess large ratio of height (H) to least horizontal dimension (D) that makes it more slender and wind-sensitive than any other structures[17]. Therefore, the purpose of this research is to design optimal high mast poles taking into account its specification, environmental conditions for placement economy.

Keywords: Fatigue, High-mast Lighting, Wind, Forensic Investigation

I. INTRODUCTION

The modern High Mast Structure (HMS) originated nearly at the beginning of the 20th century. Typically, from data a functional utility on the tip of the structure such as a wind-force turbine, a radio wave transmitter, a radar, or some lamps and lanterns. Up to today, different configurations of tubular HMS have been used widely in modern civil construction. The unit costs of these structures are low, however, their designs may cause problems (Solaria, 1999). In the past years, many accidents and much damage have been caused by strong wind or wind-induced vibrations in such structures. These frequent accidents confirm the necessity for a better understanding about HMSs' geometric configurations and structural properties, and also the necessity to develop wind-resistant design criteria for HMS for these of designers. The first focus on geometric configurations and shape factors to compare the different codes. Then, the structural and geometric properties of existing High Mast Lighting Structures (HMLS) in Taiwan are investigated to obtain the Wind resistance design criteria and procedures.

The wind resistance design criteria for high mast structure include two objectives. One is to define the identification of a yield criterion and the strength limitation of the support structure. The other is to provide uninterrupted service by the tip utilities under extreme wind. By using computational design, this study finds that the drag coefficients of an 8 or a 16-sided pole for uniform and shear flows.

A desk-top investigation was subsequently undertaken to review the fatigue and ultimate strengths of the light poles, anchor bolts, and foundations in order to decide whether repair or replacement of the poles would provide the lowest whole-of-life cost. As a result of this investigation it was decided to repair the light poles, with modified details to extend their fatigue life.

Wind force is the main consideration for the HMS design, which is affected by the shape factor, projected area, and angle of attack. Therefore, geometric configuration has an important influence on wind load. Usually, this influence can be measured by means of field measurement or wind tunnel test.

This paper describes the investigations that were undertaken, and the recommended modifications that would reduce the stress concentration in the pole mast, and hence extend the fatigue life.

As the project is being done in collaboration with SAMEER SOLAR, the Static Analysis is carried on High Mast solar light pole.

II. IDENTIFICATION OF PROBLEMS

Typically, there is usually some functional equipment on the top of the structure such as a wind-force turbine, a radio wave transmitter, radar, lamps and lanterns up to today, different configurations of tubular HMS have been used widely in modern civil construction.

Conventionally, in the solar light pole the cracks are found due to static loading, wind forces and parameters which affect galvanization. Aim is to describe some of the available repair options and reduces the damages.

The combination of the slender structural and the concentrated mass at the tip makes the structure fully aero elastic and unstable and cracks are generally found at the top of gusset due to continues loading.

This project presents a synthesis of the available knowledge related to galvanization-induced cracking of HMIP. Specific factors that can contribute to cracking at various stages of fabrication, and their potential interactions, are presented.

A. Objectives

- To discusses the main factors that contribute to galvanization-induced cracking at various stages of fabrication including cold working, welding, galvanizing, and material chemistry.
- To presents the general framework of the analytical model that was adopted to predict the cracks life of high mast poles with pre-existing cracks at the pole-to-base plate connection detail. The details of the Static loading analysis and reliability analysis will be presented.
- To presents the results of the analysis that was conducted on various pole configurations at different locations throughout the state. Calculated results will be presented in detail for a specific pole configuration.
- To describes some of the available repair options that can be considered in lieu of replacing damaged poles.

B. Existing High Mast Pole with Gusset Stiffeners



Fig. 1: Typical light pole Top

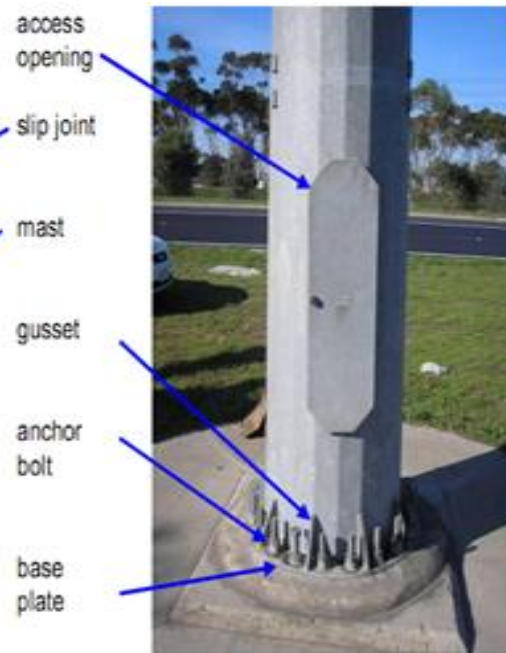


Fig. 2: Typical light pole base plate

C. Research Elaboration

The effect of wind can be observed at the bottom of the mast where cracks began to appear. The cracks are observed at the tip of the stiffener where the base plate of the mast is attached to the high mast. This project illustrates the basic theory regarding how to reduce that cracks.

This study defines design specification with proper height and depth ratio.aim is to select best design which find low stresses.

D. Technical Specifications- High Mast Structure-12 M Pole

Height of pole	12 meter
No. of sections	one
Material construction	As per BS-EN10025
Base Diameter and Top diameter 108.91mm (minimum) Bottom	311.77mm(minimum)
Plate Thickness	4mm
Cross section of mast	12 side regular continuously tapered polygonal Metal protection treatment of fabricated
Mast section	Hot dip galvanization through single dipping process
Diameter of base plate	520 mm (minimum)

Thickness of base plate	25 mm
Max. wind speed	As per IS:875
Number of foundation bolts	4 no. or 6 no.(as per manufacturing design)
PCD of foundation bolts	445 mm
Type/ diameter/ length of foundation bolts	TS 600/ 25 mm dia / 750 mm long

The above data is collected from company which is required to make a model of high mast solar light pole. This project illustrate to select the better design for high mast solar pole, which is useful to reduces cracks which are occurs due static loading.

E. Model of High Mast Pole

3D-Model of High mast pole is generated using PRO-E-2.0 Software. Model is generated for two cross-sections for hexagonal and octagonal sections to find out better result.

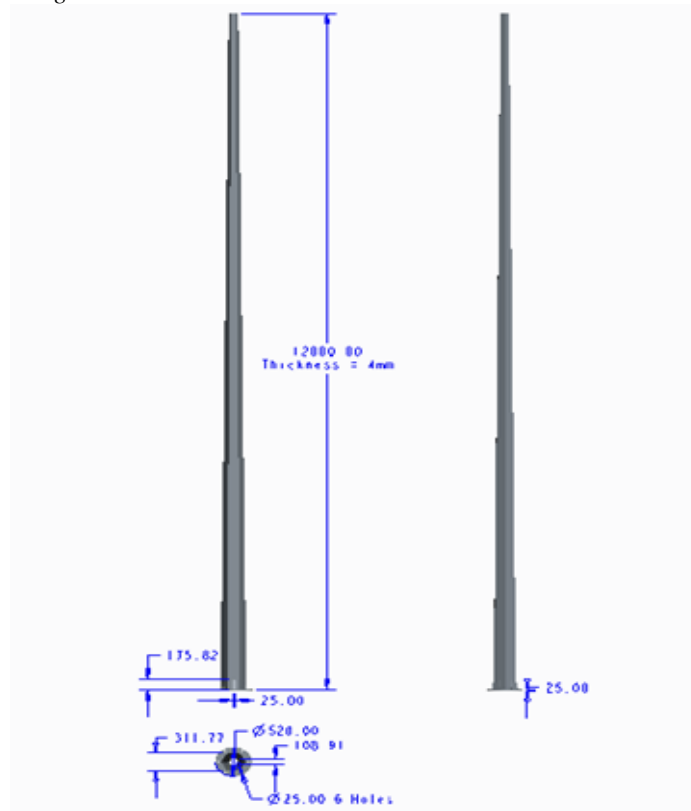
1) Shape Factor $N=6$



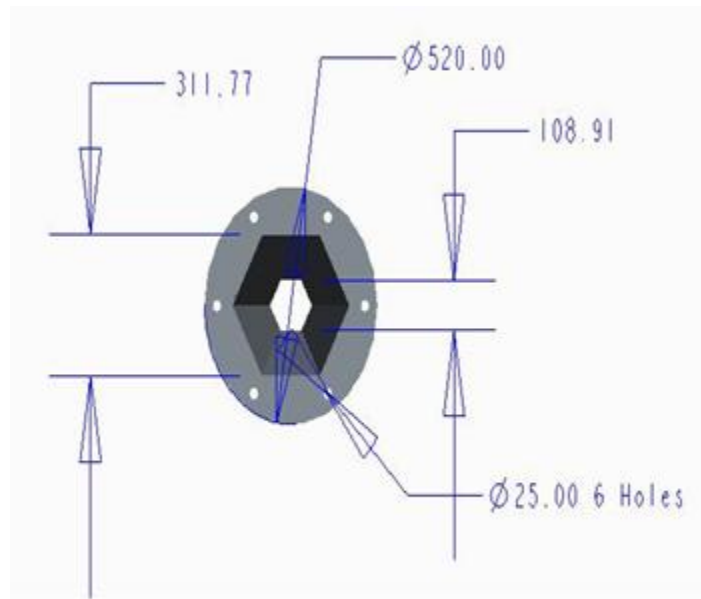
2) Shape Factor $N=8$



3) Drafting OF High Mast Solar Light Pole



4) Bottom-View



III. CONCLUSION

This paper has considered some of key factors associated with the design of HMS due to the effects of wind loading. Then major findings are summarized as follows.. According to the results of this research, the projected area is more critical in this aspect. As for the intensity of wind excitation increases with increasing of aspect ratio (height-to-width). However, it decreases with increasing of structure damping. Consequently, the results of this research indicate that HMS is quite different from the tower structure. Furthermore, the body of the tip plays a major role in design.

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