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"Design & Failure Analysis of Solar Street Light Pole under Wind Load Effect"

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Abstract - *Light shafts are for quite some time decreased posts and single cylinder structures utilized in expressways. Wind load is the essential plan power on this structure. In this examination, a correlation of the quality of steel and FRP light post is made when wind loads follow up on it. This work makes it conceivable to expand the investigation of a light post by fluctuating shapes with two materials. Round and hexagonal shapes are considered here. Additionally, the variety of stress and distortion of the light shaft are checked when a stiffener is set. Stress and disfigurement results are thought about.*

Key Words: solar energy, street light, pole, composite natural fibre, static analysis.

1. INTRODUCTION

Sun powered vitality is the innovation used to bridle the sun's vitality and make it useable. The innovation created short of what one-tenth of one percent of worldwide vitality request.

Many know about alleged photovoltaic cells, or sun powered boards, found on things like shuttle, housetops, and handheld number crunchers. The cells are made of semiconductor materials like those found in PC chips. At the point when daylight hits the cells, it thumps electrons free from their particles. As the electrons move through the cell, they produce power.

On a lot bigger scope, sun based warm force plants utilize different systems to focus the sun's vitality as a warmth source. The warmth is then used to bubble water to drive a steam turbine that creates power in much a similar design as coal and atomic force plants, providing power for a large number of individuals.

As required by their ability and game plan in the all around open enveloping, wind stacking is the basic arrangement power on these structures. Because of lightweight thin plan, the light shafts are unfathomably versatile with ordinary significant normal frequencies. The presents must be planned on limit vibration and redirection. Nowadays fashioners pick steel and composite FRP used for making light posts. Steel posts are most regularly used diminished shafts. FRP is lightweight and utilization check. Strands are two sorts of normal and produced fiber. Designed strands are typically used in structures and continuous assessments.

Figure 1: Solar Street Light Pole

II. OBJECTIVES

1. To perform Static Analysis of steel and FRP posts so as to get their heap versus diversion attributes.

2. Stiffeners are submitted in request to realize whether stress and disfigurement are decreased.

LITERATURE SURVEY

A. C.W. Chien and J. J. Jang (Taiwan Ocean University): [1]:

This paper gives the contributions of high natural frequency components are obtained by Eigenvalue analysis. The method to check vortex resonance and galloping for higher-order modes is also presented. Because of turbulent winds in the atmosphere and characteristics of the irregular bluff bodies of the structures are complicated to deal with, a mathematical model, with interactive wind and structure, is still impossible at present.

This study includes four parts:

(1) a survey of geometric configurations and shape factors;
(2) along with the wind and across-wind response analysis;
(3) develops criteria for WRD; (wind resistance design);
(4) provides case application for WRD procedures.

B. Mal Thomas and Gary Noyes-Brown: [2]:

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 pole life. The 28 light poles at the freeway interchange were all of the similar construction. figer1shows the typical luminary's arrangement at the top of the light poles, and shows a typical light pole base, with significant features being the access opening, the gusset plates, base plate anchor bolts and grout. Inspections carried out by Vic Roads identified cracking in 27 of the 28 high mast light poles at the freeway interchange. All cracking was in the light pole mast, at the tip of the gusset stiffeners. The base plates were not fully grouted; poor grouting has been known to contribute to damages of anchor bolts in other light poles and sign. Bolts need to be checked for stress due to tension and shear, however additional stress due to bending needs to also be considered if the bolts have a free length due to insufficient grout.

C. Counsell Taplin (AASHTO-2006): [3]:

In this paper, the American Association of State Highway and Transportation Officials (AASHTO) have commissioned significant research in the USA in the last five years. Culminating in the AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals" (AASHTO 2006). This standard provides a tool for the design of light poles and sign gantries. This research by AASHTO has been undertaken in response to the failure of numerous light poles in the USA. For example, in Iowa in 2003, a 43-meter-high light poles collapsed (see in fig.1) prompting an extensive investigation into this type of structure.

LIGHT POLE DESCRIPTION AND PARAMETERS

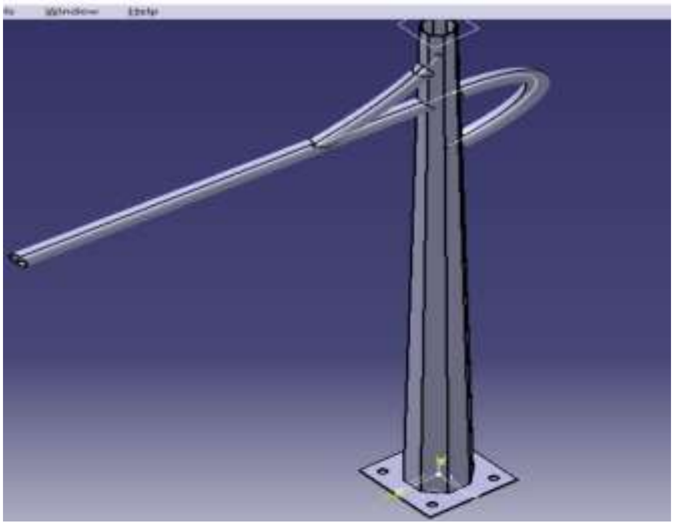
The cross-segment measurements of the posts have been chosen dependent on material accessible in the market. The all-out stature of the shaft is 19.8m with a flat a safe distance of 2m. The base of the shaft is welded to the base plate which is dashed to establishment appeared in fig .1. The light shaft has a decreasing empty roundabout segment with a base distance across of 300mm and thickness 15mm. The top distance across is 100mm and the thickness is 10mm. The size of the base plate is 400*400*20mm. The base plate is structured dependent on IS code 800: 2007. Width of the establishment is 0.5m and profundity 0.8m. The thickness of FRP is 5mm.

Table -1 Technical Specifications: High Mast Structure-12 M Pol

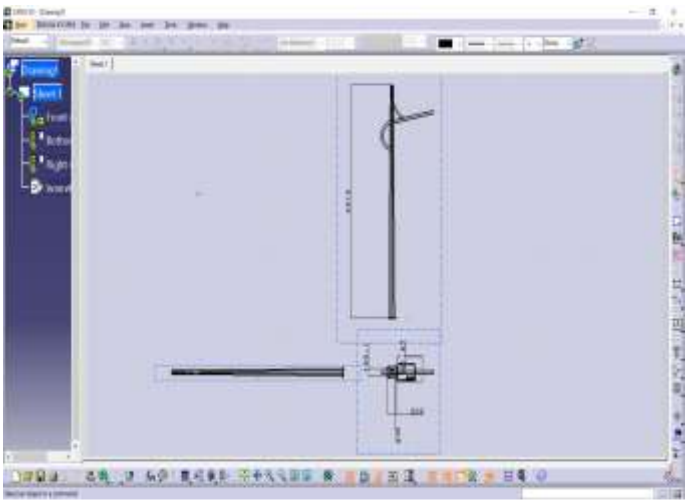
Height of pole - 4012 mm
No. of sections - one
Material construction - As per BS-EN10025
Base plate – 200*200 mm
Plate Thickness - 4mm
Cross section of **mast -** 12 side regular continuously tapered polygonal Metal protection treatment of fabricated

Mast **section -** Hot dip galvanization through single dipping process
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

Model of High Mast Pole



Drafting of Pole



METHODOLOGY

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Force Calculation of High Mast Light

Pole Parameters:

1. Base Square plate : 200*200 mm
2. Thickness of base plate : 25 mm
3. Height of pole : 4012 mm (4 m)

Calculation:

For Nagpur:

Maximum wind speed (Vw) :

Vw = 180 Km/hr

= 180*1000/3600

=50 m/sec

Design wind speed (Vz) :

Vz = K1 * K2 * K3 * Vw

Where,

K1 = risk co-efficient (i.e, life of structure in 100 years) = 1.05

K2 = terrain factor (for pole height in between 11m - 50m) = 1.01

K3 = the ground is assumed to be plain surface, so, the topography factor is 1

Vw = wind speed (m/sec)

Therefore, Vz = K1 * K2 * K3 * Vw
= 1.05 * 1.01 * 1 * 50
Vz = 53.025 m/sec

Design Wind Load Including Carriage Weight:

F = 0.6 * $(Vz)^2$

$F = 0.6 * (53.025)^2$
$F = 1686.99$
$F = 1687$ N

Analysis of High Mast Solar Light Pole

1. Static Structural Analysis

The static auxiliary investigation decides the removals, stresses, strains, and powers in structures or parts brought about by loads that don't incite huge idleness and damping impacts. Consistent stacking and reaction conditions are accepted; that is, the heaps and the structure's reaction are expected to differ gradually as for time. The sorts of stacking that can be applied in a static investigation incorporate:

1. Externally applied forces and pressures
2. Steady-state inertial forces
3. Imposed (nonzero) displacements
4. Temperatures (for thermal strain)

S. No	Values	Gravity Test		Load Test		Unit
		Max.	Min.	Max.	Min.	
1.	Total Deformation	15.4190	0	14.953	0	mm
2.	Elastic Strain	0.0004294	1.55e-9	0.00067886	3.9779e-9	mm/mm
3.	Equivalent Stress	20.685	6.75e-5	48.082	8.80e-5	MPa
4.	Reaction Force	1048.3	1048.3	1048.3	1048.3	N
5.	Stress Safety Factor	15	13.537	15	5.8234	-
6.	Fatigue Safety Factor	15	4.001	15	1.7208	-
7.	Fatigue Safety Life	1e+8	1e+8	1e+8	1e+8	Cycle

CONCLUSIONS

This project 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.

S. No	Conditions	Safe Yield Stress (MPa)	Maximum Stress (MPa)	Notes
1.	Gravity Test Only	250	20.685	Safe
2.	Gravity + Load Test	250	48.082	Safe

REFERENCES

1 AASHTO 2006 "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals"

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3 Davenport 1961 "The spectrum of horizontal gustiness near the ground in high winds" Quarterly Journal, Royal Meteorological Society, Vol. 87, London 1961 Fisher 1993 "Resistance of welded details under variable amplitude long-life fatigue loading" NCHRP Report 354