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Comparative Study of Wind Load on a Light Pole Structure With Composite Materials Using ANSYS

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Abstract: Light poles are long tapered poles that are used in highways. There are so many external force acts. Wind force is the main external force considered in light poles. In this study compare the strength of steel and FRP light pole when wind loads act on it. This project makes it possible to extend the study of light pole by varying shapes with two materials. Circular and hexagonal shapes are considered here. In first case 65 feet circular steel pole with three luminous is statically analysed. And same material hexagonal shape is analysed. Second case same process is repeated with only changing the pole material in to composite natural fibre. Stress and deformation results are compared .

Keywords: light pole; composite natural fibre; static analysis; FEA.

I. INTRODUCTION

In long years back concrete and timbers are the materials used in light poles. Concrete poles easily corroded with steel reinforcement which leads to maintenance. Wooden poles easily damage due to environmental changes. Now a days designers choose steel and composite FRP used for making light poles. Steel poles are most commonly used tapered poles. Hot dipped galvanize coating applied in steel protect from corrosion.FRP is light weight and corrosion resistance. Fibres are two types natural and synthetic fibre. Synthetic fibres are commonly used in structures and recent studies.

Here, natural fibre is selected. Kenaf is used as natural fibre. Kenaf belong to species of hibiscus cannabinus. Treated kenaf fibre shows good properties. Kenaf fibre reinforced in polypropylene, that properties are used in study. Wind induced deformation affects pole's geometric variables .Wind load vary different region. Height of light pole vary from 20 feet to 100 feet. It is very essential to design the light pole with sufficient strength and stability.

II. OBJECTIVES

- The study of light pole by varying shapes with two materials.
- To perform Static Analysis on steel and FRP poles in order to obtain their load vs. deflection characteristics.
- Identify the better shape based on the result of stress and deformation.

III. SCOPE

The scope of this work is to implement light poles in a highly economic manner with adequate strength and standard length. Also to check whether change of cross-sectional shape has any effect on light pole. If the considered shapes can withstand more stress and deformation than conventional shapes, the shape can be suggested for future models.

IV. LIGHT POLE DESCRIPTION AND PARAMETERS

The cross section dimensions of the poles have been selected based on material available in the market. The total height of pole is 19.8m with a horizontal arm length of 2m. The base of the pole is welded in base plate which is bolted to foundation shown in fig .1.The light pole has tapering hollow circular section with base diameter of 300mm and thickness 15mm .Top diameter is 100mm and thickness is 10mm. The size of base plate is 400*400*20mm. Base plate is designed based on IS code 800 : 2007.Width of foundation is 0.5m and depth 0.8m.The thickness of FRP is 5mm.

Fig . 1 Base plate bolted to foundation

A. **Material properties**

The material used is steel and natural fibre. Here, Kenaf fibre is used as natural fibre .The orthotropic property of fibre is listed in Table.1.The property of steel are available from ANSYS software that are shown in Table.2.

TABLE 1. Material properties of composite FRP

Material	Young's modulus (MPa)	Poisson's ratio	Shear Modulus (MPa)	Density (kg/m^3)
FRP	E_{ZZ} =7.891 E_{XX}=3.3080 E_{YY}=3.3080	μ_{ZX} = 0.3698 μ_{ZY} = 0.3698 μ_{YX} = 0.509	Gxy= 1.0961 G_{ZY}= 2.8120 G_{ZX}= 2.8120	1500

TABLE. 2. Material properties of steel

Sl No	Material	Youngs modulus	Poisson's ratio	Shear modulus
1	Steel	$2*10^8$ kN/m^2	0.3	$7.69*10^7$ kN/m^2

V. METHODOLOGY

Light pole is modeled in CATIA software. It is imported to ANSYS. Material properties is assigned. Fine mesh is done for accurate results. Solid 185 is the element used in ANSYS. Results obtained from the static analysis are compared. From the results identify the better shapes and material.

A. Statistical analysis

In this study the circular and hexagonal steel pole are statically analysed. Wind load are considered .wind velocity v_z is calculated based on IS 875 (part III). After the analysis stress and deformation values are obtained. Loaded diagram shown in fig.3. Results are shown in Table. 3. Comparison of stress and deformation of steel and FRP circular pole are shown in Table 4.

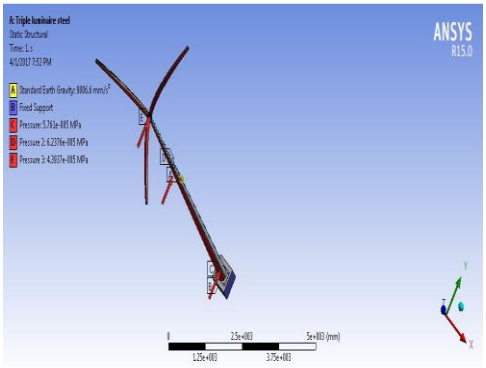

Fig 3: 3 Loaded diagram

B. Results and conclusion

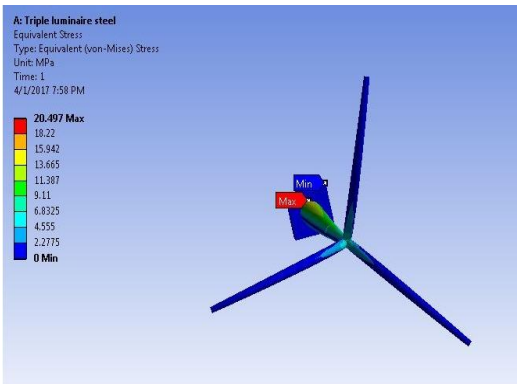

Fig.4: Stress diagram of circular steel pole

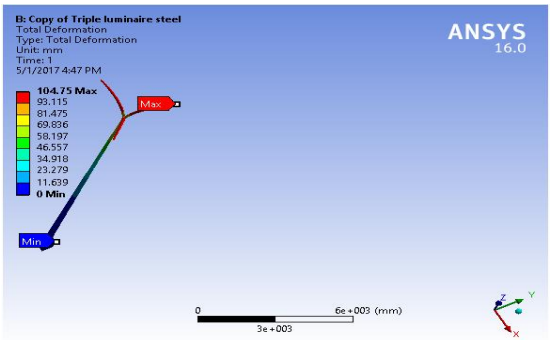

Fig .5: Deformation diagram of circular steel pole

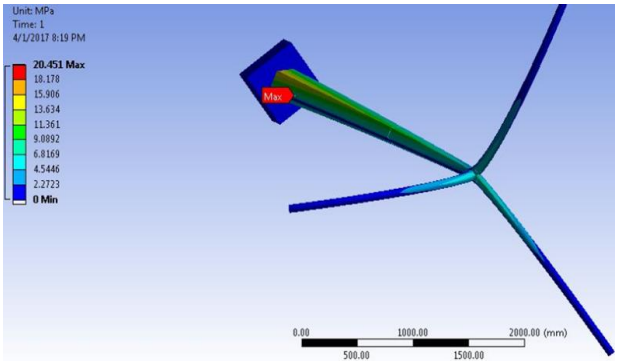

Fig .6: Stress diagram of hexagonal steel pole

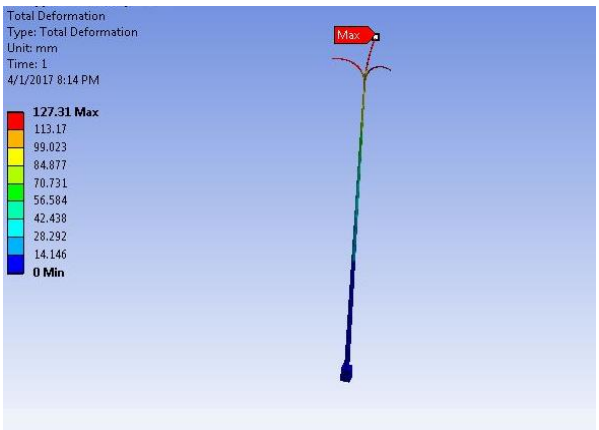

Fig .7: Deformation diagram of hexagonal steel pole

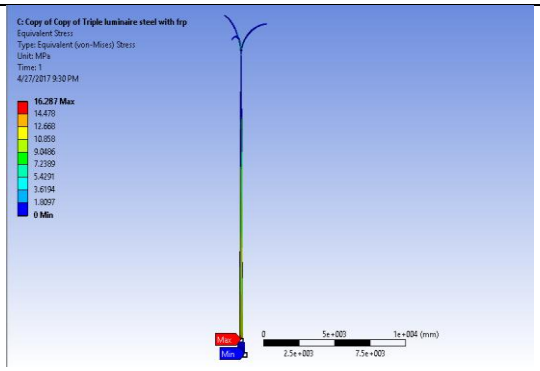

Fig 8: Stress diagram of circular FRP pole

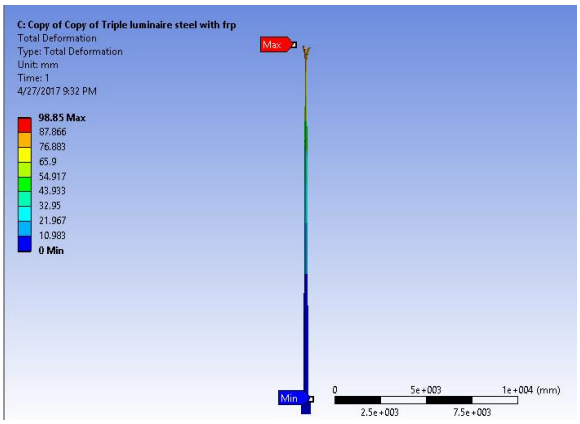

Fig.9: Deformation diagram of circular FRP pole

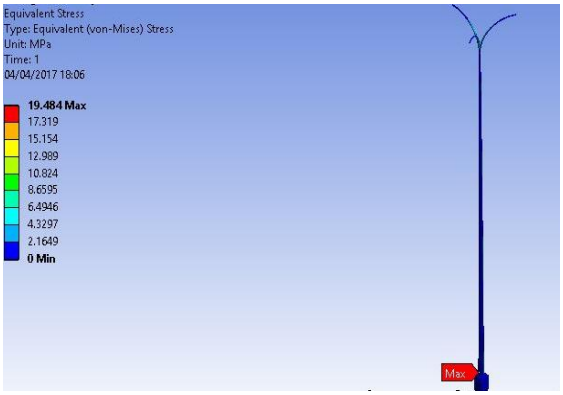

Fig.10: Stress diagram of hexagonal FRP pole

Fig.11:Deformation diagram of hexagonal FRP pole

TABLE.3 Stress and deformation of two materials without FRP

Shape	Stress (MPa)	Deformation (mm)
Circular without FRP	20.497	104.75
Hexagonal without FRP	20.451	127.31

TABLE.4 Stress and deformation of two materials with FRP

Material	Stress (MPa)	Deformation (mm)
Circular with FRP	16.297	98.85
Hexagonal with FRP	19.484	124.42

VI. CONCLUSION

- Both Circular and hexagonal shapes were statically analysed.
- Result shows that there is slight difference in stress value of circular and hexagonal light pole.
- When materials are compared FRP can reduce the stress and deformation in light pole.
- There is an increasing of 17.72% of deformation in hexagonal pole without FRP compare to that of circular without FRP
- In hexagonal pole with FRP the stress is16.4% increasing compare to that of circular pole with FRP.
- There is an increasing of 20.55% of deformation in hexagonal pole with FRP compare to that of circular pole with FRP.

VII. FUTURE SCOPE

- Stiffners are placed at base of light pole connected with base plate in order to check whether the stress and deformation is reduce.
- Find the natural frequencies and mode shapes of light poles .
- To check the cyclonical effects of composite light pole.

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