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DESIGN AND DEVELOPEMENT OF LIGHT TOWER

[#1]Prof. M.M.Shete, [#2]Ashish Hole, [#3]Supriya Desai, [#4]Nilesh Bhandari, [#5]Sourav Shinde

[2]ashishhole33@gmail.com

[#1]Assistant Professor, Mechanical Department
[#2345]Student, Mechanical Department

P.E.S Modern College of Engineering, Pune
Savitribai Phule Pune University.

ABSTRACT

Lighting is a major requirement when we deal with working inside a mine whether it is underground or opencast mining and also on construction sites, oil field, sports complex etc. In the present work a new system of light mast tower is proposed & designed which increases the usability of the existing light mast towers. In this new system, each light of the light mast is given a rotation about its vertical & horizontal axis which enables the light to focus at any particular direction & position without disturbing the other lights in use. In addition to this 360 degree rotation about the vertical axis which enables the user to provide the light source at multiple positions. In this designing of a new mechanism is proposed which will provide various rotations to the light mast which will increase its usability considerably. In order to overcome many of the challenges, proper and adequate lighting arrangements need to be provided on night time construction sites. Insufficient lighting contributes to an increase in worker injury rates and adversely affects work quality. In order to fully realize the benefits of night time construction and minimize its adverse effects on work safety, self-generating tower is used.

Keywords: Frame, Generator, Boom, Hand winch, Leaf spring, Wheels, Lightning system.

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I. INTRODUCTION

High-mast lighting dates back to the 1800's when tall masts were installed in several cities to illuminate large areas. The first known application of high-mast lighting to highways was the Heerdter Triangle installation in Dusseldorf, Germany, in the late 1950's.

Safety in the work zone, quality of work, and morale of workers are all directly related to work zone lighting. Before allowing or mandating night construction as an option or as a requirement in the, two fundamental conditions should be met in order for night construction to proceed: reduced traffic volumes; and setup and removal of temporary traffic control patterns can be done on a nightly basis.

Now a days light towers are mostly used for lighting construction sites. Cost of this tower is very high which is not affordable by builder taking low price tender. However some of the companies make these available for a rent on hourly basis. But construction of highway, bridges, roads, buildings will not completed in few hours, it may take months as well as years. So it becomes costlier to rent light tower for months and years.

The mission is to create a user-friendly and low-cost light tower taking into account the requirements of current situation; the idea was created to prepare a light mast which is portable and will reduce the labour injuries and accidents.

II. PROBLEM STATEMENT

Many challenges occurs during work time, proper and adequate lighting arrangements need to be provided on nighttime construction sites, mining, military base, and rescue operations and sports complex. Insufficient lighting contributes to an increase in worker injury rates, and adversely affects work quality. High costs of machines and maintenance, heaviness of light tower that cannot easily move which cater to and suit the requirements of cost effective light tower.

A. OBJECTIVES:

1. To develop the design with the knowledge and the selected material which are cost effective.

2. To evaluate the performance of selected lighting arrangements (both mobile and fixed) for a variety of typical construction operations.

3. To develop the idea to suitable mechanical principles and to design the idea to practice.

III.WORKING METHODOLOGY

1. Determine The Work Activities and Lighting Levels

First we have to identify the work activity that will be performed, whether it is construction or maintenance then based on that we can determine the luminance level. There are the locations in the work area that require closer interaction between workers and equipment. The speed of the equipment or the complexity of the work may necessitate an increase in illumination. To increase the illumination to 10 fc, additional fixtures may be added directly to equipment.

2. Determine The Work Zone Area To Be Illuminated

The general steps in determining the lighting area of a work zone according to the ATTSA Night Lighting Guide are as follows:

1. Use a scale layout of the roadway to determine the area of need.
2. Draw the project area on the layout. This should show types of work, with location of workers and equipment. This may need to be done to match the construction stages of the work and should include any other incidental work and workers such as material testing inspectors (pavement coring after the paving operation), installation of lighting or signing structures attached to a bridge, or any other work after the major work has been completed.
3. Sketch locations of key items from the traffic control plan and other site characteristics on the layout such as lane drop details, on-site obstructions, existing street lighting, and lane shifts.
4. Locate any flagger or spotter stations on the layout and provide for lighting their station.

3. Select Type of Lighting System And Source

Once the work activities have been identified, it is necessary to determine the type of lighting source to use. Based on the planned work activities and whether the work is mobile, stationary, or long duration, a lighting source using balloon luminaires, portable light plant towers, or roadway luminaires should be chosen. (ATTSA Night time Lighting Guidelines for Work Zones, April 2013) .In this case I choose the MILQPS400 (pulse start metal halide) lamp and tried to modelled this as a balloon luminaire, the one most likely to be used in applications like the night work zone constructions using AGi32 software, similar to Figure 1. Once the Luminaire selected an IES files should be given, where the American Electric Lighting' provides IESNA-formatted photometric data as an aid to lighting professionals who use lighting design software as part of their lighting specification process.

4. Select Fixture Locations

When placing lighting sources on the design the location needs to be one that is accessible and adequate for transporting and placing the light source. To ensure that we choose the good location of the luminaire we need to know where the lighting Levels fall on the roadway, in order to know that we need to use the Iso-footcandel diagrams. Iso-footcandle diagrams are lines that show you the light level at any given point, each line goes through all point of surface that has the same illumination. The dimension of this diagram is based on the mounting height of the light.

5. Calculation of load exerted by weight of boom and generator

i. Pressure exerted by weight of Boom
ii. Pressure exerted by weight of generator
iii. Height of Boom

These are main factor which are useful for calculation analysis of light tower.

6. Design of Boom and frame by Solid works and structural analysis in Ansys

By knowing all conditions of failure, calculating the weight, height of boom by using solid works and analysis in ansys.

7. Manufacturing of light tower

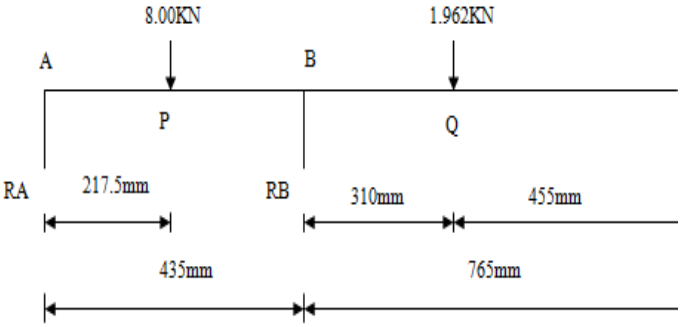
After all the calculation the materials are selected according to their strength, withstand capacity. At last manufacturing of the light tower is start.

IV. CONSTRUCTION

The light tower consists of following components,

- Frame
- Generator
- Boom
- Hand winch
- Leaf spring
- Wheels
- Lightning system
- Sound absorbing material(Foam and Rockwool)
- Anti-vibration generator mountings

V. ANALYSIS



Now,
Load on frame by boom=8.009KN
Load on frame by generator=1.962KN
RA and RB are the vertical reactions at A and B respectively,

To determine the support rections taking moment about point A
∑MA=0
(8.009*217.5)-(RB*435)+(1.962*745)
RB=7.36497 KN

Now,
Sum of all vertical forces is zero
RA-8.009+RB-1.962=0
RA-8.009+7.36497-1.962=0
RA=2.60636 KN

Shear force calculations,

1) SF at Q to B
   SF=1.962 KN

2) SF at B to P
   SF= 1.962-7.36497
   =-5.40K N

3) SF at P to A
   SF=1.962-7.364+8.009
   =2.60 KN

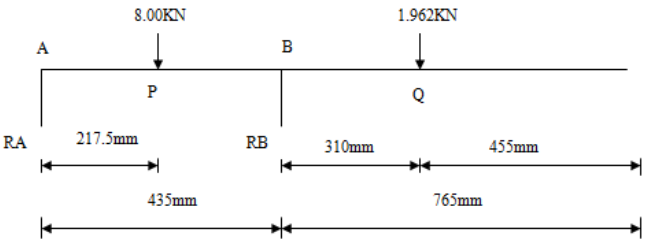
Bending moment calculations,

1) BM at Q,
   BM=0 KN-mm

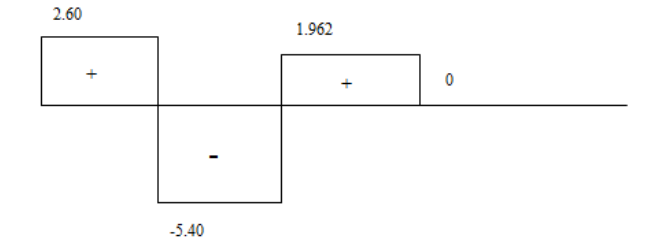
2) BM at B
   BM=1.962*310
   =608.22 KN-mm

3) BM at p
   BM=(1.962*527.5)-(7.364*217.5)
   =-566.715 KN-mm

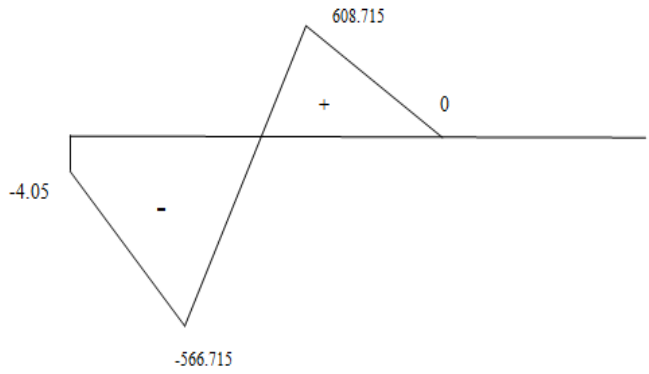
4) BM at A
   BM=(8*21705)-(7.364*435)+(1.962*745)
   =-4.05 KN-mm



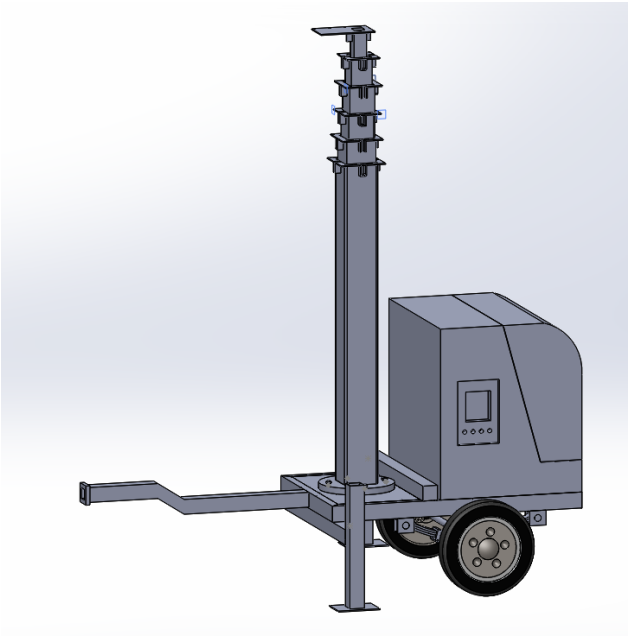
a) Load distribution diagram



b) Shear force diagram



c) Bending moment diagram



VI. CONCLUSION

Hand winch operated light tower is very crucial element for various outside work. Model is constructed in software like solidworks and analyse using ansys workbench. It is seen that design is safe. Also the focus was emphasized on the cost and weight of frame .Due to reduction in weight of frame of light tower, material requirement for manufacturing is also reduced. Hand winch mechanism is also provided to adjust the height of the boom as per requirement.

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