A Novel Method for Lattice Tower Vandalism Eradication

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Abstract—This study aims in eradicating vandalism of lattice tower steel bracings which in the recent time has increased rapidly. Due to financial constraints, some members of the society has engaged in vandalizing of steel bracings which are used as scrap metals hence adversely affecting transmission lines reliability. In recent time, Kenya Power has incurred high losses due to vandalism of steel bracings in most of its transmission lines particularly those traversing through rural area. For instance 2014, the power utility – KPLC spent millions of money after four towers collapsed due to vandalism of steel bracings. In addition, Company spends money on daily ground patrol along the transmission lines to ensure the towers are in good condition. Because of this perpetual problem, there is need for researching a better method of reducing/eradicating the steel tower vandalism. In this regards, a novel surveillance system has been designed and implemented to monitor and alert the Company management of any vandalism attempt on lattice tower. Lattice tower is a frame construction of angled-profiled galvanized steel. It is usually assembled at the point where it is to be erected. Lattice tower is commonly used for transmission of high voltage transmission lines; AC or DC, and communication mast. It is the single unit most expensive in transmission line construction. Lattice tower can be either self-supporting or guyed tower. Guyed towers are most vulnerable to collapse when substantial bracings are vandalized. The novel method constitutes of a solar panel, rechargeable battery, battery charger, alarm system, warning system, communication system, vibration and motion detectors. Vibration and motion sensors detect presence of ‘vandal’ and send a signal to the control system which depending on the rate of incoming signal, the system either send a message to the designated numbers, or switch on the buzz and warning system or either both. Solar panel and rechargeable battery are to supply power to the system. This implies that the vandals will be scared away and the power utility will be informed of vandalism attempt on a particular tower along a specific transmission line.

Keywords—Tower, steel bracings, vandals, Kenya Power

I. INTRODUCTION

Lattice towers are steel framework construction used for different purposes such as supporting overhead conductors, communication cables (OPGW) and lightning shielding conductor wire. Towers are also used in radio transmission, satellite receptions, flood light stands, oil drilling mast, meteorological measurements etc. [1]. They are single most expensive component in a transmission line. Transmission towers are of different shape and sizes. There are four types of towers namely suspension (line tower), terminal, tension and transposition tower. Tower structure can be tubular, lattice, wooden, concrete, fiberglass or aluminum. Lattice towers are preferred because of ease of erecting them on site and relatively low cost compared to tubular (monopole) towers. They consist of steel framework of angle-profiled galvanized steel braces which are arranged in many forms, and carry solely tension, or alternatively tension and compression [2]. Bracings hold the structure stable by transferring the loads sideways down to the ground. In addition they are also used to resist lateral loads, thereby preventing sway of the structure against side sway or drift. If some bracings are removed, the compression members would buckle leading to failure of the lattice tower.

Lattice towers, however, are faced with a major challenge of vandalism of steel bracings. This involves removal of angle-profiled galvanized steel braces by vandals where they sell them as scrap metals mostly to informal sector. As result, this compromises the safety factor of the tower hence making it buckle leading to failure of the affected tower. The consequence is tremendous as it usually causes system disturbances which may result to national wide power blackout. As result, it causes loss of sale of electricity to power utility, cost for transport of labors and materials to the site of where the tower has collapsed, and hiring tower erecting equipment.

Some of the mitigation measures the power utility company has undertaken to combat steel bracings menaces are [4].

i. Routine inspection (Ground and aerial patrol).
   ii. Painting bracings color red
   iii. Use of anti-theft bolt (shearing bolt).
   iv. Involving police and local chiefs to guard towers.
   v. Punching the bracings
   vi. Use of anti-climbing devices

The number of bracings vandalized on Kenya Power lattice towers as depicted in table 1 are approximately 1,800 pieces. From the data obtained, it is evident that vandalism is rampant on power utility transmission line structures. The figure 1 shows a double circuit self-supporting lattice steel bracings tower [2].

II. TOWER SURVEILLANCE SYSTEM

The aforementioned mitigation methods have not been effective in eradicating vandalism on lattice steel bracing.
towers. There is need for an advanced method which offers a better solution of ‘guarding’ the lattice towers. The surveillance method proposed consists of a solar panel, rechargeable battery, battery charger, alarm system, lighting system, communication system and motion and vibration detector [3]. Motion and vibration sensors detect the vandals as they climb up the tower and trigger on the alarm system (buzz), light up LED siren light, and send a short message to control center or any contracted security firm. The short message contains details such as tower number, location and transmission line. The figure 2 below illustrated how the system be realized.

![Diagram of a tower]

**Fig. 1. Double circuit lattice self-supporting steel tower**

III. COST INCURRED TO REPLACE VANDALIZED TOWER

When a tower collapses due to vandalism of steel bracings, the costs escalate as shown in table II below.

### TABLE II

<table>
<thead>
<tr>
<th>No.</th>
<th>Item particulars</th>
<th>Quantity</th>
<th>Cost per item</th>
<th>Estimated Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Average length of replaced bracings</td>
<td>175m</td>
<td>300</td>
<td>52,500</td>
</tr>
<tr>
<td>2</td>
<td>Labour and transport</td>
<td>-</td>
<td>-</td>
<td>300,000</td>
</tr>
<tr>
<td>3</td>
<td>Materials such as bolts, grinder, fuel etc</td>
<td>-</td>
<td>-</td>
<td>70,000</td>
</tr>
<tr>
<td>4</td>
<td>Overtime and call out</td>
<td></td>
<td></td>
<td>125,000</td>
</tr>
<tr>
<td>5</td>
<td>Crane charges</td>
<td>6 hours</td>
<td>50,000</td>
<td>300,000</td>
</tr>
<tr>
<td>6</td>
<td>Loss of units sale</td>
<td>335,000</td>
<td>8</td>
<td>2,680,000</td>
</tr>
</tbody>
</table>

Grand estimated Total cost (Ksh) 3,527,500/=
usually high as it mainly consist of replacing bracings, transportation of both materials and labor, hiring the equipment to erect the tower and compensation of cropped damaged during erection if the tower collapse where there are flora. The table I depicts the estimated cost incurred to replace a vandalized tower and table II depicts estimated cost incurred to erect a collapsed tower.

From table II, the cost of erecting a tower is usually very high. It is worth noting that during the time the line is off, the company may opt to load shed some loads if the unaffected lines have no capacity to carry addition power. It’s imperative to ensure such incidences do not occur at any transmission line. For this reason, any project which can reduce or eliminate this menace is worthy implementing.

IV. CONCLUSIONS AND RECOMMENDATIONS

a) A tower is one of the single most expensive components in transmission line and therefore need to be secured to maintain the transmission lines up from ground level.

b) Most of Kenya power High Voltage transmission lines are supported by steel lattice towers which are either self-supporting or guyed type.

c) However, these towers are vulnerable to collapsing because of vandalism of steel bracings which is currently very rampant at some parts of the country.

d) Due to high cost incurred to replace the vandalized bracings and carrying out ground and aerial patrol, there is need to install an surveillance system that monitor the lattice towers 24/7.

e) In this regards, the proposed system is expected to reduce the steel bracings vandalism hence securing the lattice towers. The system will reduce mileage as any tower installed with the system will alert the management in case there was any an attempt of vandalism of steel bracings.

f) It is expected that vandalism of steel bracings will decrease drastically and the cost incurred to patrol and erect a collapsed towers will be eliminated.

g) It is therefore recommended to have a pilot project on a few selected transmission lines before implemented in other most vulnerable transmission lines country wide.

REFERENCES

[4] KPLC standard code of practice on transmission line maintenance