Abstract

With the advance of mobile communication, nowadays, communication network requires telecommunication towers of considerable height to cover the large area of population. Among Monopole, Self-supporting and Guyed, the most commonly used are the self-supporting towers in the field of telecommunication. In this project an attempt is made to study a simple monopole tower, its analysis and design. Very popular software namely TNX and STAAD(X) TOWER are used for the analysis and design of monopole telecommunication towers. The usual structural analysis models for telecommunication and transmission steel tower design tend to assume a simple truss behavior where all the steel connections are considered hinged. Despite this fact, the most commonly used tower geometries possess structural mechanisms that could compromise the assumed structural behavior. A possible explanation for the structure stability is related to the connections semi-rigid response instead of the initially assumed pinned behavior. This work proposes an alternative structural analysis modeling strategy for monopole steel towers design, considering all the actual structural forces and moments, by using three-dimensional beam and truss finite elements.
1. INTRODUCTION
Telecommunication towers, such as the ones used for emergency response systems, require elevated antennas to effectively transmit and receive radio communications. In the absence of tall buildings that antennas can be mounted to, monopole, self-supporting and guyed towers tend to be the most economical choice for mounting antennas. These types of towers are generally lightweight in comparison to building a solid structure and are also easier to fabricate and erect. Detailed analysis must be performed on a model of the tower in question to analyse whether seismic effects are important and whether a more in-depth analysis is required. TNX software and STAAD(X).TOWER is used to analyse the seismic, wind and ice loading. “Structural Standards for Steel Antenna Towers and Supporting Structures”- also contains detailed revisions in specifying environmental loads and design criteria with a notable increase in emphasis on seismic loads.

2. EASE OF USE
I. Tnx software
Tower Numeric Inc. (TNX) develops software for structural design of communication and wind turbine towers. TNX Tower is a general-purpose modelling, analysis, and design program created specifically for communications towers. It was founded by Peter Chojnacki, whose 20 years of design expertise cover a wide range of structural types from highway bridges to communication towers TNX Tower is a general-purpose modeling, analysis, and design program created specifically for communications towers using the RS-222, RS-222-A, RS-222-B, EIA-222-C, EIA-222-D, EIA-222-E, TIA/EIA-222-F or TIA-222-G Standards, as well as the Canadian CSA-S37-01 Standard. The program will: Automatically generate nodes and elements for a subsequent finite element analysis (FEA) for standard tower types including self-supporting towers, guyed towers and monopoles.

II. STAAD(X).TOWER
Staad(X).tower easily allows engineers to generate self-supporting towers, guyed towers and monopoles using its parametric setup wizards and Staad(X).tower offers bi-directional interoperability with other Staad(X) products like Staad(X) and Staad foundation to provide additional analysis and design of your structure. Automatically generates wind, ice, and seismic loads, following the tia-222-f and tia-222-g standards.

3. ANALYSIS OF TOWER USING TNX SOFTWARE
The analysis result are obtained directly such as deflection, tilt, twist.

I. Equations
- Front Aspect Ratio = L/w
- Front Area = L*w
- Side Aspect Ratio = L/d
- Side Area = L*d
II. DETAILS OF ANTENNA

PANEL ANTENNA TMBXX-6516-R2M(50.9”x12”x6.5”)

a) Front Area
- AA = 50.9”x12” = 4.242 ft^2
- Aspect Ratio =50.9”/12” =4.242
- Ca =1.4+(2-1.4)[(4.242-7)/(25-7)]= 1.308
- (EPA)N = (CA x AA)N =1.308x4.242 =5.548 ft^2

b) Side Area
- AA = 50.9”x6.5” = 2.297 ft^2
- Aspect Ratio = 50.9/6.5 =7.83
- Ca =1.4+(2-1.4)[(7.83-7)/(25-7)]= 1.427
- (EPA)N = (CA x AA)N =1.427x2.297 = 3.277 ft^2

Figure 1: Flat Panel Antenna

Table 1: Section Capacity

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Elevation ft</th>
<th>Component Type</th>
<th>Size</th>
<th>Critical Element</th>
<th>P K</th>
<th>ϕP_allow K</th>
<th>% Capacity</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>100 - 48.4167</td>
<td>Pole</td>
<td>TP24.82x14.5x0.25</td>
<td>1</td>
<td>-6.435</td>
<td>1369.390</td>
<td>41.3</td>
<td>Pass</td>
</tr>
<tr>
<td>L2</td>
<td>48.4167 - 0</td>
<td>Pole</td>
<td>TP34x23.503x0.313</td>
<td>2</td>
<td>-13.533</td>
<td>2313.630</td>
<td>48.3</td>
<td>Pass</td>
</tr>
</tbody>
</table>

Summary
- Pole (L2) Rating = 48.3 Pass

Table 2: Maximum Tower Deflections

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Elevation ft</th>
<th>Horz. Deflection in</th>
<th>Gov. Load Comb.</th>
<th>Tilt °</th>
<th>Twist °</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>100 - 48.4167</td>
<td>48.008</td>
<td>18</td>
<td>4.188</td>
<td>0.022</td>
</tr>
<tr>
<td>L2</td>
<td>52.5 - 0</td>
<td>13.239</td>
<td>18</td>
<td>2.365</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Table 3: Pole Interaction Design Data

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Elevation ft</th>
<th>Ratio Pn</th>
<th>Ratio Mux</th>
<th>Ratio Mny</th>
<th>Ratio Vn</th>
<th>Ratio Tn</th>
<th>Comb. Stress Ratio</th>
<th>Allow. Stress Ratio</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>100 - 48.4167 (1)</td>
<td>0.005</td>
<td>0.408</td>
<td>0.000</td>
<td>0.011</td>
<td>0.000</td>
<td>0.431</td>
<td>1.000</td>
<td>4.8.2</td>
</tr>
<tr>
<td>L2</td>
<td>48.4167 - 0 (2)</td>
<td>0.006</td>
<td>0.477</td>
<td>0.000</td>
<td>0.010</td>
<td>0.000</td>
<td>0.431</td>
<td>1.000</td>
<td>4.8.2</td>
</tr>
</tbody>
</table>
4. ANALYSIS OF TOWER USING STAAD(X).TOWER

The data is input to the software and the result such as deflection, tilt and twist is obtained from the software.

Figure 2: 3D Model of tower

Figure 3: Deflection graph

Figure 4: Tilt Graph
5. COMPARISION OF TNX SOFTWARE AND STAAD(X).TOWER

Table 4: Comparison Results

<table>
<thead>
<tr>
<th>Force/Reaction in the tower</th>
<th>TNX SOFTWARE(in)</th>
<th>STAAD(X) TOWER(in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TILT</td>
<td>4.114</td>
<td>3.33</td>
</tr>
<tr>
<td></td>
<td>2.365</td>
<td></td>
</tr>
<tr>
<td>TWIST</td>
<td>0.022</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>DEFLECTION</td>
<td>48.00</td>
<td>41.52</td>
</tr>
<tr>
<td></td>
<td>13.239</td>
<td></td>
</tr>
</tbody>
</table>

6. CONCLUSION

i. A simple monopole tower is taken up for study and detailed analysis is carried out using Tnx software.

ii. The software used gives the detailed design of monopole tower structure and flat panel antenna.

iii. To establish a communication tower requires a great deal of planning, access to experienced personnel and good tools. Without any of these components, the tower will not stand up for a long time.

iv. A "base" of good quality is essential for the life time of a tower/mast. If the base is not done with care, fatal accidents can occur which might not just turn out to be expensive but also include personal tragedies.

v. A principal feature of the monopoles is their simple design and aesthetical features. The poles are optimal particularly for smaller heights, relatively small antenna areas, and small site locations. As an alternative to the stepped design, the poles can be constructed using slip joints.

vi. Monopole towers need very less area than any other types of towers. Installations of monopole towers are very easy and economical.

7. REFERENCES

[1] Design of Steel Transmission Pole Structures, Manual 72, American Society of Civil Engineers (ASCE).


