Wind Analysis of Tubular Telecommunication Tower with Bracing Systems

Ms. Puja S. Jotawar¹, Prof. M. S. Kakamare² & Prof. M. B. Pendhari³

¹PG Student, Civil Engineering Department, P. V. P. I. T Budhgaon, Maharashtra, India
²Prof, Civil Engineering Department, P. V. P. I. T Budhgaon, Maharashtra, India
³Associate Prof, Civil Engineering Department, P. V. P. I. T Budhgaon, Maharashtra, India

Abstract: This research paper consists of effects of wind force on tubular tower structure with different bracing system. The Indian standard code of practice IS-875:1987(Part III), IS-800-2007 guidelines and methodology are used to analyze the tower structure. Etab2015 structural analysis software is used to analyze the tower under the effect of wind forces in zone III. wind analysis done by Response Spectrum Analysis. The behaviour of tower was examined and compared on the basis of displacement and base shear.

Introduction

The telecommunication industry plays a great role in human societies and thus much more attention is now being paid to telecommunication towers Fig.1 than it was in the past. The Indian telecom service business is the fastest growing one in the world, with over seven million mobile subscribers being added every month. This expanding base possesses challenges to mobile operators in terms of augmenting and upgrading infrastructure to maintain to quality of services. During the natural disasters such as the earthquakes telecommunication towers have the crucial task of instant transmission of information from the affected areas to the rescue centres. The general availability of a wide range of square, rectangular, and round structural tubing increased. The use of tubular joints greatly improved the aesthetic qualities of the truss, and the higher load carrying capacity of the structural capacity of the structural tube members provided a wide range of applications for a triangular cross section truss. Tubular sections are used for truss members, the range of different standard shapes and sizes produced is much less than wide flange shapes and availability of some standard shapes is still limited. Due to these important roles, towers should preserve their immediate occupancy level when strong ground motion happen. Fastest growing telecommunication market has increased the demand of steel towers. The major loads considered for design of these towers are self-weight, wind load, seismic load, antenna load, platform load, steel ladder load etc. Failure of towers is generally due to high intensity winds. Several studies have been carried out by considering wind and earthquake loads. A failure of a telecommunication tower especially during a disaster is a major concern in two ways. Failure of telecommunication systems due to collapse of a tower in a disaster situation causes a major setback for rescue and other essential operations. Also, a failure of tower will itself cause a considerable economic loss as well as possible damages to human lives. Hence, analysis of telecommunication towers considering all possible extreme conditions is of utmost importance. The tubular sections are more efficient sections which are adoptable to many different situations. The tubular section cannot be surprised in its efficiency by other sections.

Fig 1 Telecommunication Towers

Tube Structure

The tubular sections are used as structural component since along. A large no of tubular structures have been constructed in the past. The tubular section are effectively used in large space frame, lattice structures for antennas, stadium exhibition hall, where appearance as well as weight become an important design consideration. The mast and transmission towers are other examples where
tubular section are utilized effectively. In the past, the use of tube was hampered because of connection details. The tubular sections are more efficient sections which are adoptable to many different situations. The tubular section cannot be surprised in its efficiency by other sections.

Modeling and Loading Details:

A. Structural data

<table>
<thead>
<tr>
<th>Ht of tower</th>
<th>58m</th>
<th>66m</th>
<th>74m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base width</td>
<td>4.1m</td>
<td>4.6m</td>
<td>4.8m</td>
</tr>
<tr>
<td>Top width</td>
<td>1m</td>
<td>1m</td>
<td>1.2m</td>
</tr>
</tbody>
</table>

B. Wind data (As per IS:875-1987)

1) Wind speed: 39 m/s
2) Terrain category: 4
3) Structure class: c
4) Risk Coefficient k: 1
5) Topography factor k3: 1

C. Loading data

Live load: 1 KN/m (Only one side of tower)

Antenna load:

<table>
<thead>
<tr>
<th>Items</th>
<th>CDMA</th>
<th>CDMA</th>
<th>GSM</th>
<th>GSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Size</td>
<td>0.26X2.5</td>
<td>0.26X2.5</td>
<td>0.3X2.6</td>
<td>0.3X2.6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>20</td>
<td>20</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Total Load</td>
<td>0.615</td>
<td>0.615</td>
<td>0.641</td>
<td>0.641</td>
</tr>
</tbody>
</table>

D. Modeling of Tower structure

Static equivalent loads EQX & EQY are applied in ETABS. Also Response spectrum cases SPEC X & SPEC Y are applied in ETABS.
Earthquake Analysis for Tubular Telecommunication Tower

<table>
<thead>
<tr>
<th>Tower Ht.</th>
<th>58m</th>
<th>66m</th>
<th>74m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Story Displacement</td>
<td>35.5</td>
<td>50.9</td>
<td>85.9</td>
</tr>
<tr>
<td>Base Shear</td>
<td>78.863</td>
<td>94.2145</td>
<td>113.0253</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Tower Ht.</th>
<th>58m</th>
<th>66m</th>
<th>74m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Story Displacement</td>
<td>30.9</td>
<td>42.7</td>
<td>66.6</td>
</tr>
<tr>
<td>Base Shear</td>
<td>67.7916</td>
<td>79.7234</td>
<td>93.5808</td>
</tr>
</tbody>
</table>

Table 3

**Conclusion:**
1. The lateral displacement goes on increasing as the height of tower increases.
2. The base shear goes on increasing as the height of tower increases.
3. The inverted V bracing has less displacement as compare to X bracing.
4. Inverted V bracing is efficient than X Bracing under the wind loading.

**Acknowledgements**

I am thankful to my guide Prof. M. S. Kakamare Sir for their guidance and providing necessary information with new ideas for this paper, and also thankful to Mr. M. B. Pendhari Sir for their useful guidance. I am very grateful to Prof. Dr. Satishchandra V. Joshi, Principal of P. V. P. I. T. Budhgaon for motivating me for this paper work. Also I am thankful to Prof. V. T. Gaikwad Head of Civil Engineering department for providing necessary facilities for completion of this paper work. Lastly I am thanking all the persons who have guided and helped us directly or indirectly.

**References**

Top Telecommunication Towers”


10. IS 875:1987(Part I), Indian Standard Code of Practice for Design loads (Other than Earthquake ) for buildings and structures, Part I Dead loads - unit weights of building materials and Stored materials (second revision), bureau of Indian standards, New Delhi.

11. IS 875:1987(Part II), Indian Standard Code of Practice for Design loads (Other than Earthquake ) for buildings and structures, Part II Imposed loads - unit weights of building materials and Stored materials (second revision), bureau of Indian standards, New Delhi.


