Seismic Analysis of Tubular Telecommunication Tower with Bracing Systems

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Abstract: - This research paper consists of effects of earthquake force on tubular tower Structure with different bracing system. The Indian standard code of practice IS- 1893 (Part I: 2002), 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 earthquake forces in zone III. Seismic 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 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. Seismic data (As per IS: 1893-2002)

1) Zone factor: 0.16 (Zone III)
2) Response reduction factor: 4
3) Important factor: 1
4) Type of Soil: II, (Medium Soil)

C. Loading data

LIVE LOAD: 1 KN/m (Only one side of tower)

ANTEENA LOAD:

<table>
<thead>
<tr>
<th>Items</th>
<th>CDMA</th>
<th>CDMA</th>
<th>GSM</th>
<th>GSM</th>
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</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>

Table 1

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>EQ analysis for X Bracing</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tower Ht.</td>
<td>58m</td>
<td>66m</td>
<td>74m</td>
</tr>
<tr>
<td>Story Displacement</td>
<td>16.1</td>
<td>17.4</td>
<td>18.7</td>
</tr>
<tr>
<td>Base Shear</td>
<td>13.3169</td>
<td>16.489</td>
<td>19.6624</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>EQ Analysis for X Bracing</th>
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</tr>
</tbody>
</table>

Fig 4

EQ Analysis for Inverted V Bracing

<table>
<thead>
<tr>
<th>EQ Analysis for Inverted V Bracing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Story Displacement</td>
</tr>
<tr>
<td>58m</td>
</tr>
<tr>
<td>66m</td>
</tr>
<tr>
<td>74m</td>
</tr>
</tbody>
</table>

Fig 5

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 seismic loading.

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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.


