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Model and Seismic Analysis of Transmission Tower with I, C and Circular Sections Using Finite Element Analysis

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Abstract: ***In the contemporary era, 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. Many of the towers were failed for seismic load. Once happens the earthquake, the transmission line may collapse, it will cause economic loss, fire and whole society paralyze and also produce great difficulties to relief and emergency recovery by using stable steel section for the construction of tower we can resist the collapse. Therefore it is necessary to find the best steel section for stable microwave tower. In this work, the structural strength of microwave transmission tower with different steel section (I, C and circular) were analyzed under seismic loading conditions using ANSYS and the best stable steel section was found out.***

Keywords: Microwave tower, seismic, stable section, mode

1. Introduction

Telecommunication towers are tall structures usually designed for supporting parabolic antennas which are normally used for microwave transmission for communication, also used for sending radio, television signals to remote places and they are installed at a specific height. These towers are self-supporting structures and categorized as three legged and four legged space trussed structures. Generally, the design of self-supporting towers takes into account the effect of wind load and earthquake loads.

Many of the towers were failed for seismic load. Few examples are, Andra Pradesh, collapse of 101 m MW tower during Nov 1996 at Ravalepalm Gujarat and collapse of 80 m MW tower during June 1998 at Kutch. These failures revealed the importance of investigating the effects of seismic of tall tower structures. It is necessary to analyze the microwave tower with different steel sections also demands the challenges for enabling cost effective telecommunication and find the best stable section.

2. Methodology

1. Modelling was done using ANSYS software.
   Material Properties:
   - Truss Material: SS 316
   - Young's Modulus = 1.93E5MPa
   - Yield Strength = 240MPa
   - Poisson's ratio = 0.3
   - Density = 8000 kg/m^3
   - Allowable Strength = 144 MPa
2. Analysis of the structural strength of different steel sections (I,C and circular) with seismic loading conditions using ANSYS software.

Types of Loads and load combinations:
i: Dead
 a. Dead load assumed at 44 m height below top =150 kg
 b. Dead load assumed at 50 m height = 100 kg
ii: Dead + Seismic Load on MW tower
3. Comparison of results.
4. Selection of most stable section.

3. Modelling Phase

The tower was modelled as a steel structure. For the static analysis, the loads considered were dead load of satellites and wind load. CATIA V5 and ANSYS softwares were used for modelling. CATIA V5 was used to draw the line model of tower then the line model is exported to ANSYS, then properties and loads were assigned

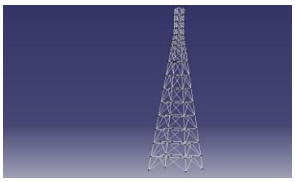

Figure 1: Line Model in CATIA

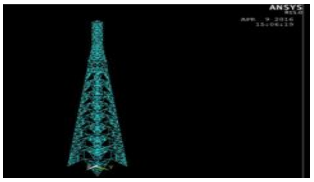

Figure2: Exported Model in ANSYS

3.1. Properties

Properties were assigned to the members. The following properties were considered.

- Truss Material: SS 316

- Young's Modulus = 1.93E5MPa
- Yield Strength = 240MPa
- Poisson's ratio = 0.3
- Density = 8000 kg/m^3
- Allowable Strength = 144 MPa
- Length of top flange,W_1 =75 mm
- Length of bottom flange,W_2 = 75 mm
- Depth of web, = 150 mm
- Thickness of top flange of I section,t_1 = 6 mm
- Thickness of bottom flange of I section,t_2=6mm
- Thickness of web of I section,t_3 = 6 mm
- Outer diameter of circular section = 76 mm
- Inner diameter of circular section = 70 mm
- Top and bottom width of C section = 75 mm
- Depth of C section = 150 mm
- Thickness of C section = 6 mm

3.2. Supports

The support conditions were given to the structure as fixed.

3.3. Loads

The following loads were considered for the analysis of the structure
Dead Load

- For 44 m height = 150 kg =1470.998 N
- For 50 m height = 100 kg = 980.605 N

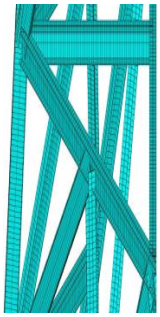

Figure 3: 3D Model of Tower with I Section

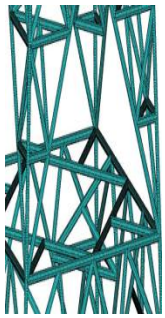

Figure 4: 3D Model of Tower with Circular Section

Figure 5: 3D Model of Tower with C Section

4. Model Analysis

Model analysis is used to find the natural frequency of the structure. For the model analysis 6 modes were considered. A mode is the combination of frequency and corresponding deformation. Model analysis was carried out for performing the seismic analysis. Model analysis of various sections (I, Circular and C) were carried out and the analysis results were included

Table 1: Model Analysis Results

	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
I Section						
Deformation(mm)	0.016	0.0162	0.0259	0.0220	0.022	0.0172
Frequency (Hertz)	0.0332	0.0332	0.0617	0.0751	0.087	0.1090
Circular Section						
Deformation(mm)	0.0118	0.0118	0.0126	0.0126	0.007	0.0168
Frequency (Hertz)	0.0333	0.0333	0.1095	0.1095	0.213	0.2156
Channel Section						
Deformation(mm)	0.0162	0.0162	0.0258	0.0209	0.017	0.0173
Frequency (Hertz)	0.0332	0.0333	0.0903	0.1085	0.109	0.1092

5. Seismic Analysis

Seismic analysis was done by using frequency response spectrum (FRS).Microwave tower is situated at Ahmedabad. So for the seismic analysis for MW tower frequency response spectrum of Ahmedabad was used and the details were given in the table. Seismic analysis of MW tower with different steel section (I, Circular and C) were carried out and the analysis results were included.

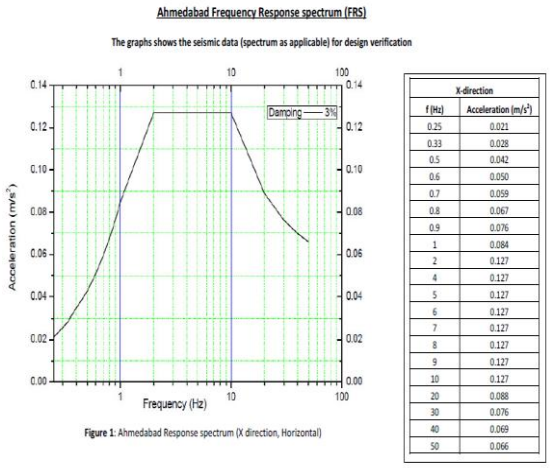

Figure 6: Ahmedabad Frequency Response Spectrum

- I Section

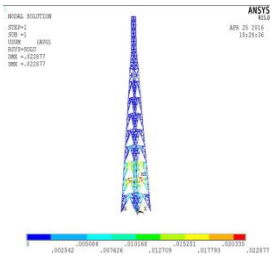

Figure7: Displacement Diagram of I section (Seismic Analysis)

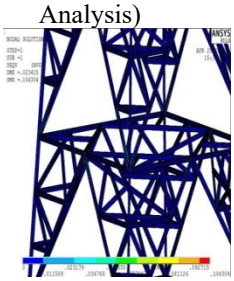

Figure 8: Stress Distribution Diagram of I section (Seismic Analysis)

- Circular Section

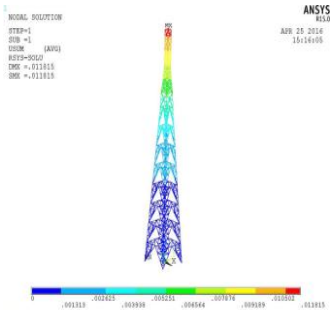

Figure 9: Displacement Diagram of Circular Section (Seismic Analysis)

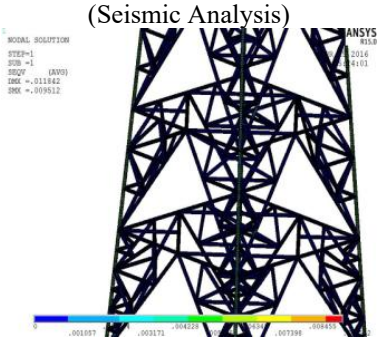

Figure 10: Stress Distribution Diagram of Circular Section (Seismic Analysis)

- Channel Section

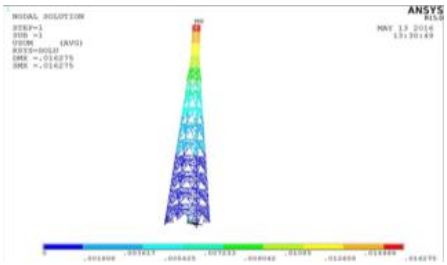

Figure 11: Displacement Diagram of Channel Section (Seismic Analysis)

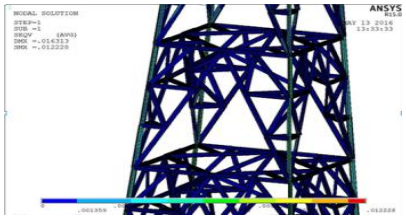

Figure12: Stress Distribution Diagram of Channel Section (Seismic Analysis)

Table 2: Seismic Analysis Results

	Maximum Deformation (mm)	Maximum Stress (MPa)
I Section	0.02287	0.104304
Circular Section	0.011815	0.009512
Channel Section	0.016275	0.012228

6. Conclusion

- I section, channel section and circular section for stable microwave tower were analyzed using ANSYS software.
- From model analysis frequency and deformation for different sections (I, Circular and C) were obtained and further seismic analysis was based on these results.
- From seismic analysis the displacement diagram and stress distribution diagram of microwave tower were obtained.
- Maximum deformation and maximum stress obtained for circular section was less. Therefore it was concluded that circular section is the most stable steel section
- The second stable section observed was channel section.
- Finally, concluded that circular section is the most stable section and channel section is the stable section.

7. Acknowledgement

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