Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 11, November -2017

A Review on Buckling Analysis of Lattice Transmission Tower

Falguni Patel[1], Unnati Bhagat[2], Dimple Desai[3], Bijal Chaudhri[4]

[1]*Civil Engineering, Chhotubhai Gopalbhai Patel Institute of Technology,*
[2]*Civil Engineering, Chhotubhai Gopalbhai Patel Institute of Technology,*
[3]*Civil Engineering, Chhotubhai Gopalbhai Patel Institute of Technology,*
[4]*Civil Engineering, Chhotubhai Gopalbhai Patel Institute of Technology,*

Abstract — *Transmission line structures are often constructed from steel lattice structures, due to their ease of assembly and due to their light weight, which results in relatively small foundations. Transmission line towers, though designed per code provisions, may fail during mandatory testing required in many countries. Different types of premature failures that were observed during full-scale testing of transmission line towers at Tower Testing and Research Station, Structural Engineering Research Centre, Chennai (CSIR-SERC) are studied, and the results are discussed in detail. Due to the complicated load conditions and the nonlinear interaction among the large number of structural components, accurate structural analysis of the LTT systems has been a challenging topic for many years. Still today there are some gaps between research and industrial practice. This paper presents a summary of research outcomes from current literature.*

Keywords- *Transmission tower; Buckling analysis; Structural failures; Staad.Pro*

I. INTRODUCTION

India has a large population residing all over the country and the electricity supply need of this population creates requirement of a large transmission and distribution system. Transmission line towers are important structures, and their design requires special techniques and criteria. The safety of these structures is essential in order to provide continuous energy transfer from power plants to communities. Due to electrical clearances and attachments, transmission line towers often have complex geometries. The towers are a lattice type, consisting of legs, primary, secondary bracings, and cross-arm members. The structural design of the tower is governed by wind loads acting on the conductor, tower body, self-weight of the conductor, tower, and other loads caused by icing, line deviation, broken wire condition, cascading, erection, maintenance, etc.

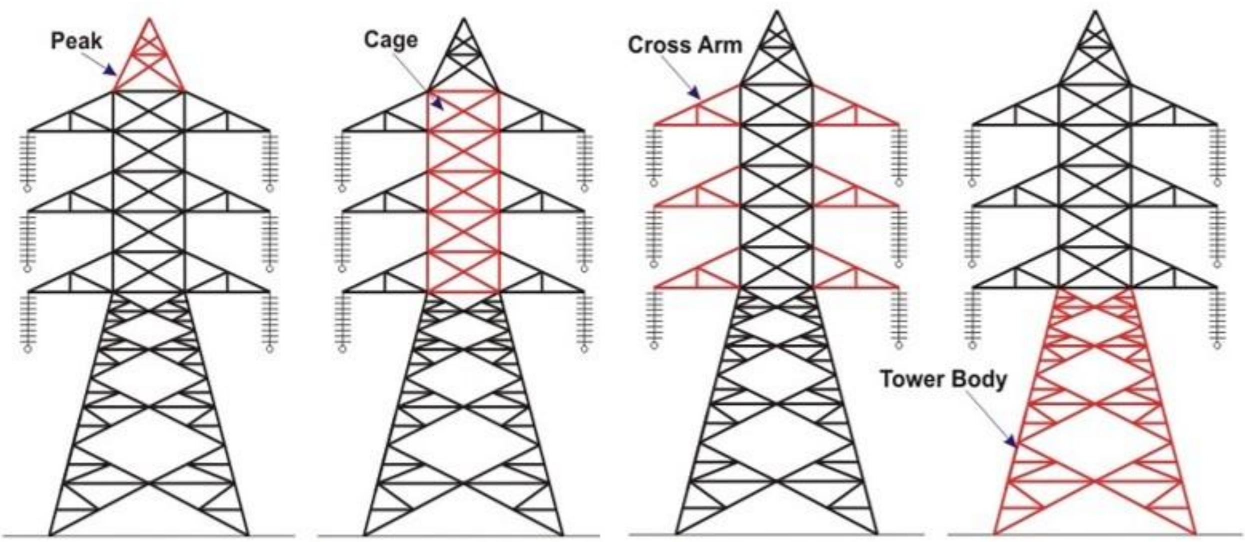

Figure 1: Components of Transmission Tower

II. LITRATURE REVIEW

(1) N.PrasadRao, G.M.Samuel Knight, S.J.Mohan, N. Lakshmanan [1] "Studies on failure of transmission line towers in testing" Structural Engineering Research Center, Chennai 600 113,India

The towers are vital components of the transmission lines and hence, accurate prediction of their failure is very important for the reliability and safety of the transmission system. When failure occurs, direct and indirect losses are high, leaving aside other costs associated with power disruption and litigation. Different types of premature failures observed during full scale testing of transmission line towers at Tower Testing and Research Station, Structural Engineering Research Centre, Chennai are presented. Failures that have been observed during testing are studied and the reasons discussed in detail. The effect of non-triangulated hip bracing pattern and isolated hip bracings connected to elevation redundant in „K" and „X" braced panels on tower behaviour are studied. The tower members are modelled as beam column and plate elements. Different types of failures are modelled using finite element software and the analytical and the test results are compared with various codal provisions. The general purpose finite element analysis program NE-NASTRAN is used to model the elasto-plastic behaviour of towers. Importance of redundant member design and connection details in overall performance of the tower is discussed.

(2) **Y. M. Ghugal , U. S. Salunkhe** [2] "Analysis and Design of Three and Four Legged 400KV Steel Transmission Line Towers: Comparative Study" International Journal of Earth Sciences and Engineering 691 ISSN 0974-5904, Volume 04, No 06 SPL, October 2011, pp 691-694

The four legged lattice towers are most commonly used as transmission line towers. Three legged towers only used as telecommunication, microwaves, radio and guyed towers but not used in power sectors as transmission line towers. In this study an attempt is made that the three legged towers are designed as 400 KV double circuit transmission line tower. The present work describes the analysis and design of two self-supporting 400 KV steel transmission line towers viz three legged and four legged models using common parameters such as constant height, bracing system, with an angle sections system are carried out. In this study constant loading parameters including wind forces as per IS: 802 (1995) are taken into account. After analysis, the comparative study is presented with respective to slenderness effect, critical sections, forces and deflections of both three legged and four legged towers. A saving in steel weight up to 21.2% resulted when a three legged tower is compared with a four legged type.

Table 1: Maximum Axial Force

SR No.	Different Node Point	Maximum Axial Force			
		Four Legged Tower		Three Legged Tower	
		NC	BWC	NC	BWC
1	Leg	613.1	659.2	1090	1110
2	Main Members	108.4	108.5	89.6	271.8
3	Secondary Members	6.9	6.9	19.7	61.6
4	Cross Arm	98.2	102.9	586.7	638.9
5	Diaphragm	24.8	24.8	58.1	59.9

Table 2: Comparison of Maximum Deflection

SR No.	Different Node Point	Deflection in mm		Maximum Permissible Deflection (H/100)
		Four Legged Tower	Three Legged Tower	
1	Base of Leg	0	0	0
2	Bottom hamper point	66.3	85.2	282
3	Bottom Cross arm Tip	85.3	138.7	282
4	Middle Cross arm Tip	126.2	172.5	365
5	Top Cross arm Tip	179.3	292.8	442
6	Ground Wire arm Tip	212.6	270	480
7	Topmost point of Leg	210.3	249.7	500

(3) **Gopi Sudam Punse** [3] "Analysis and Design of Transmission Tower" International Journal of Modern Engineering Research ISSN:2249-6645, Volume 04, Issue 01, January 2014, pp 116-138

In this thesis Analysis and Design of narrow based Transmission Tower (using Multi Voltage Multi Circuit) is carried out keeping in view to supply optimum utilization of electric supply with available ROW and increasing population in the locality, in India. Transmission Line Towers constitute about 28 to 42 percent of the total cost of the Transmission Lines. The increasing demand for electrical energy can be met more economical by developing different light weight configurations of transmission line towers. In this project, an attempt has been made to make the transmission line more cost effective keeping in view to provide optimum electric supply for the required area by considering unique transmission line tower structure. The objective of this research is met by choosing a 220KV and 110KV Multi Voltage Multi Circuit with narrow based Self Supporting Lattice Towers with a view to optimize the existing geometry. Using STAAD PRO v8i analysis and design of tower has been carried out as a three dimensional structure. Then, the tower members are designed.

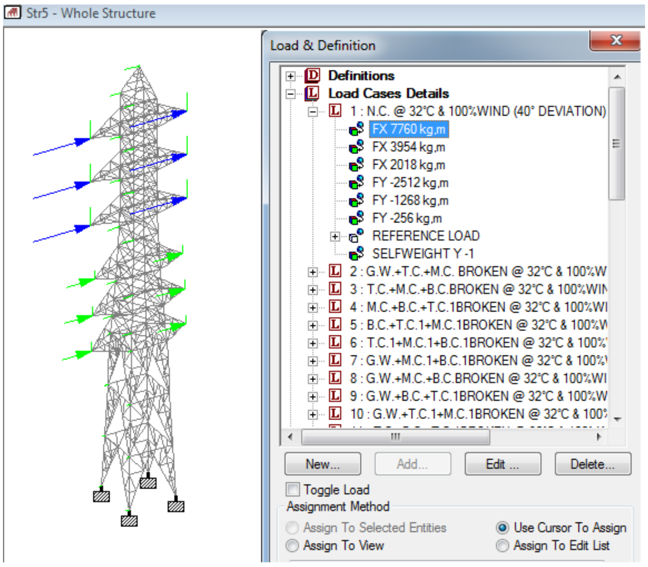

Figure 2: Loads acting on transmission tower under normal (intact wire) Condition

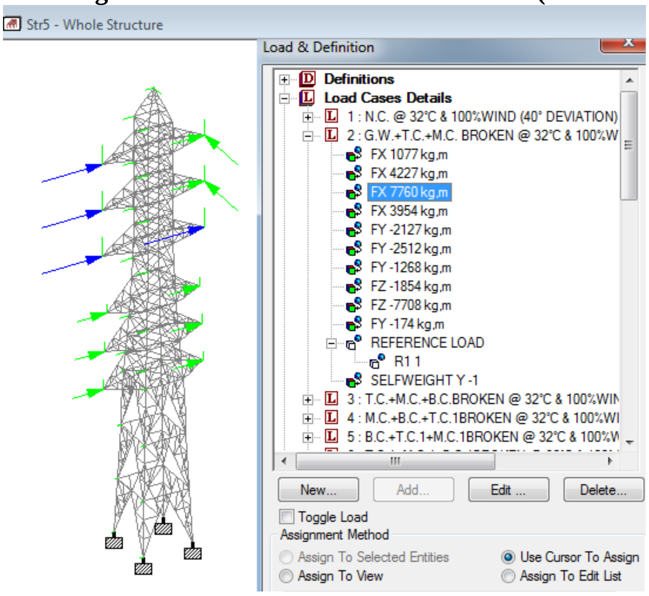

Figure 3: Loads acting on transmission tower under broken wire condition

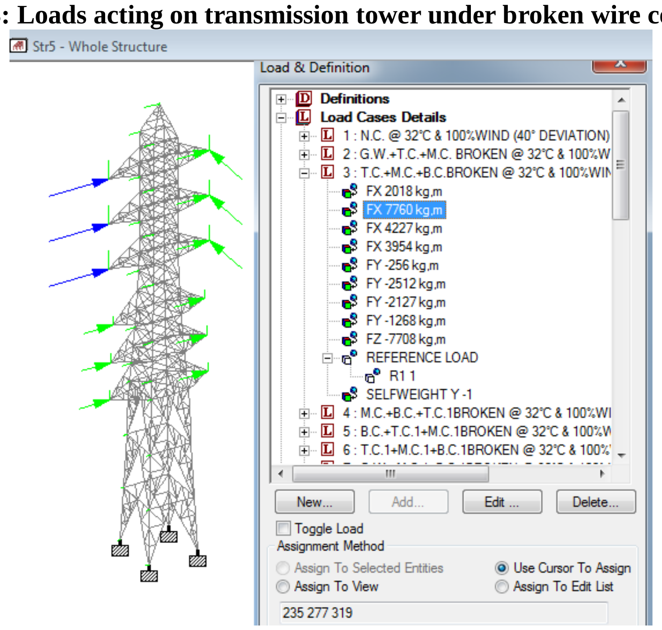

Figure 4: Loads acting on transmission tower under broken wire condition

(4) **Mustafa Mahamid , Mutaz Al Hijaj , Adeeb Rahman , Faris Malhas** [4] "Nonlinear and Buckling Analysis of Steel Transmission Towera" International Journal of Modern Engineering, Volume 16, Number 01, Fall/Winter 2015

Transmission line structures are often constructed from steel lattice structures, due to their ease of assembly and due to their light weight, which results in relatively small foundations. These structures are typically constructed from standard single or built-up steel angles all of which are as-assembled and connected together by a steel gusset plate. To better understand the true behavior of the tower, full-scale tests are usually performed under design loads. These tests are required to investigate the overall behavior of the structure and the behavior of the steel connections that connect multiple members together. This practice is essential before producing multiple trans-mission towers for a single project. However, full-scale tests are expensive to build and time consuming, which may cause delays in project schedules. As an alternative to full-scale testing, and as an approach to prevent certain unexpected behavior of these structures, the authors of this cur-rent research project proposed detailed finite element models to determine the capacity of these structures and to investigate the global and local buckling behaviors, which are hard to predict using full-scale testing. Previous experi-mental results were used to validate the finite element models. The finite element modeling of the members used beam elements for the steel angles with pin connections for the joints; the commercial finite element package ABAQUS was used for the modeling.

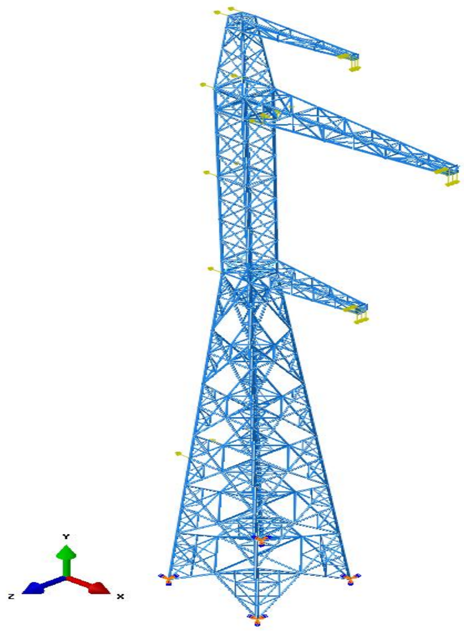

Figure 5: Finite Element Model of the Transmission Tower

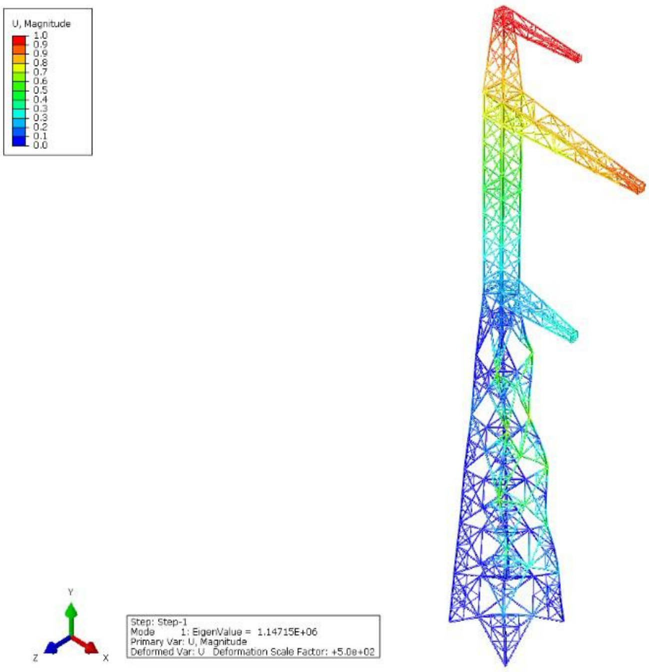

Figure 6: Deflections for the First Buckling Mode

III. CONCLUSION

From the above literature we conclude that,

- Narrow based steel lattice transmission tower structure plays a vital role in its performance especially while considering eccentric loading conditions for high altitude as compared to other normal tower.
- It was observed that the finite element results were in agreement with the load-test results, except for some locations where strain gauges were possibly damaged.
- For such structures with many structural elements, it was challenging to determine buckling loads experimentally, especially at the local levels.
- It was concluded that the finite element model can be used to deter-mine the buckling load and to capture the buckling behavior for transmission towers and its different components.
- The axial forces are increased by 77.81% in three legged tower support components as compared four legged tower support components.
- The moments are increased by 60% in three legged tower components as compared four legged tower.
- Triangular tower deflection is found to increase by 27.4% in normal condition compare with Square tower.
- A saving in steel weight of 21.2% resulted when using a three-legged tower as compared with a four legged type with angle section.
- In addition, 3.05 % area saving in three legged tower can be achieved as compare to four legged tower.

REFERENCES

[1] N.PrasadRao, G.M.Samuel Knight, S.J.Mohan, N. Lakshmanan, “Studies on failure of transmission line towers in testing” Structural Engineering Research Center, Chennai 600 113, India.
[2] Y. M. Ghugal , U. S. Salunkhe “Analysis and Design of Three and Four Legged 400KV Steel Transmission Line Towers: Comparative Study” International Journal of Earth Sciences and Engineering 691 ISSN 0974-5904, Volume 04, No 06 SPL, pp 691-694, October 2011.
[3] Gopi Sudam Punse “Analysis and Design of Transmission Tower” International Journal of Modern Engineering Research ISSN:2249-6645, Volume 04, Issue 01, pp 116-138, January 2014.
[4] Mustafa Mahamid , Mutaz Al Hijaj , Adeeb Rahman , Faris Malhas [4] “Nonlinear and Buckling Analysis of Steel Transmission Towera” International Journal of Modern Engineering, Volume 16, Number 01, Fall/Winter 2015.
[5] Bureau of Indian Standards (IS) (1978). “Code of practice for use of structural steel in over head transmission line towers—Testing.” IS: 802 (part III)), New Delhi, India.
[6] Bureau of Indian Standards (IS) (1992). “Code of practice for use of structural steel in over head transmission line towers—Permissible stresses.” IS:802 (Part 1/Sec 2), New Delhi, India.

