IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8538

Comparative Study on Isolated Foundation of Suspension and Tension Transmission Tower under Different Soil Conditions

Labdhi Doshi[1], Prof. Poonam I. Modi[2]

Post Graduate Student, Applied Mechanics Department, L. D. College of Engineering, Gujarat, India[1]

Assistant Professor, Applied Mechanics Department, L. D. College of Engineering, Gujarat, India[2]

Abstract: Foundations are one of the major factors affecting the behaviour of the transmission tower as it transmits loads to the soil. Recently with increase in size of transmission tower with extra high transmission voltages, loads acting on the foundation increases and thus, requiring heavier foundation. Hence, it is necessary to design the foundation considering safety and economy. Also, it is necessary to consider the soil type for which the foundations have to be designed. In this work, Models of self-supported suspension and tension towers are analysed for 66 kV, 220 kV and 400 kV transmission voltages in STAAD PRO v8i. Comparative study for 2-stepped and 3-stepped isolated foundations of towers has been carried out for five types of soil conditions. Analysis and design of all foundations has been done for all given conditions and estimated quantities of materials are compared. It has been observed that 2-stepped isolated foundation requires 1.1 to 1.27 times more steel than 3-stepped isolated foundation for all types of soil condition. It was also shown that the minimum cost is obtained for dense soil than any other soil type. Hence, it can be concluded that the economical design of foundation is obtained by using 3-Stepped foundation with dense sand.

Keywords: Transmission Line Tower, Suspension and Tension Tower, Isolated Foundation, Different soil conditions

I. INTRODUCTION

Now a days, with demand of high transmission voltages, size of transmission line towers increases and resulting into the increase in loads. In any transmission line project, large numbers of foundations are normally required. Hence,the cost of foundation involved becomes considerably large for any project. Previous records had shown that failures of tower foundation are also one of reason for collapse of transmission tower super structure and hence it endangers the safety of the tower. Failures of tower foundation are mostly because of certain deficiencies in the design or in the classification or in the construction of foundation. Generally, due to improper classification,foundations are designed overly on safer side which results into the increase in resources unnecessarily. It raises need to find the optimum solution for design of foundations.

- **Types of Loads on Foundation**

Types of loads are considered to act on the foundations of transmission tower are given asbelow:

- The downward thrust (compression)
- The uplift (tension)
- The side thrusts in both transverse and longitudinal directions (lateral forces)

The magnitude of these forces depends upon types of tower and the transmission capacity oflines. The limit loads taken for design of foundations should be 1.1 times of these for the corresponding towers. The additional moments developed due to eccentricity of the loads isalso taken into account for design of the base slab of the foundation.

- **Soil Parameters Considered for Foundation Design:**

Following parameters are required for designing of the foundation:

a) Limit bearing capacity of soil

To ensure the stability of foundation against shear failure of soil, limit bearing capacity of soil is important. It is also useful to check stability against the excessive settlement of foundation, when foundation is subjected to downward loads and moments due to horizontal forces and eccentricity of the loads.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8538

b) Density of soil

Density of soil is important for the calculation of uplift resistance of foundation as well as to calculate differential weight of soil and concrete below ground level for checking the bearing pressure under foundation.

c) Angle of Earth frustum

Angle of earth is signification for finding uplift resistance of the foundation.

This study was done to check the feasibility of 2-stepped and 3-stepped isolated foundation for three different transmission voltages under different soil conditions. The main objective is to compare and derive the optimum solution for foundation design as per Indian standards.

II. MODELING AND ANALYSIS

- **Design parameters for 66 kV transmission tower:**

Design span:	300 m
Wind zone:	V
Basic wind speed:	50.00 m/s
Reliability Level:	1
Terrain category:	1
Design wind pressure:	925 N/m^2
Drag coefficient for conductor:	1.0
Drag coefficient for Ground wire:	1.2
Drag coefficient for Insulators:	1.2

Gust-response factor for conductor:	1.96
Gust-response factor for Ground wire:	1.91
Gust-response factor for Insulators:	1.94
Size of insulator string:	1.41×0.28 m
No. of insulator string:	1
Conductor:	ACSR
Diameter of conductor:	0.0210 m
Ground wire type:	OPGW
Diameter of ground wire:	0.01240 m

- **Modeling of Tower:**

Modeling of towers has been done in STAAD.Pro v8i software for three different transmission voltages. Figure 1 shows the model of 66 kV transmission tower. Excel sheet has been developed to calculate sag tension for ground wire and conductor according to Indian standards. Loads applied on the towers are calculated as per IS 802 (Part1/Sec 1): 2015 and analysis has been carried out. Figure 2 shows the application of loads on towers.

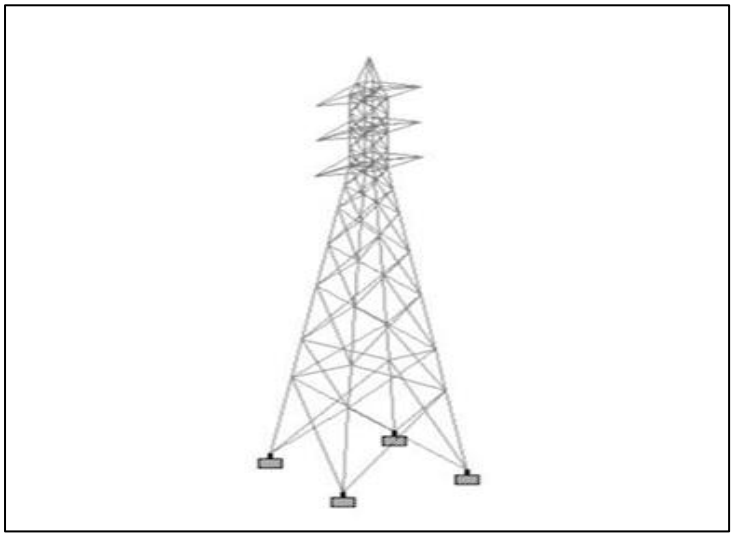

Figure 1: Modeling of 66 kV Transmission Tower in STAAD.Pro

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8538

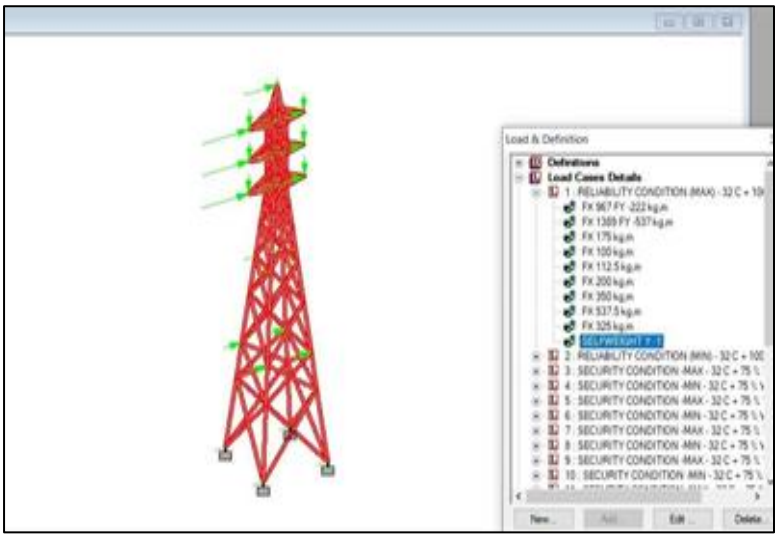

Figure 2: Application of Loads on Tower

- **Types of soil considered for the study:**

Table 1: Soil Parameters

Sr. No.	Soil Type	Angle of Earth Frustum (Degrees)	Unit Weight of Soil (kg/m^3)	Limit Bearing capacity (kg/m^2)
1	Dense Sand	36	2070	45000
2	Loose Sand	29	1750	25000
3	Silty Sand	27	1750	15000
4	Stiff Clay	17	2000	20000
5	Soft Clay	17	1750	10000

III. RESULTS

For the design and stability analysis of foundation for tower, excel sheets has been prepared for both 2-stepped and 3-stepped isolated foundation with the help of manual on Transmission line by CBIP. Then, 2-stepped and 3-stepped isolated foundations have been designed for 66 kV, 220 kV and 400 kV suspension and tension towers. Comparative study of cost associated with foundations has been carried out for five different types of soil as given above.

- **Model name description:**

DS – Dense Sand
LS – Loose Sand
SS – Silty Sand
SC – Stiff Clay
SOC – Soft Clay
2 – 2-stepped Isolated Foundation
3 – 3-stepped Isolated Foundation

S – Suspension Tower
T – Tension Tower
66 – 66 kV
220 – 200 kV
400 – 400 kV

Examples: S66DS2: 2-stepped Isolated Foundation of 66 kV Suspension Tower for Dense Sand
T400SOC3: 3-stepped Isolated Foundation of 400 kV Tension Tower for Soft clay

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8538

- **Result Comparison:**

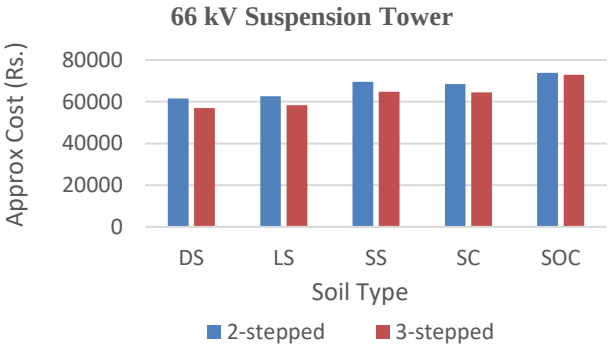

Figure 3: Cost Comparison of 2-Stepped and 3-Stepped Isolated Foundation for 66 kV Suspension Tower

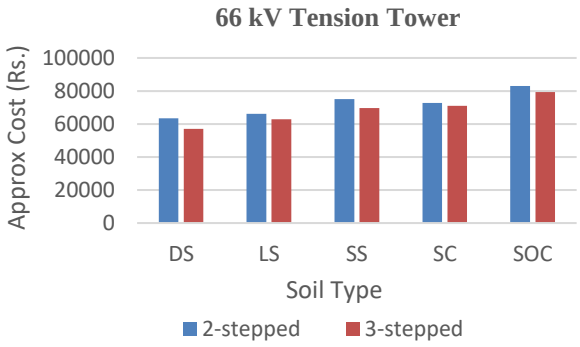

Figure 4: Cost Comparison of 2-Stepped and 3-Stepped Isolated Foundation for 66 kV Tension Tower

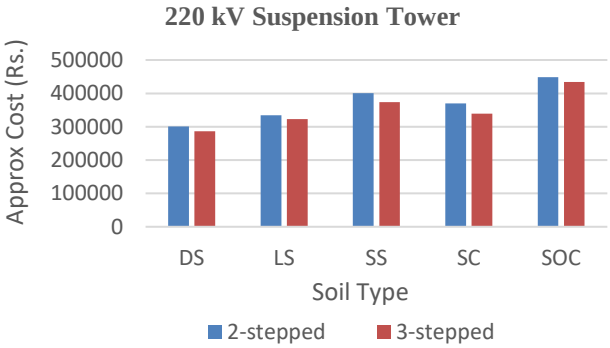

Figure 5: Cost Comparison of 2-Stepped and 3-Stepped Isolated Foundation for 220 kV Suspension Tower

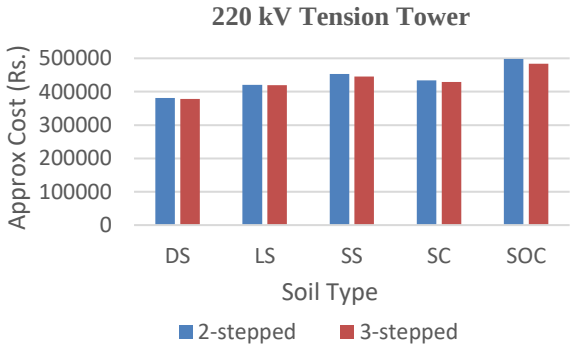

Figure 6: Cost Comparison of 2-Stepped and 3-Stepped Isolated Foundation for 220 kV Tension Tower

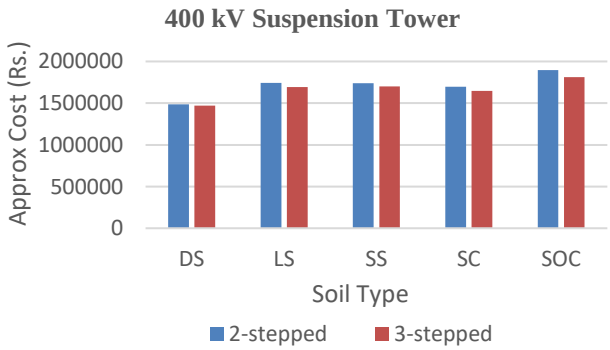

Figure 7: Cost Comparison of 2-Stepped and 3-Stepped Isolated Foundation for 400 kV Suspension Tower

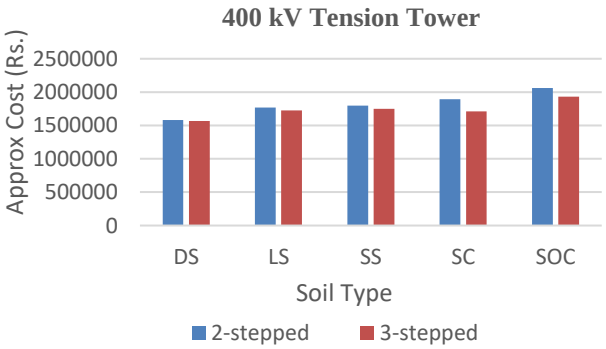

Figure 8: Cost Comparison of 2-Stepped and 3-Stepped Isolated Foundation for 400 kV Tension Tower

IV. CONCLUSION

It has been observed that 2-stepped isolated foundation require 1.1 to 1.27 times more quantity of steel than 3-stepped isolated foundation for all types of soil condition. Hence,the material cost of 3-Stepped foundation is less as compared to 2-Stepped isolated foundation.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Vol. 8, Issue 5, May 2021

DOI: 10.17148/IARJSET.2021.8538

- It is also observed that the Dense sand has given better results for both 2-stepped and 3-stepped isolated foundation and for both suspension and tension tower than any other soil type.
- For 400 kV both suspension and tension tower, 15-26% reduction in quantity of steel for3-stepped foundation is observed as compared to 2-stepped isolated foundation.
- It has seen that the quantity of materials required for silty sand condition is more than that of required for stiff clay condition under all condition.
- For 3-Stepped isolated foundation, the requirement of shear reinforcement is less as compared to 2-Steped isolated foundation for all type of soil condition.
- For soft clayey soil, percentage increase in steel is about 27-52% as compared to densesand for 220kV transmission tower foundations, whereas for others, it is between 19- 31% for both type of isolated foundation.

REFERENCES

[1] Dongxue Hao, Rong Chen, Guangsen Fan, "Ultimate Uplift Capacity of Transmission Tower Foundation in Undisturbed Excavated Soil", Energy Procedia 17, ELSEVIER 2012.
[2] Guanglin Yuana, Biao Yanga, Zhaohui Huang, Xiaozhe Tan, "Experimental study on the stability of the transmission tower with hybrid slab foundation", Engineering structures, ELSEVIER 2018.
[3] Akash M. Popat, Prof. P. G. Patel, "Parametric Study of Foundation of Tension and Suspension Tower with Square and Rectangular Base", International Research Journal of Engineering and Technology, 2018
[4] Prof. R.G. Bade, Mr. Zeeshan Qureshi, Mr. Shrikant Yadav, "Design of ShallowFoundation under Downward, Uplift and Side Thrusts Loadings for Transmission LinesTower", International Journal of Engineering Research and Development, 2016.
[5] Doohyun Kyung, Youngho Choi, Sangseom Jeong, Juhnwan Lee, "Improved Performance of Electrical Transmission Tower Structure Using Connected Foundation in Soft Ground", Energies 2015
[6] M. P. Pacheco, C. Pereira Pinto, F. A. B. Danziger, "Design of shallow foundations under tensile loading for transmission line towers: An overview", Engineering Geology,ELSEVIER 2008.
[7] Transmission line manual by Central Board of Irrigation and Power, Publication no. 268
[8] IS 802 (Part 1 / Sec 1): 2015 - Use of Structural Steel in Overhead Transmission Line Towers — Code of Practice