Static Analysis and Design of Transmission Line Towers

using Etabs

Osama Khalfalla Alshambati
Dept. Civil Eng. Al Zaiem Al Azhari University
Khartoum, Sudan

Majdi Elgaili Mukhtar Ahmed
Dept. Civil Eng. Al Zaiem Al Azhari University.
Assistant Professor
Khartoum, Sudan

Abstract:- **The maim of this thesis is to study the transmission line towers with their different types and have a better comprehensive loads behavior on the towers transmitting 110 kv; this is because the majority of the transmission lines used in Sudan of this type. Using the specifications of the British standers in manual design (CP3: Chapter v: Part2:1972).**

. Also the effect of both of slope in tower legs and width of the upper part on the transmitted forces to foundations and on the weight of towers; had been studied. With ETABS through several steps. And recommended some better ways in understanding the towers loading behavior. Using steel angels, which if far better economically.

Keywords:- Steel design t; tower design ; analysis of towers ;angle design; etabs software ; design of towers

I. INTRODUCTION

. This research article is a study of how to design a steel tower (transmission of power / electricity) using Etabs software for analyzing and design, considering the factors of wind loads, Wires, and the dead load of the structure. To have clear picture of the load paths considering this process in SUDAN, this case study shows how the wind loads here in SUDAN can affect the design, after assuming the lengths and heights of the steel angles. And the results are more than satisfying duo to SUDAN nature of slow winds regarding the heights. And duo to the wire load the result of the main slope accruing the tower legs , and tower lower parts is significantly lower than the same design in BIRTIN or USA because of the rock solid land and the lower loads.

. After the analysis and design the results were shown, model been made to take a clear look on the structure behavior , also this design is one of the majors which can conclude to us towers design is same globally.

II. LITERATURE REVIEW

Transmission line towers are usually, latticed steel structure. In addition to their self-weight, the main loadings acting on them are the weight of the wires and their accessories, and the wind load acting on the wires and the towers. Due to the importance of this type of steel structures special codes of practice and specifications were issued to deal with the design and construction of them. The first guide for design of steel transmission towers was issued by the American Society of Civil Engineers, ASCE, in 1971 (1).). A revised edition of which has been published in 1988 as ASCE Manual No.52 (2). In 1987 the American Society of Civil Engineers established a committee to develop a standard for the design of latticed steel transmission structures. This standard has been completed in 1990 and approved by the ANSI in December 1991. Then published as ANSI / ASCE 10 in 1992 (3) and updated in 1997 (4). Substantial effort has been going on to improve methods for determining structural loads on transmission line structures. The task committee, on
structural loading of the committee on electrical transmission structures has gathered, discussed, and presented the results of these effort as an ASCE Manual No.74 in 1991 (5). The manual presented detailed guidelines and procedures for developing transmission line structure loads. In addition to the ASCE, the Institute of Electric and Electronic engineers IEEE has issued some publications concerning their recommendations and safety regulations (6-9). The study shows that tower with angle sections are most economical and effective section compared to other two sections.

RESEARCH METHODOLOGY :-

A. *Software used in modelling*:

E*tabs sofware program is a one of the most relaible programs in modelling , which can be very flexible with all types of inserted DATA.*

B. *Model features :-*

Table 1:1 tower description

Type of the tower	KV110
Height of the tower	31 m
Base width	6 m
Length of cross arm	15 m
Type of bracing	Fixed bracing
Width of hamper	1.5 m
Conductor material	Aluminum Conductor Steel Reinforced
Virtual spacing between conductors	8.5 m

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C. ***Methdology:***

D. *. emphasizing on the contributions made to facilitate each step. Typical calculations of the design of a single tower are presented. Comparison between several specifications concerning wind loading is presented as well (Wind pressures on wires have been calculated using three manuals and Codes of practice, these are, ASCE Manual No.74 (5), CP3: Chapter V: part 2: 1972 (10).*

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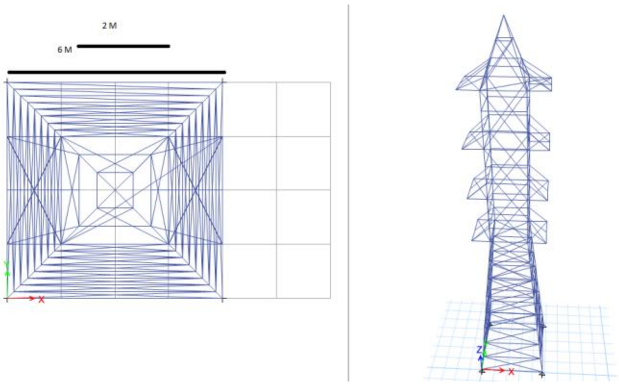


Figure 1, plan view & 3D view. (total height 30 m).

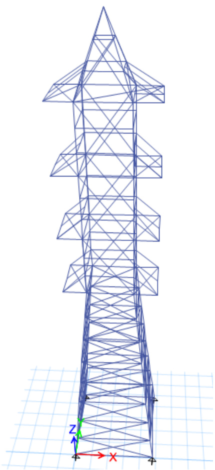


Figure 2 3D elevation / height (30)

(1)

E. ***Loads assigns & combinations***

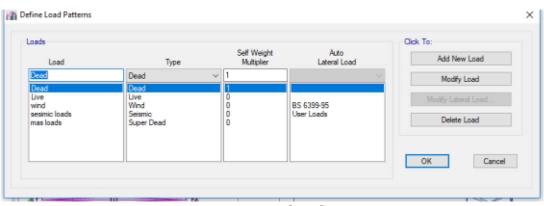
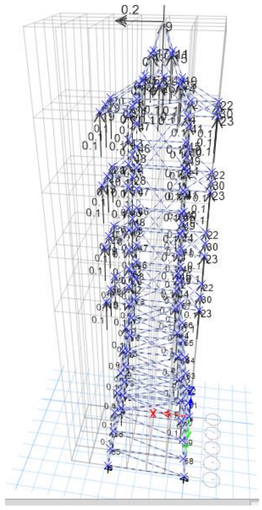


Figure 3 loads



III. RESULTS

After assigning the loads to the structure, analysis is done to evaluate the axial force displacement and steel take off for determining the economic section .After following above mentioned steps the results obtained from the study are summarized below .

table 1:2 maximum axial force

S .no.	Different node point	Axial force
1	Bottom leg	37.307 KN
2	Top column	2.222 KN
3	Bottom horizontal member	3.452 KN
4	Bottom bracing	-37.98 KN
5	Top & cross bracing	-0.2158 KN
6	Inclined member of cross arm	-0.2736 KN

$\alpha + \beta =$

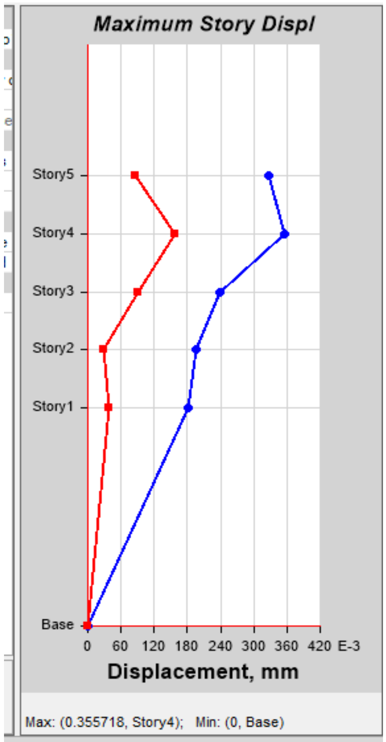


Figure 4 chart showcasing the max/min values of displacement

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Following are the main steps of the design of transmission line towers

- Calculation of wind load on wires.
- . Assuming geometry and cross sections of the members
- . Calculation of wind load, directly, applied on the tower.
- . Calculation of forces transmitted from wires to the tower.
- Constructing of a loading table taking into account all the loading conditions.

Making preliminary design for each member for the worst loading condition.

Tower Configuration Steel Weight	(kN)
1 Angle section	321.652 2

A. *Recommendations & discution:-*

.From the previous results we can concluded that angular section is more economical and effective with other sections. Also the cable weights (wires) can be added to the total dead load duo to it small effect on the structure displacement & loading behavior.

.As final result we can sum-up some points:-

- Angular section saving a steel weight as 20.62% compared to tubular section . which is significantly beneficial.
- Angular section are better in resisting axial forces which can decrease the amount of displacement and slope in the tower lower parts.

REFERENCES

[1] ASCE Manuals and reports on Engineering Practice No.52 "Guide for Design of Steel Transmission Towers" First Edition. American Society of civil engineers 345 East 47th Street New York, NY 10017-2398, 1971

[2] ASCE Manuals and reports on Engineering Practice No.52 "Guide for Design of Steel Transmission Towers" Second Edition. American Society of civil engineers 345 East 47th Street New York, NY 10017-2398, 1988

[3] ANSI/ASCE 10-90, Standard for the "Design of Latticed Steel Transmission Structures" presented by the American Society of Civil Engineers and approved by the American National Standard Institution (ANSI) 345 East 47th Street New York, NY 10017-2398, on December 9th, 1991.

[4] ANSI/ASCE 10-97, Standard for the "Design of Latticed Steel Transmission Structures" presented by the American Society of Civil Engineers and approved by the American National Standard Institution (ANSI) 345 East 47th Street New York, N.Y 10017-2398, 1997.

[5] ASCE Manuals and reports on Engineering Practice No.74 "Guide Lines for Electrical Transmission Line Structural Loading",

[6] 345 East 47th Street New York, N.Y 10017-2398, 1991.

[7] KRAVITZ, R.A. "Transmission Line Tower Analysis and Design in Review." Paper 82 WM 204-6, IEEE Power Engr. Soc., Winter Meeting, New York, N.Y., 1982

[8] BROCKENBROUGH, R.L., and SCHMITT, R.J. "Considerations in the Performance of Bare High Strength Low-Alloy Steel Transmission Towers." Paper C 75 041-9, IEEE Power Engrg.Soc., Winter Meeting, New York, N.Y., 1975.

[9] CARPENA, A., and DIANA, G. " Behavior to Wind Action of Angle and T-bars on H.V. Lattice Structures." Paper 71 TP 668-PWR, IEEE Power Engr. Soc., Summer Meeting, Portland, 1971.

[10] PEYROT, A.H. "Microcomputer Based Nonlinear Structural Analysis of Transmission Line Systems." IEEE Trans. Power Appar. Sys. PAS-104, 1985.

[11] "British Standard Institutions", CP3: Chapter V: Part2: September: 1972.

[12] Specification Presented by the Iraqi National Electricity Corporation (INEC), 1999.

[13] "Standard Specification for Zinc-Coated Steel Transmission Tower Bolts, Designation A394." Annual Book of ASTM Standards, Section 15, Vol.15.08, American Society for Testing and Materials, Philadelphia, PA, 1982.

[14] "Requirements and Information of the Transmission Line Towers 110 KV", Presented by the Sudanese National Electricity Corporation (SNEC), 1996.

[15] "Structural Use of Steel Work in Building", BS 5950: part1, 1985