Optimization of 400kv Transmission Line Towers

M.Amala, V.Gokul, G.Salaiamuthavalli, K.G.Akshaya

Abstract*— Paper Setup Electric power plays an important role in the life of the community and the development of various sectors of economy. Developing countries like India therefore give a high priority to power development programmes. Wind pressure on conductor, insulator and ground wire and the wind load on the tower has been arrived based on IS 802 – 1995 by taking into consideration of the following factors like average height of the conductor above the ground, drag coefficient of conductor, insulator and ground wire, position of different panels, total surface area of members in each panels, height from C.G to the ground level. Different loading conditions like Reliability condition, safety, security and anti cascading condition will be considered in different aspects which will be used in analysis and design. This project deals with "optimization of 400KV double circuit transmission line towers" in which the design can be executed by using STAAD PRO. The design and optimization of the tower can be carried out by altering the tower base width. By altering the base width of the tower, the corresponding members, bracing sizes and material properties of the members are being changed for analyzing the economical section. Depending upon the modified tower base width, the member and bracing sizes are suitably provided for different effective base width trials so as finalize the output of economical modified base width tower. The best optimized tower can be determined and recommended for safety and economy of steel.

***Keywords*— Conductor, Ground wire, base width of tower, optimization.**

I. INTRODUCTION

A tower or mast is a large skeleton structure, with a relatively small cross section which has a large ratio between height and maximum width. A tower is a freely standing self supporting structure fixed to the base or foundation.

Towers are generally made up of high tensile steel rods. Transmission line towers are classified based on circuits. They are Single circuit, double circuit and Multi circuit tower. The tower configuration is dictated by the number of circuit and clearance required for the transmission line and the clearance required for the ground or other obstructions within limits, various tower configurations can be developed and the designer should investigate all these to select the most economical one. The purpose of a transmission line tower is to support conductors carrying electrical power and one or two ground wires at suitable distances above the ground level and from each other.

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The transmission line tower cost about 35 to 45 percent of the total cost of the transmission line. A transmission tower is a space frame and is a high order indeterminate structure.

II. SCOPE OF THE STUDY

The main objective of this is the Design of Optimization of 400 KV Double circuit transmission line towers in which the base width of the transmission line tower is being altered. By altering the base width of the tower, the corresponding members, bracing sizes and material properties of the members are being changed for analyzing the economical section. Depending upon the modified tower base width, the member and bracing sizes are suitably provided for different effective base width trials so as finalize the output of economical modified base width tower. Thus the best optimized tower can be obtained.

The aim of the project is to design the best optimized tower in which it results in the economy of the steel. By adopting suitable base width this can be achieved. Thus finally the optimized tower is said to be cost wise effective and consumption of steel is reduced. The anticipated growth of electrical power and the transmission line tower programmes in the future is very great. Thus economical type of transmission line tower design is preferred. The different wind loading conditions, sag and tension calculations and the loads acting on the tower can be computed by using IS 802. Thus 400KV Double circuit has to be designed properly with tower angle to ensure safety for different practical load combinations.

IIIL BACKROUND STUDY

Analysis and design of three legged and four legged tower and thus three legged tower results in 21.2% of saving of steel when compared to four legged tower. Y. M. GHUGAL, U.S. SALUMKHE (2011).

Comparison of tubular and angular section where tubular section results in 20.9% of saving of steel when compared with angular section VINAY R. B, RANJITH A, BHARATH A (2015).

Corrosion of transmission line tower and its rehabilitation in which if tower leg corrodes it has to be rectified or it may lead to collapse of tower. S.CHRISTIAN JOHNSON, G.S.THIRUGNANAM (2010).

Computer Aided analysis and structural optimization of transmission towers in which six different panels are considered for 132kv double circuit transmission line tower , so as to adopt suitable tower. MR. T.RAGHAVENDRA (2012).

Weight optimization of double circuit steel transmission line towers is compared by using staad pro and PSO algorithm. PSO algorithm shows better results compared to STADD PRO. R.NAGAVINOTHINI, C.SUBRAMANIAN (2015)

Upgrading of transmission line towers using diaphragm bracing system is analyzed using fem software. F.ALBERMANI, M.MAHENDRAN (2010**).**

Static and dynamic analysis of transmission line towers under seismic loads in which zone 1 and zone 2 is considered and it is compared. SIDDU KARTHIK CS, G.V. SOWJANYA (2015).

Analysis of single circuit transmission line towers is analyzed using staad pro and the results which are obtained shows that by using triangular base self-supporting tower will bring a saving of 9.23% in the weight of structural steel, and using square base guyed mast will lead to a saving of 39.96% in the structural steel. C. PREETI, K. JAGAN MOHAN (2013).

IV. METHODOLOGY

In this study it deals with the study of 400KV Double circuit Transmission line towers. This involves the details of fixing the structural details of the tower. Adopting ground clearances for different height of the tower and also calculating the wind pressure which is acting on the conductor, ground wire and insulator. According the nature and type of the tower and its circuit, the conductor and ground wire which has to be adopted is selected. The sag and tension calculations of the conductor and ground wire can be calculated by the data which are provided for selection of the type of the conductor and the ground wire.

Modeling of the tower has to be done in Staad pro and the required properties have to be provided. Different loading conditions like Reliability condition, Security condition adopted for the conductor and ground wire, Safety condition and Anti cascading condition for the angle tower as well as broken wire condition is being considered for the analysis of the tower. Then the axial load acting on the member is taken and thus according to that loading suitable member size has to be adopted. Thus design has to be carried out for all the members of the tower.

Then different base width trials has to be made by increasing and decreasing the base width of tower by 1m and thus the base width is said to be altered. The base width dimensions are 13.893m, 14.893m, 15.893m, 16.893m, and 17.893m. From this the economical base width of the tower can be determined.

V. DESIGN PARAMETERS

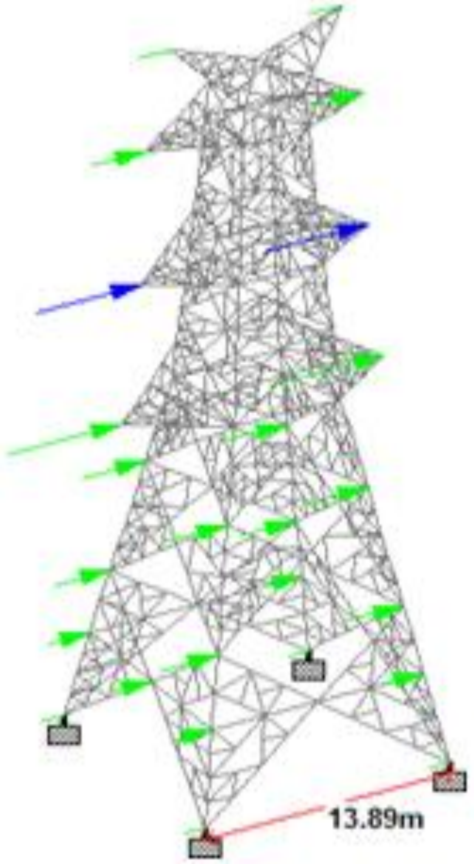
Span	= 400m
Wind zone	= 5
Reliability condition	= 1
Terrain category	= 1
Design wind speed	= 36.364m/sec.
Wind Pressure on Conductor	=185.063kg/m^2
Wind Pressure on ground wire	=230.007kg/m^2
Wind Pressure on insulator	=232.386kg/m^2
Total Height above G.L	= 44.130m

Thus wind pressure of conductor, ground wire and insulator can be calculated by knowing the values of drag coefficient of the conductor and ground wire, design wind speed, Terrain categories and gust response factor of conductor, ground wire and insulator.

VI. CONDUCTOR AND GROUND WIRE DETAILS & RESULTS

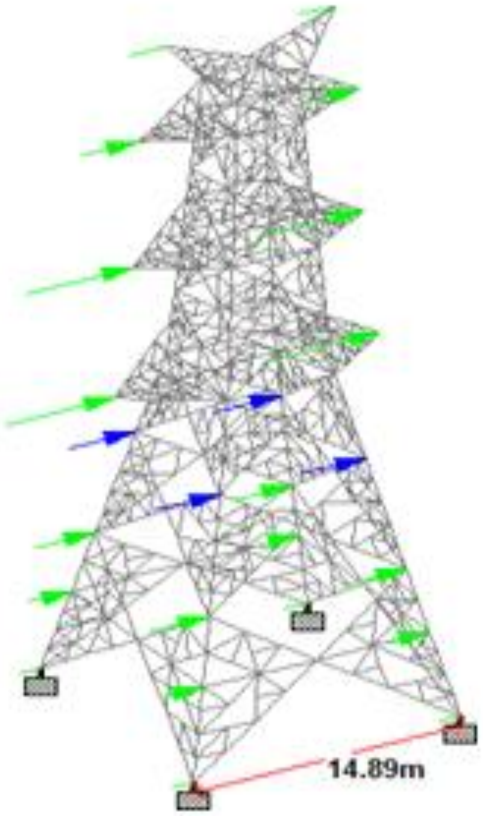
DESCRIPTION	CONDUCTOR	GROUND WIRE
Name/ code	ACSR MOOSE	GSS
Nominal size	54/3.18+7/3.18	7/3.66
Diameter(cm)	3.177	1.098
Unit weight (kg/m)	2.004	0.583
UTS (kg)	16428	6975
Cross sectional area(cm^2)	5.97	0.7365
Co.eff. of linear Expansion. (/ ^{0}c)	1.935 x 10^{-6}	11.5x10^{-6}
Final modulus of elasticity (kg/cm^2)	7.03x10^5	1.933x10^6
Min. Température.	10^{0}c	10^{0}c
Every day temperature.	32^{0}c	32^{0}c
Max. Température.	75^{0}c	53^{0}c
Max. Wind pressure (kg/m^2)	185.063	230.007
Basic span(m)	400	400

BASE WIDTH 13.893M



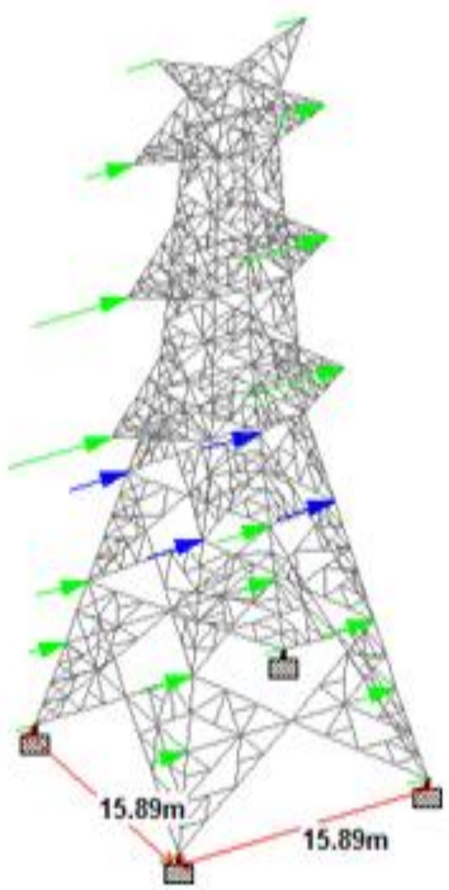
PROFILE	LENGTH (M)	WEIGHT (KG)
200x200x25	38.39	2837.021
200x200x24	28.95	2058.345
200x200x20	21.73	1303.8
200x200x16	33.46	1622.81
130x130x10	32.76	645.372
120x120x12	181.27	3915.432
120x120x12	366.58	7918.128
120x120x8	144.80	2128.56
110X110X10	70.22	1165.652
110X110X10	171.19	2841.754
100x100x8	93.13	1126.873
100x100x8	35.69	431.849
100x100x6	11.84	108.928
90x90x6	282.68	2317.976
80x80x6	36.27	264.771
75x75x6	91.92	625.056
60x60x4	123.87	458.319
50x50x4	188.75	566.25
45x45x3	111.85	234.885
40x40x3	106.12	191.016
TOTAL		**32498.026**

BASE WIDTH 14.893M



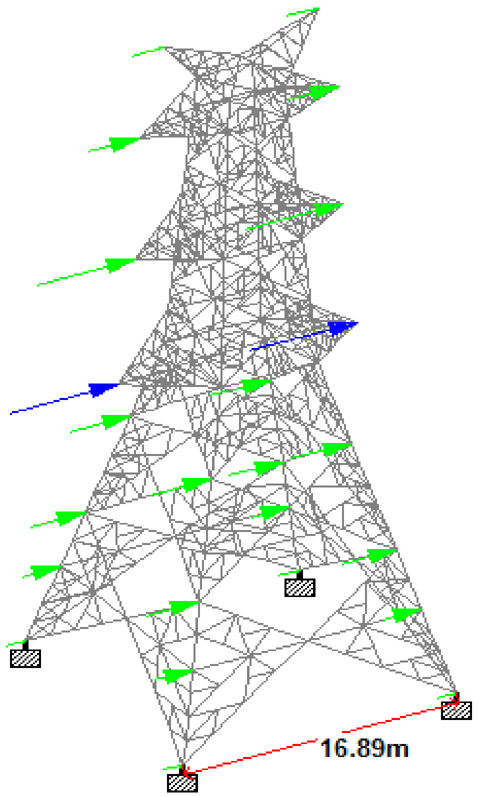
PROFILE	LENGTH (M)	WEIGHT (KG)
200X200X24	38.71	2752.281
200X200X24	29.19	2075.409
200X200X20	21.91	1314.6
200X200X16	33.46	1622.81
130X130X10	32.76	645.372
130X130X8	71.11	1130.649
120X120X12	181.27	3915.432
120X120X12	366.58	7918.128
120X120X8	144.80	2128.56
110X110X8	179.37	2403.558
100X100X8	35.69	431.849
100X100X7	95.87	1025.809
100X100X6	11.84	108.928
90X90X6	293.54	2407.028
75X75X6	91.92	625.056
80X80X6	36.27	264.771
60X60X4	124.64	461.168
50X50X4	193.82	581.46
45X45X3	111.85	234.885
40X40X3	106.12	191.016
TOTAL		**32238.769**

BASE WIDTH 15.893M



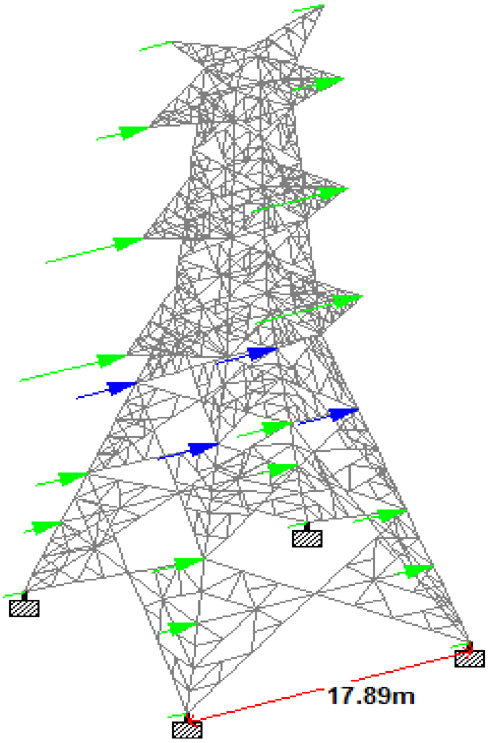
PROFILE	LENGTH (M)	WEIGHT (KG)
200X200X24	39.07	2777.877
200X200X24	29.46	2094.606
200X200X20	22.12	1327.2
200X200X16	33.46	1622.81
130X130X10	32.76	645.372
150X150X10	181.27	4151.083
120X120X12	366.58	7918.128
120X120X8	72.02	1058.694
120X120X8	144.80	2128.56
100X100X8	187.66	2270.686
100X100X8	35.69	431.849
100X100X7	98.66	1055.662
100X100X6	11.84	108.928
90X90X6	304.57	2497.474
80X80X6	36.27	264.771
75X75X6	91.92	625.056
60X60X4	125.51	464.387
50X50X3	199.03	457.769
45X45X3	111.85	234.885
40X40X3	106.12	191.016
TOTAL		**32326.813**

BASE WIDTH 16.893M



PROFILE	LENGTH (M)	WEIGHT (KG)
200X200X24	39.46	2805.606
200X200X24	29.76	2115.936
200X200X20	22.34	1340.4
200X200X16	33.46	1622.81
130X130X10	32.76	645.372
150X150X10	181.27	4151.083
120X120X12	366.58	7918.128
120X120X8	144.80	2128.56
110X110X8	72.94	977.396
100X100X8	196.02	2371.842
100X100X8	35.69	431.849
100X100X6	11.84	108.928
80X80X10	101.49	1197.582
90X90X6	315.70	2588.74
80X80X6	36.27	264.771
75X75X6	91.92	625.056
60X60X4	126.37	467.569
50X50X3	204.27	469.821
45X45X3	111.85	234.885
40X40X3	106.12	191.016
TOTAL		**32657.35**

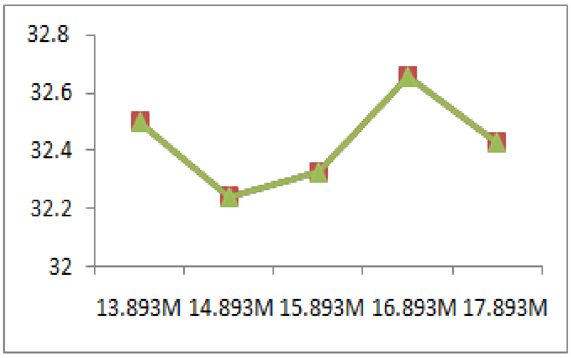
BASE WIDTH 17.893M



PROFILE	LENGTH (M)	WEIGHT (KG)
200X200X24	39.89	2836.179
200X200X24	30.08	2138.688
200X200X20	22.58	1354.8
200X200X16	33.46	1622.81
130X130X10	32.76	645.372
150X150X10	181.27	4151.083
120X120X12	366.58	7918.128
120X120X8	144.80	2128.56
100X100X8	35.69	431.849
100X100X7	204.51	2188.257
100X100X6	11.84	108.928
100X100X6	104.36	960.112
90X90X10	73.87	989.858
90X90X6	327.08	2682.056
80X80X6	36.27	264.771
75X75X6	91.92	625.056
60X60X4	127.40	471.38
50X50X3	209.60	482.08
45X45X3	111.85	234.885
40X40X3	106.12	191.016
TOTAL		**32425.872**

VII COMPARISON OF BASE WIDTH OF TOWER

BASE WIDTH	WEIGHT (MT)
13.893m	32.4980 MT
14.893m	32.2387 MT
15.893m	32.3268 MT
16.893m	32.6573 MT
17.893m	32.4258 MT



VIII CONCLUSIONS

Different base width of tower has been calculated. The base width of 14.893m has 32.2387 MT which is said to be economical. Thus it results in economy in steel when compared to other base width. Thus the base width of 14.893m is said to be economical optimized tower.

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