PAPER • OPEN ACCESS

Analysis of Internal Force Based on In-situ Electrified Jacking of Transmission Tower

To cite this article: Yu-Bin Shi et al 2021 J. Phys.: Conf. Ser. 2044 012159

View the article online for updates and enhancements.

You may also like

- <u>Case Study of sewerage pipe installation</u> using Pipe Jacking and Micro-tunnelling Boring Machine (MTBM) in Ipoh Muhammad Shafiq Aiman, M Hadri and H Mohamad
- <u>Deformation analysis of pipe-jacking</u> process for a large-section shallowcovered project crossing highway L Zhen, W Yu, W Xu et al.
- <u>Numerical analysis on surface settlement</u> in parallel rectangular pipe jacking construction

Jianwu Gong, Kang Zhang and Peilin Qi





DISCOVER how sustainability intersects with electrochemistry & solid state science research



This content was downloaded from IP address 13.58.121.214 on 08/05/2024 at 08:43

Analysis of Internal Force Based on In-situ Electrified Jacking of Transmission Tower

Yu-Bin Shi^{1a}, Kong-Liang Chen^{1b,*}, Guo-qing Yuan^{1c}

(¹School of Civil Engineering and Architecture, Wuyi University, Jiangmen, Guangdong 529000)

^{1b,*}Email: civil@wyu.edu.cn, ^{1a}1501393137@qq.com, ^{1c}Jmygq@qq.com

Abstract: This paper mainly studies the law of the change of the internal force of the conductor and the climbing line with the number of rotation angles and the change of the jacking height during the construction process of the electric in-situ jacking of the transmission tower. First, the initial line type of the wire is calculated by the nodal line method to obtain the control point coordinates, and then the initial coordinates are repeatedly iterated through the Midas Civil finite element to obtain the final line type and the theory of the internal force change of the wire and the climbing line during the jacking process is calculated. law. Finally, combining the actual engineering case, the theoretical value and the actual value are compared and analyzed, and several conclusions are drawn.

1. Introduction

With the continuous development of the country, many old economic transmission lines have been unable to meet the needs of current social development: the problem of insufficient headroom height has been highlighted. In addition, road foundation filling such as road construction and road reconstruction often bury the foot of the existing transmission tower, which is extremely unfavorable to the anti-corrosion and daily maintenance of the transmission tower. Therefore, the transmission tower needs to be optimized and improved. At present, there are not many methods for highly optimizing transmission lines. Traditional methods include raising the transmission tower as a whole through basic transformation or increasing the overall height of the transmission line by replacing the old tower with a new tower. However, the traditional method has a large investment in capital^[1]. During the lifting process of the transmission tower, the wire will inevitably be tightened, that is the process of tightening the wire ^[2]. During the tightening of the wire, the sag of the wire decreases, and the internal force and stress increase ^[3]. When the wire stress increases beyond the ultimate tensile strength of the material, the wire will break at the weak section. Furthermore, the internal force of the climbing line is constantly changing during the construction process. If the internal force of the climbing line cannot be accurately calculated and monitored, this may result in the overall overturning of the transmission tower during the lifting process. Therefore, this article mainly studies and analyzes the internal forces of wires and cable climbing during the lifting process of towers with different angles to ensure the safe and orderly lifting process of transmission towers^[4].

In order to solve the above-mentioned problems, it is necessary to carry out a quantitative analysis of the overhead lines, and the type finding of the transmission line is the basis of the quantitative calculation and analysis of the overhead lines. Based on this, this article uses an engineering example to use the nodal method to perform initial type finding of transmission conductors, and then import the results of the nodal method into Midas Civil finite element for precise type finding, and calculate the

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

lifting process of different corner towers The law of internal force change in middle wire and climbing wire^[5].

2. Example

A 110kv transmission line in Xiamen City, Fujian Province, because the net height does not meet the requirements for use, now needs to be fully charged without removing the original line. The height of the adjacent transmission towers is 51m, the span is 100m, the conductor is designed to sag 15m, and the lowest suspension point of the transmission line is 36m above the ground. Now the transmission tower belt line needs to be lifted by 2 meters to meet the requirements, as shown in Figure 1, and wire materials are shown in Table 1:



Figure 1 Field operation diagram

Table 1 Wire physical paran	neters
-----------------------------	--------

Wire model (LGJ-900/75)							
Wire outer diameter	Calculated weight	Elastic Modulus	Ultimate wire tension				
40.6 mm	30.086 N/m	6.538×10 ⁴ MPa	219.74 KN				

(1) The pitch line method is used to calculate the included angle of the transmission line at 180. The initial coordinates of the time wire are shown in Table 2, and then the initial coordinates are imported into the finite element software Midas to obtain the precise coordinates.

Control point	0	20	40	60	80	100			
Nodal method	51.000	40.966	35.972	35.972	40.966	51.000			
Finite element	51.000	40.604	36.466	36.466	40.604	51.000			

Table 2 Coordinates of traverse line method (m)



Figure 2 Finite element model

Table 3 The included angle of the 2m jacking line and the change of the climbing line and the internal force of the conductor

Included angle(°)	180	165	150	135	120	105	90
Climbing internal force(KN)	0.600	1.871	3.141	5.677	8.212	9.807	11.402
Maximum internal force (KN)	5.722	5.891	6.060	6.229	6.398	6.567	6.736

It can be seen from Table 3 that as the angle between the transmission towers gradually decreases, the internal force of the climbing line used to fix the jacking tower increases nonlinearly. With the continuous decrease of the angle between the towers, when the magnitude of the sub-vector angle changes, the angle of the resultant vector does not change, and the magnitude continues to increase, resulting in the continuous increase of the internal force of the climbing line. The internal force of the conductor decreases linearly with the increase of the rotation angle of the transmission line, but it is not obvious.

(2) Changes in internal force of tower feet at different corners. According to Midas Civil analysis and calculation, the internal force change of the tower foot at different corners when lifting 2 meters is shown in Table 4 and Figures 3 to 4.

Tuble 1 vertieur feuerien foree ut the foot of the 2m juering to ver								
Rotation angle Tower foot	180	165	150	135	120	105	90	
Tower foot 1(KN)	93.4	102.3	111.1	121.8	132.5	137.6	142.6	
Tower foot 2(KN)	68.4	89.6	110.8	121.5	132.1	141.0	149.9	
Tower foot 3(KN)	95.5	76.1	56.6	48.3	40.0	32.0	24.0	
Tower foot 4(KN)	70.8	63.9	56.9	48.4	39.9	35.9	31.8	

Table 4 Vertical reaction force at the foot of the 2m jacking tower



Figure 3 Tower bottom vertical reaction force

Figure 4 Internal force of jacking unit

From Table 4 and Figures 3 to 4, it can be seen that the reaction force of the vertical support at the base of feet 1 and 2 shows a non-linear downward trend, and the reaction force of the vertical support at the base of the feet 3 and 4 shows an upward trend. This is consistent with the theoretical expectation. Due to the continuous decrease of the angle between the transmission lines, the anti-overturning moment of the tower foot increases. Therefore, as the rotation angle continues to increase, the tower foot feet 3 and 4 show a continuous upward trend, while tower feet 1 and 2 show a continuous downward trend. From the chart, it can be concluded that the jacking tower is in a stable state. When the transmission line is a straight tower, that is, when the angle of rotation is 180 degrees, the initial value of the reaction force of the four tower foot supports is different due to the traction of the climbing line, and the reaction force of the traction side support is greater than the other side. , So the initial values of tower feet 1 and 2 are greater than the initial values of tower feet 3 and 4.

(3) The relationship between the internal force of the most unfavorable element of the tower foot and the angle of rotation

			U				
Rotation angle Tower foot	180	165	150	135	120	105	90
Unit 1 (KN)	-77.67	-82.51	-87.35	-98.56	-109.84	-113.89	-117.93
Unit 2 (KN)	-51.98	-68.45	-84.92	-95.79	-106.66	-114.38	-122.09
Unit 3 (KN)	-79.28	-61.48	-43.67	-37.30	-30.93	-23.92	-16.90
Unit 4 (KN)	-53.87	-47.60	-41.33	-34.73	-28.13	-24.84	-21.54

Table 5 Internal force changes of unfavorable elements

2044 (2021) 012159 doi:10.1088/1742-6596/2044/1/012159



Figure 5 Diagram of unfavorable units

It can be seen from Table 5 and Figure 5 that the change law of the unfavorable element axial force is consistent with the law of the tower foot vertical reaction force, and the pre-tensioning force of the cable-climbing force separates the internal forces of the element. Therefore, controlling the pre-tension of the climbing line is a key factor in determining the success or failure of the jacking.

(4) The maximum internal force change of the 2m wire at the top of the transmission tower.



It can be seen from Figure 6 that as the jacking height continues to increase, the internal force of the wire increases non-linearly. The top of the transmission tower rises 2 meters, and the maximum internal force of the wire increases by 18.75%. Therefore, the jacking process should monitor the increase in the internal force of the wire in real time to ensure the safe and orderly progress of the jacking process. It can be seen from Figure 7 that the maximum internal force of the conductor during the jacking process of the transmission line fluctuates around the maximum internal force of the conductor of the conductor after balance.

(5) Vertical reaction force at the foot of the 2m tower. It can be seen from Figure 8 and Figure 9 that the vertical reaction force at the base of the transmission tower increases linearly during the lifting process. At the beginning of each jacking process, there is a slight sudden change in the reaction force of the vertical support, but the overall stability is safe.

IOP Publishing



3. Conclusion

(1) During the live jacking process of the transmission tower, the maximum internal force of each conductor increases and decreases nonlinearly with the increase of the jacking height, and the internal force used to fix the power transmission tower increases linearly with the increase of the jacking height.

(2) During the live jacking process of the power transmission tower, the internal force of the conductor is affected by the change in the number of rotations little, the internal force changes caused by it can be ignored.

(3) During the live jacking process of the transmission tower, the internal force of the climbing line decreases with the increase of the angle between the phase lines.

(4) When the number of rotation angles of the transmission line increases, the reaction force of the two tower feet of the jacking tower rises nonlinearly, and the vertical reaction force of the two tower feet decreases nonlinearly, and the maximum internal force of the conductor increases non-linearly.

The conclusion shows that the live jacking of the transmission line is more economical and safer.

Acknowledgements

The paper is supported by the Special Funds of Guangdong Science and Technology Department Project (2016A040403125)

References:

- Zengrui Wu, Liying Cheng, Bing Zheng. (2010). Analysis of transmission line shape and stress during in-situ live jacking of transmission towers. Guangdong Water Resources and Hydropower, pp.43-45
- [2] Futang Lang. (2007). Research on the construction technology of the tight line of the 1000kV UHV overhead transmission line project. Electric Power Construction, pp.24-29+32.
- [3] Xu Wang, Hongmei Wang, Kai Qin. (2019) Analysis of the fracture mechanism of a transmission line during the process of wire tightening. Hubei Electric Power, pp. 34-44.
- [4] Yaoqing Gong, Xiaodong Chen.(2015). Unified analytical beam and finite nodal method in solid mechanics. Chinese Journal of Solid Mechanics, pp. 105-113.
- [5] Yaoqing Gong, Yanan Luo.(2018). Finite nodal method analysis of single-box double-chamber box girder with unequal wall thickness under bending and restraining torsion. Journal of Chang'an University (Natural Science Edition), pp. 59 -66.