Dynamic Impact Load Effect on Suspension Crossing Frame at Transmission Tower

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Abstract. With the increasing number of UHV transmission lines crossing projects, suspension type spans are widely used in cross-construction. Among them, under the condition of construction accidents, the dynamic impact of the bearing cables and towers on the wires has received extensive attention. Based on this problem, this paper studies the impact of dynamic impact loads on transmission towers under construction accident conditions, and proposes reinforcement measures for transmission towers.

1. Introduction

As the company's power grid construction process continues to advance, the situation across construction is increasing. Suspension type spanning frame has the advantages of simple structure, convenient installation, convenient transportation and low construction cost. It is widely used in cross-construction and withstands the dynamic impact of wires under construction accident conditions, thus ensuring the crossing of construction accidents. Under the circumstance of being safe. Under the condition of construction accidents, the load-bearing cable and the tower are subjected to the dynamic impact of the wire. The analysis of the load of the load-bearing cable and the tower under the dynamic impact of the wire is an important basis for the design of the suspension type span and the tower. It is the bearing cable and the tower. The theoretical basis for safety assessment under construction accident conditions.
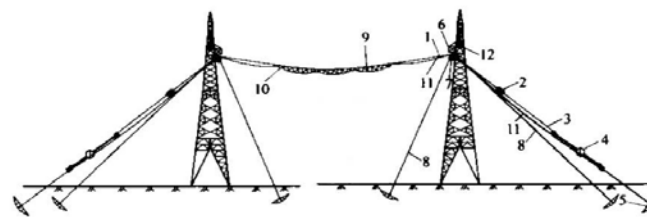
2. Suspension Spanning Frame and Transmission Tower Introduction

Suspension type spanning frame, also known as no-crossing frame system, means that temporary beams or soft cables are installed as support devices on the towers at both ends of the spanning gear, and the supporting cables are installed between the temporary cross-arms and the insulating nets are installed and the insulating strut is installed. To protect the safety of the crossed objects. It is mainly composed of temporary cross-arm, bearing cable and sealing device. It has the advantages of long distance span, simple structure, convenient installation and small construction difficulty, as shown in
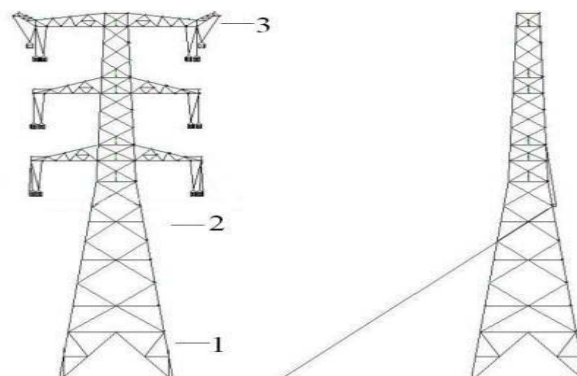
Figure 1.

1-Carrier cable (insulation section); 2-Connector; 3-Carrier cable (non-insulated section); 4-Adjustment tool; 5-Ground anchor; 6-Temporary cross arm; 7-Carrier cable pulley; 8-Temporary beam pull; 9-Insulation net; 10-Insulating strut; 11-Anchor rope; 12-Wire take-up pulley

Figure 1. Schematic Crossover System Diagram

A transmission tower is a tower structure used to support and overhead conductors, lightning rods, and other accessories, such that the conductors and conductors, conductors and towers, conductors and lightning conductors, and conductors to the ground or cross-overs maintain a specified safe distance, structure. The tower mainly consists of three parts: the tower head, the tower body and the tower leg, as shown in Figure 2.

1-Tower leg; 2-Tower body; 3-Tower head

Figure 2. Transmission Tower Schematic

3. Basic Theory of Dynamics
In the course of research, it involves related knowledge of rigid body dynamics, such as the principle of energy conservation and the principle of conservation of momentum.

3.1. Principle of Conservation of Energy
Taking the suspension type spanning frame as the research object, for the running line or disconnection phenomenon in the wire laying line construction, the wire can be calculated in the falling proless, according to the principle of energy conservation, the wire can be calculated before the suspension cable type spanning frame For the speed, take the position of the wire just touching the suspension type span as the zero potential energy reference plane. For the specific relationship, see equation (1):

$$\frac{1}{2}mv_2^2 = \frac{1}{2}mv_1^2 + Q_1$$

(1)

In the middle:

m —Wire quality;

v_1 —Initial speed of the wire;

v_2 —The speed at which the wire just touches the suspension span;

Q_1 —Gravitational potential energy of a wire.

3.2. Principle of Conservation of Momentum

In the process of studying flexible system dynamics modeling method and simulation analysis method, the momentum conservation equation is finite element discrete, and the speed variation is used as the weight function. The solution area is divided into discrete bodies with N1 nodes and N2 units. The derivative of the stress tensor contains the second derivative term of the velocity, and the second derivative term is integrated separately. Combined with the corresponding stress boundary conditions, the momentum conservation discrete form of the flexible system can be derived, as shown in equation (2):

$$\sum_{i=1}^{N_2}\left\{\int_{A_i}\rho\dot{v}_i\delta v_i dA_i + \int_{A_i}\sigma_{ij}\delta v_{i,j}dA_i - \int_{S_i}p_i\delta v_i dS - \int_{A_i}F_i\delta v_i dA_i\right\} = 0$$

(2)

In the middle:

δv_i —Speed variation;

ρ —Flexible body density;

σ_{ij} —Stress tensor in flexible body;

p_i —External force received by the flexible body;

F_i —Physical strength inside the flexible body.

4. Numerical Modeling of Suspension Type Spanning Frame and Transmission Tower
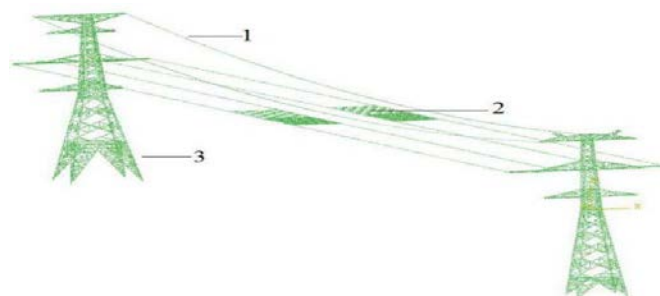
4.1. Creation and Simplification of the Finite Element Model

In this paper, the actual engineering parameters are shown in Table 1, and the finite element model is established. For the dynamic response of the suspension type spanning frame and the transmission tower under the dynamic impact of the conductor, in the unit selection process, the transmission tower adopts the beam element to establish the unit model, and one node has three degrees of freedom,

corresponding to the axial direction. The tensile force and bending moment, the force exerted by the node has three components. The suspension type spanning frame and the transmission line are flexible bodies. The finite element model is established by the truss rod unit. One node has two degrees of freedom, and the corresponding one can only bear the axial tensile force, and the tension of the node is decomposed into two components. . The global simulation model established with reference to the engineering site layout is shown in Figure 3.

Table 1. Main Engineering Parameters of Suspension Type Spanning Frame and Transmission Tower

parameter	value
wire	LGJ-630/45
Span	500m
Net length	62m
Net width	12m
Hanging net left and right suspension height	48m
Bearing cable diameter	φ18mm
Wire rope diameter	φ14mm
Number of braided ropes	32
Tray spacing	2m
Tower height	50m
Tower materialQ345	Yield Strength345Mpa

1-wire; 2-Suspension span; 3-Transmission tower

Figure 3. Global Model of Simulation Model for Suspension Type Spanning Frame and Transmission Tower Construction

4.2. Loading Methods and Boundary Conditions
As shown in Figure 4, the gravitational field loading of the wire is achieved by applying a vertical downward gravitational acceleration of 9.8 m/s2 to the wire. A hinge constraint is applied to the left end of the wire and the right end of the wire is released. Set a fixed constraint at the bottom of the tower. A universal contact is provided between the wire and the suspension type span, which has both normal contact force and tangential friction force.
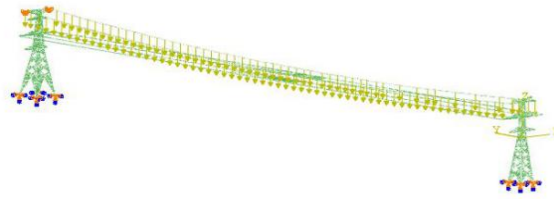
Figure 4. Loading Mode and Boundary Condition Settings

4.3. 630 Wire Impact Spanning Frame Conditions

In order to study the dynamic response of the wire to the suspension type span and the transmission tower, the impact condition of the 630 specification wire at a height of 5 m from the suspension type span is set. To study the dynamic response relationship between the wire and the suspension span and the transmission tower.

5. Numerical Simulation Results

The moment when the wire impact suspension type spanning frame is dropped is shown in Figure 5. The maximum local maximum of the wire impact suspension type spanning frame is 15.7Mpa, which meets the construction requirements. After analysis, it is calculated that the stress on the joint between the temporary cross-arm of the right-hand tower and the tower is 392.5Mpa, which has the risk of failure, as shown in Figure 7.
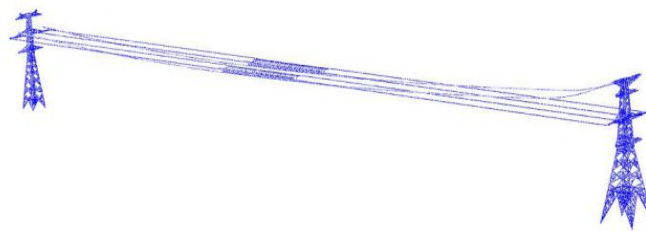

Figure 5. Wire Impact Suspension Cable Jumper Impact Moment
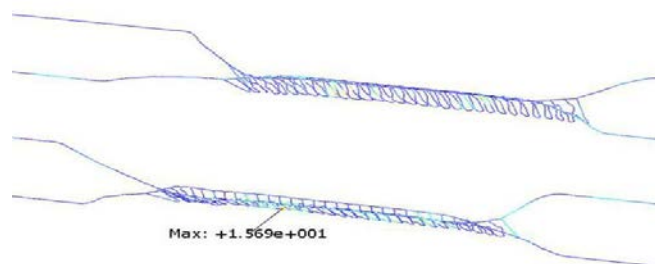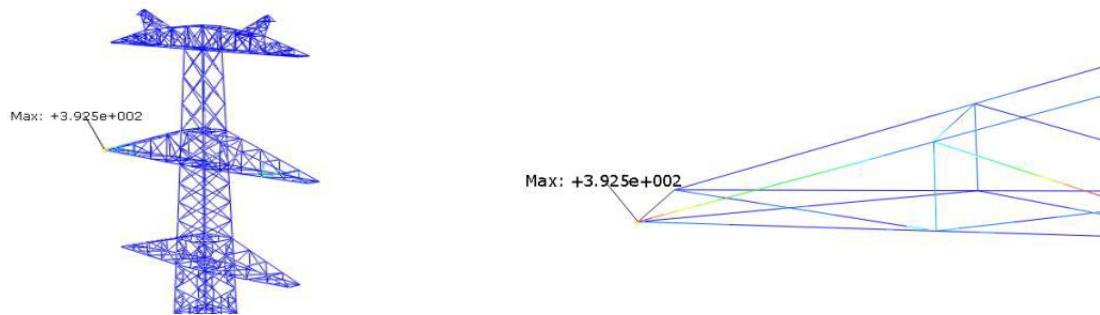

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Figure 6. Local Stress Diagram of the Suspension Type Span Frame

(a) Tower maximum stress local map   (b) Partial enlargement of the maximum stress of the tower

Figure 7. Tower Stress Map

In view of the failure risk of the tower, a remedy for Φ20 reinforcing cable at the end of the temporary crossarm and the middle portion is taken, as shown in Figure 8. The calculation result is 0.009 MPa as shown in Figure 9. It occurs at the top of the right-hand tower, and it can be seen that the remedial measures are effective.

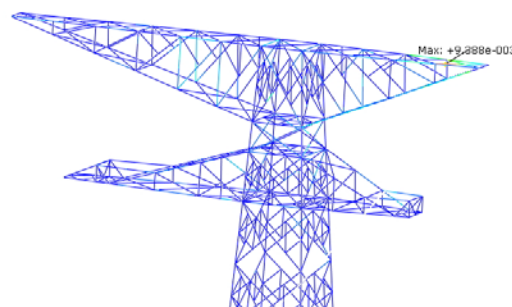**Figure 8.** Strengthening the Cable Installation Diagram

Figure 9. Principal Stress Variation Curve at the Time when the Wire Hits the Right Closed Net Rope at Different Heights from 0 to 0.6 s

6. Conclusion

(1) The 630 wire falls at a height of 5 m, and the impact suspension type span will indirectly cause the risk of failure of the tower.

(2) When the reinforcing tie between the temporary crossarm and the tower is used, the safety of the tower can be significantly guaranteed.

7. Acknowledgement

8. References

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