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Wind Tunnel Tests on Aerodynamic Characteristics of two types of Iced Conductors with Elastic Support

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Abstract. The wind tunnel tests were carried out to obtain the variation laws of static aerodynamic characteristics of crescent and D-shape iced conductor with different wind velocities, wind attack angles and torsional elastic support stiffness. Test results show that the variation of wind velocity has a relatively large influence on the aerodynamic coefficients of crescent conductor with torsional elastic support 1.However, the influence on that of D-shape conductor is not obvious. With the increase of the torsional elastic support stiffness, the lift and moment coefficient curves of the crescent iced conductor form an obvious peak phenomenon in the range of 0 ° ~30°. Meanwhile, the wind attack angle position corresponding to the maximum value of the lift and moment coefficients of the D-shape iced conductor appear a backward moving phenomenon.

1. Introduction

There are lots of researches about the aerodynamic characteristics of iced conductors. Den Hartog (1932) proposed that the galloping of conductor should be associated with ice shape. Aerodynamic characteristics of a single iced conductors have been investigated in wind tunnel by Nigol (1974) and Chabart, O et al. (1998) as well. Besides using the wind tunnel test to measure the aerodynamic characteristics, Computational Fluid Dynamics (CFD) has become one of the important research methods (Linshu Zhou et al.2015). However, the present wind tunnel test and CFD method ignored the effect of the torsional stiffness of the iced conductor. In this study, the wind tunnel test will be carried out to obtain variation laws of the aerodynamic characteristics of iced conductors under different wind velocities and torsional elastic support stiffness. The obtained results may provide the fundamental data for the development of anti-galloping technique of iced conductors.

2. Experiment Design

The wind tunnel tests were carried out in 1.4 m 1.4 m low-speed wind tunnel at the China Aerodynamics Research and Development Center (CARDC).The maximum wind velocity is 60m/s. In this experiment, the two point support scheme with two balances is used to measure the aerodynamic force of the iced single conductor. The actual transmission conductors were chosen for the test model, whose type is LGJ400/35 (d=26.8mm) and the model ratio is 1:1. The ice shape model is fixedly connected to the surface of the conductor model. The ice shape includes the crescent and D-shape, and the ice thicknesses of models are 33mm, 12mm, respectively. The schematic diagram of the ice shape and the definition of wind attack angle, aerodynamic force of the iced conductor are shown in Fig.1. The installation of the model in wind tunnel is shown in Fig.2.Both ends of the iced conductor were mounted on a set of balances with different torsional elastic support stiffness. According to the order of the torsional elastic support stiffness from small to large, the case of different elastic support at both ends of the conductor is denoted as torsional elastic support 1 to torsional elastic support 5, respectively. The detailed test contents are shown in table 1.

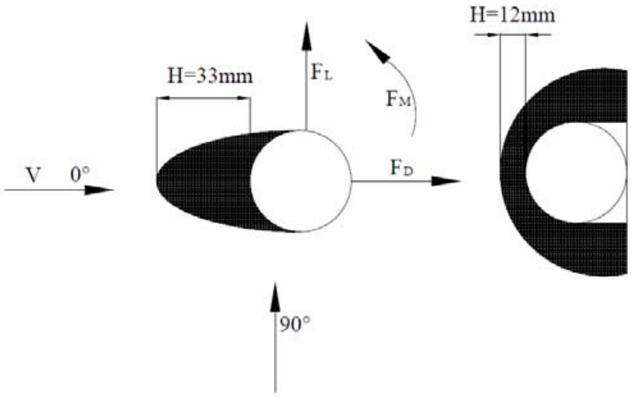


Fig. 1 The section of crescent and D-shape iced conductor

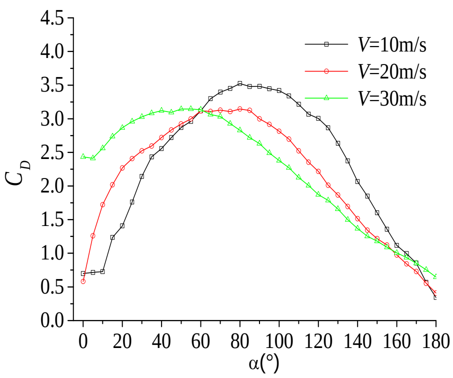
Fig. 2 Model in the wind tunnel

Table 1 Test contents of iced conductor with elastic support

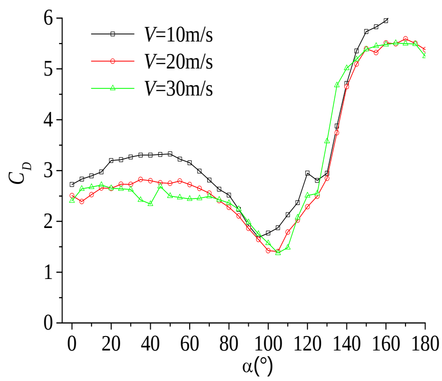
Number	Elastic support method	Wind velocity (*m/s*)	Wind attack angle (°)	Ice shape
1	torsional elastic support 1 ~ 5	10, 20, 30	0~180	crescent
2	torsional elastic support 1 ~ 5	10, 20, 30	0~180	D-shape

3. Test Results

3.1. Influence of wind velocity



(a) Crescent iced conductor



(d) D-shape iced conductor

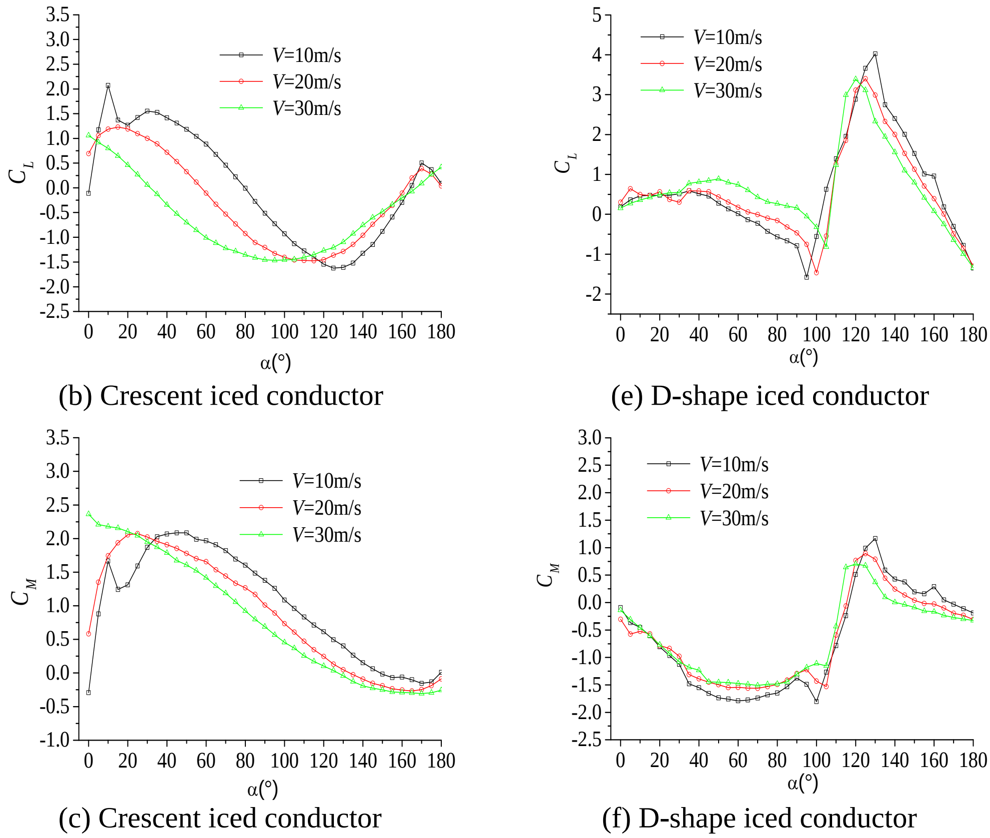
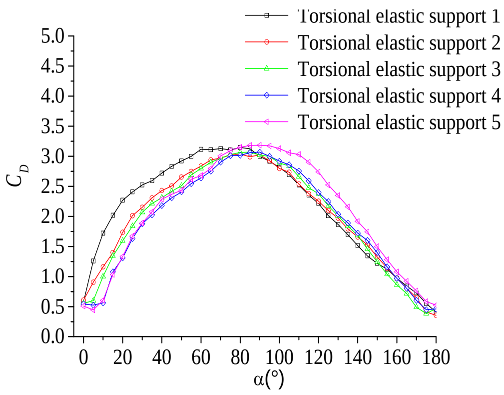


Fig.3 Influence of the wind velocity on aerodynamic coefficients of conductor with torsional elastic support 1

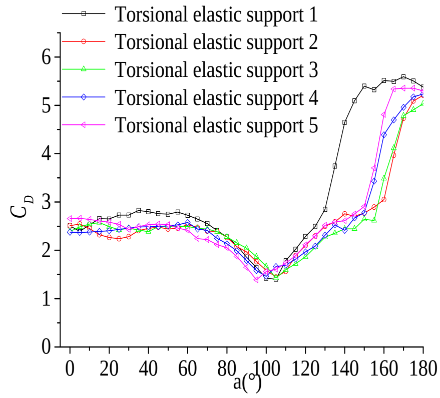
The Fig.3 (a) ~ Fig.3 (c) shows that the influence of wind velocity on the aerodynamic coefficients of crescent conductor is obvious. The initial torsional displacement caused by the high wind velocity at the angle of wind attack of 0 ° makes the conductor's drag coefficient curves different from that of the low wind velocity. This is mainly due to that the lift coefficient is relatively large, and the corresponding lift force is also relatively large under the condition of high wind velocity and low torsional elastic support stiffness. The larger lift load leads to a large initial torsional displacement. The Fig.3 (e) ~ Fig.3 (f) shows that the variation of wind velocity generally has little effect on the aerodynamic coefficient of D-shape iced conductor.

3.2. Influence of torsional elastic support stiffness

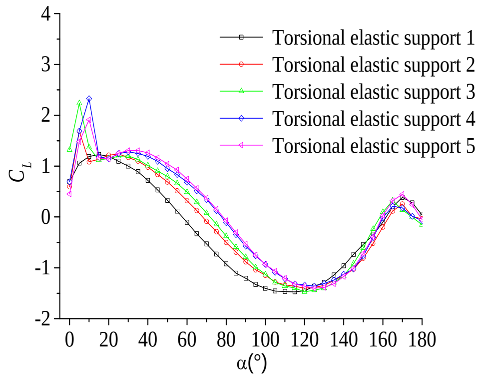
The aerodynamic coefficients varying with the wind attack angles under different torsional elastic support stiffness are shown in Fig.4.



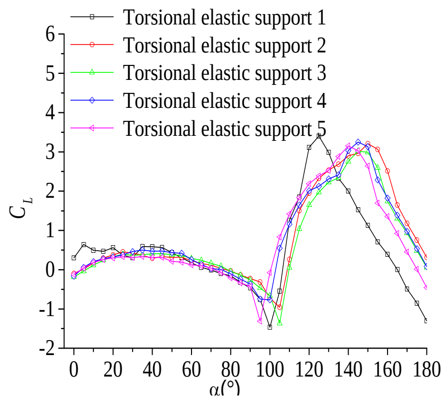
(a) Crescent iced conductor



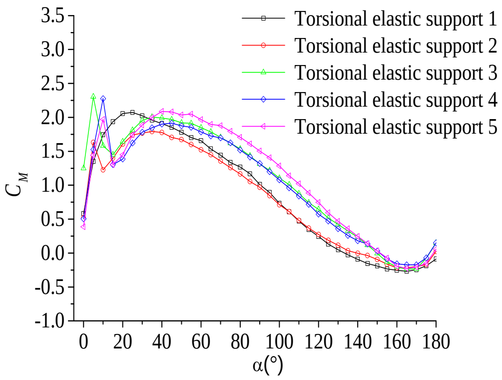
(d) D-shape iced conductor



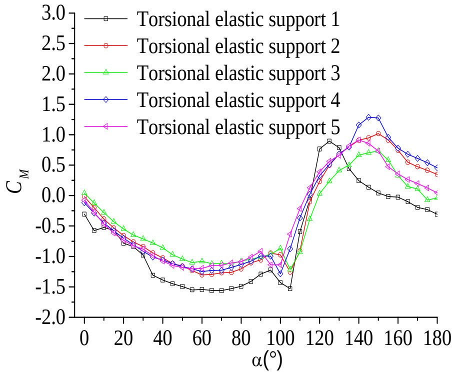
(b) Crescent iced conductor



(e) D-shape iced conductor



(c) Crescent iced conductor



(f) D-shape iced conductor

Fig.4 Influence of torsional elastic support stiffness on aerodynamic coefficient (V=20m/s)

The Fig.4 (a) ~ Fig.4 (c) shows that that the variation of torsional elastic support stiffness generally has little effect on the aerodynamic coefficients of the crescent iced conductor. It is worth noting that when the torsional elastic support stiffness is relatively small, the lift and moment curves of the conductor are smooth in the range of wind attack angle 0 °~30 °. With the increase of the torsional elastic support stiffness, the curve forms a significant peak phenomenon in this range of wind attack angle.

The Fig.4 (e) ~ Fig.4 (f) shows that the variation of the torsional elastic support stiffness has an obvious influence on the aerodynamic coefficients in the range of wind attack angle 120 °~180 °. With

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the increase of the torsional elastic support stiffness, the position of wind attack angle corresponding to the maximum values of lift and moment coefficient appears a backward moving phenomenon.

4. Conclusion

The wind tunnel tests were carried out to measure the aerodynamic characteristics of crescent and D-shape iced conductor .The main conclusions are as follows:

(1) The variation of wind velocity has a relatively large influence on the aerodynamic coefficients of crescent conductor with torsional elastic support stiffness 1, especially in the vicinity of wind attack angle 0°, the high wind velocity makes the model produce a large initial torsional displacement.

(2) When the elastic support stiffness at both ends of the D-shape conductor is small, the influence of wind velocity on the aerodynamic coefficients is not obvious.

(3) With the increase of the torsional elastic support stiffness, the lift and moment coefficient curves of the crescent iced conductor form an obvious peak phenomenon in the range of 0 ° ~30°, meanwhile, the wind attack angle position corresponding to the maximum value of the lift and moment coefficients of the D-shape iced conductor appear a backward moving phenomenon.

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