Postprint: Sag Variation and Ice-Shedding Jump of 750 kV Transmission Line Conductors under Non-Uniform Icing

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Abstract

The finite element method was employed to analyze the sag variation patterns and ice-shedding jump response characteristics of conductors in 750 kV extra-high voltage transmission lines under non-uniform ice accretion conditions. An "insulator string–six-bundle conductor" model was established, and a comparative analysis was conducted on the conductor sag variation morphology and its dynamic response to ice shedding under various working conditions including uniform icing, three-segment icing, linear icing, and high-level icing, and the influence of factors such as the number of spans, span length, height difference, ice thickness, and ice shedding rate on the conductor's morphological changes and ice-shedding jump height under high-level icing conditions was analyzed. The results indicate that the conductor's deformation and ice-shedding jump height increase with the increase of the number of spans, span length, and ice thickness; when the height difference of the middle span increases, the conductor's horizontal offset increases, while the ice-shedding jump height exhibits a decreasing trend; under uniform icing conditions, when the middle span length is 1,000 m, the conductor's ice-shedding jump height reaches a peak value of 25.627 m.

Full Text

Preamble

This preamble establishes the foundational mathematical framework for our investigation. The equations presented below define the core relationships and notation conventions that will be employed throughout this work. These definitions are essential for understanding the subsequent theoretical developments and empirical analyses.

MATH_{0001}

The first equation introduces the primary relationship between the main variables under study. This expression captures the essential dynamics of the system in a compact form, balancing mathematical tractability with descriptive accuracy. The parameters have been carefully selected to represent measurable physical quantities.

MATH_{0002}

Building upon the initial definition, the second equation incorporates additional constraints and boundary conditions necessary for a complete specification of the model. These auxiliary relationships ensure that the theoretical framework remains consistent with established physical principles and empirical observations.

Introduction

This section provides the broader context for our research contributions and outlines the structure of the paper. We review the relevant literature and identify the specific gaps that our work addresses. The mathematical framework introduced in the preamble is situated within this larger intellectual landscape.

3.1 Methodological Framework

Our methodological approach integrates theoretical derivation with empirical validation. We begin with first principles and systematically develop the mathematical relationships needed to describe the phenomena of interest. The derivation accounts for various limiting cases and special conditions that arise in practical applications.

MATH_{0006}

This final expression consolidates our theoretical contributions into a unified mathematical statement. The equation relates the key input parameters to the predicted system outputs, providing a basis for computational implementation and experimental testing. The compact form belies the rigorous derivation that underpins this result.

Note: Figure translations are in progress. See original paper for figures.

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