Vibration of structures and protection methods

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Abstract

Structures in power transmission and energy production are often exposed to dynamic and aerodynamic loads under extreme weather conditions, which may result in the reduction of the range of operation or even damage of the structure. Transmission line conductors exhibit high-frequency or high-amplitude vibration due to wind or ice shedding. Aeolian vibration is a high-frequency, wind-induced vibration caused by the alternate shedding of vortices and results in fatigue. Galloping is a high-amplitude, wind-induced vibration, and ice shedding induces a high conductor rebound height followed by decaying vibration. Such conductor motions are associated with excessive dynamic forces that may damage some elements of the transmission line in a relatively short time. These problems justify the effort to study the atmospheric phenomena and resulting vibrations; furthermore, to develop solutions in order to protect the transmission line. Models are developed for simulating vibrations due to wind and ice shedding, and two line protection methods are discussed. Active vibration control is applied at a specific location of the conductor, which attenuates aeolian vibration, and conductor rebound height after ice shedding is reduced by the axial motion of one of the supports. Time delay due to sampling in the digital control is considered in both cases, and its effects on the efficiency of control and on the dynamics of the system is discussed.

Wind energy is exploited via the installation of wind turbines that are also exposed to natural phenomena in the atmosphere. Ice accretion on the blade changes its shape and the flow around it; thereby, it influences the aerodynamic performance of the wind turbine. Consideration of the possibility of ice accretion in the design process contributes to the extension of range of operation of wind turbines under limited extreme weather conditions.