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Optimal Design of Tuned Inerter Damper-Based System for the Control of Wind-Induced Vibration in Tall Buildings through Cultural Algorithm

Authors : Luis Lara-Valencia, Mateo Ramirez-Acevedo, Daniel Caicedo, Jose Brito, Yosef Farbiarz

Abstract : Controlling wind-induced vibrations as well as aerodynamic forces, is an essential part of the structural design of tall buildings in order to guarantee the serviceability limit state of the structure. This paper presents a numerical investigation on the optimal design parameters of a Tuned Inerter Damper (TID) based system for the control of wind-induced vibration in tall buildings. The control system is based on the conventional TID, with the main difference that its location is changed from the ground level to the last two story-levels of the structural system. The TID tuning procedure is based on an evolutionary cultural algorithm in which the optimum design variables defined as the frequency and damping ratios were searched according to the optimization criteria of minimizing the root mean square (RMS) response of displacements at the nth story of the structure. A Monte Carlo simulation was used to represent the dynamic action of the wind in the time domain in which a time-series derived from the Davenport spectrum using eleven harmonic functions with randomly chosen phase angles was reproduced. The above-mentioned methodology was applied on a case-study derived from a 37-story prestressed concrete building with 144 m height, in which the wind action overcomes the seismic action. The results showed that the optimally tuned TID is effective to reduce the RMS response of displacements up to 25%, which demonstrates the feasibility of the system for the control of wind-induced vibrations in tall buildings.

Keywords : evolutionary cultural algorithm, Monte Carlo simulation, tuned inerter damper, wind-induced vibrations
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