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This study proposes a novel approach, the equivalent single-degree-of-freedom (ES) model, to accurately and efficiently estimate the wind-induced energy dissipation and responses of base-isolated tall buildings. Validation of the ES model is demonstrated through time history analyses of base-isolated tall buildings, considering several values of structural parameters. Comparative analysis between the newly-proposed ES model and the commonly-used multi-degree-of-freedom (MDOF) model shows that the ES model has accurate estimation of (i) energy input, (ii) energy dissipation (including steel-damper, oil-damper, and upper-structure energy dissipation), and (iii) responses (including standard deviation of the isolation layer deformation, maximum and residual deformation of the isolation layer, and maximum displacement distribution of the upper structure). These findings suggest that structural engineers can practically use the ES model to accurately and efficiently estimate the energy dissipation and responses in the initial stage of wind-resistant design for base-isolated tall buildings.