

Modal Properties and Free Vibration of Uplifting Behavior of Multistory Buildings Modeled as Uniform Shear-Beam

It has been pointed out that buildings during strong earthquakes have been subjected to foundation uplift. The rocking motion accompanied by uplift can reduce the damage of structures as mentioned in previous studies. In this paper, dynamic behavior of buildings allowed to uplift is investigated by means of classical modal analysis. The system considered is a uniform shear-beam model on a rigid ground. After solving the eigenproblem during uplift, equivalent single-degree-of-freedom system for every mode is introduced to represent the physical properties intuitively. Free vibration under gravity during the first excursion of uplift is analyzed to show the responses of uplift behavior. In addition to the confirmation of significant force-reduction effect, the main conclusions are summarized as follows: (1) For slender structures, higher modes during uplift can still have relatively large equivalent modal masses, and their modal directions can be close to vertical. (2) Uplifting behavior can be decomposed into large uplifting response of the first rigid-body mode and vibrations of higher modes accompanied with slight sinking. (3) Higher modes have to absorb a part of potential energy of self weight as their strain energy. This is the main reason why higher mode effect is well observed during uplift.