World Academy of Science, Engineering and Technology
International Journal of Geological and Environmental Engineering
Vol:12, No:06, 2018

Estimation of the Effect of Initial Damping Model and Hysteretic Model on Dynamic Characteristics of Structure

Authors : Shinji Ukita, Naohiro Nakamura, Yuji Miyazu

Abstract : In considering the dynamic characteristics of structure, natural frequency and damping ratio are useful indicator. When performing dynamic design, it's necessary to select an appropriate initial damping model and hysteretic model. In the linear region, the setting of initial damping model influences the response, and in the nonlinear region, the combination of initial damping model and hysteretic model influences the response. However, the dynamic characteristics of structure in the nonlinear region remain unclear. In this paper, we studied the effect of setting of initial damping model and hysteretic model on the dynamic characteristics of structure. On initial damping model setting, Initial stiffness proportional, Tangent stiffness proportional, and Rayleigh-type were used. On hysteretic model setting, TAKEDA model and Normal-trilinear model were used. As a study method, dynamic analysis was performed using a lumped mass model of base-fixed. During analysis, the maximum acceleration of input earthquake motion was gradually increased from 1 to 600 gal. The dynamic characteristics were calculated using the ARX model. Then, the characteristics of 1st and 2nd natural frequency and 1st damping ratio were evaluated. Input earthquake motion was simulated wave that the Building Center of Japan has published. On the building model, an RC building with 30×30m planes on each floor was assumed. The story height was 3m and the maximum height was 18m. Unit weight for each floor was 1.0t/m2. The building natural period was set to 0.36sec, and the initial stiffness of each floor was calculated by assuming the 1st mode to be an inverted triangle. First, we investigated the difference of the dynamic characteristics depending on the difference of initial damping model setting. With the increase in the maximum acceleration of the input earthquake motions, the 1st and 2nd natural frequency decreased, and the 1st damping ratio increased. Then, in the natural frequency, the difference due to initial damping model setting was small, but in the damping ratio, a significant difference was observed (Initial stiffness proportional≒Rayleigh type>Tangent stiffness proportional). The acceleration and the displacement of the earthquake response were largest in the tangent stiffness proportional. In the range where the acceleration response increased, the damping ratio was constant. In the range where the acceleration response was constant, the damping ratio increased. Next, we investigated the difference of the dynamic characteristics depending on the difference of hysteretic model setting. With the increase in the maximum acceleration of the input earthquake motions, the natural frequency decreased in TAKEDA model, but in Normal-trilinear model, the natural frequency didn't change. The damping ratio in TAKEDA model was higher than that in Normal-trilinear model, although, both in TAKEDA model and Normal-trilinear model, the damping ratio increased. In conclusion, in initial damping model setting, the tangent stiffness proportional was evaluated the most. In the hysteretic model setting, TAKEDA model was more appreciated than the Normal-trilinear model in the nonlinear region. Our results would provide useful indicator on dynamic design.

Keywords : initial damping model, damping ratio, dynamic analysis, hysteretic model, natural frequency
Conference Title : ICEES 2018 : International Conference on Earthquake Engineering and Seismology
Conference Location : San Francisco, United States
Conference Dates : June 06-07, 2018