Paper Code. 4134

Evaluation of Frequency Response Functions of Structural System under Various Base Conditions

Ali Niousha[1]
Quality Control Management Director, Kayson Co., a.niousha@kayson-ir.com

Abstract
Forced vibration test and seismic wave observations are commonly used to determine the modal parameters of the actual structures from system identification analysis. In practice and for usual structures, the effect of the soil-structure interaction is neglected and the fixed-base modal parameters, which reflect the dynamic characteristics of the structure alone, are assumed to be nearly equal to those of the flexible base one. The common result is that the natural frequency of the building is underestimated and the damping ratio is overestimated. The objective of any system identification analysis is to evaluate the unknown system having the input-output data. The system can be described as impulse response function (in time domain) or frequency response function (in frequency domain). The purpose of this study is to evaluate the frequency response functions of the structural system under various base conditions for forced vibration analysis using the recorded data of the system. The method to evaluate these frequency response functions is derived and its applicability is shown. The frequency response functions for three various base conditions; namely the fixed-base, flexible base and pseudo-flexible base are analytically obtained subjected to a unit input ground motion to the target models. Then the proposed method to identify the frequency response functions is applied and the results are compared with those of the targets. It is shown that the obtained frequency response functions are identical to the target ones.

Keywords: Frequency response function, System identification analysis, Soil-structure interaction, Response analysis

1. Introduction

Forced vibration test and seismic wave observations are commonly used to determine the modal parameters of the actual structures from system identification analysis. In practice and for usual structures, the effect of the soil-structure interaction (SSI) is neglected and the fixed-base modal parameters, which reflect the dynamic characteristics of the structure alone, are assumed to be nearly equal to those of the flexible base one (considering the effect of SSI). But in massive and stiff structures on relatively soft soils, the SSI effect becomes an important factor in the response of the building and such simplifying assumption may lead to serious error in estimating the natural frequencies and damping ratio of the fixed-base condition. The common result is that the natural frequency of the building is underestimated and the damping ratio is overestimated [1)].

The objective of any system identification analysis is to evaluate the unknown system having the input-output data. The system can be described as impulse response function (in time domain) or frequency response function (in frequency domain). The purpose of this study is to evaluate the frequency response functions of the structural system under various base conditions for forced vibration analysis using the recorded data of the system. The method to evaluate these frequency response functions is derived and its applicability is shown.

Three different base conditions are investigated, namely 1) the fixed-base which all effects of SSI are eliminated, 2) the flexible base which includes the SSI effects and 3) an intermediate case named pseudo-flexible base which the translation motion of the foundation is eliminated but the rotational motion is remained in the system[2)].