# EVALUATION OF MAXIMUM RESPONSES CONSIDERD GROUND CHARACTERISTICS

Keiichi OHTANI [1]

## SYNOPSIS

One of the most important problems in the field of earthquake engineering is to suppose reasonable earthquake excitation patterns for the dynamic analysis of structures. In particular, in the response analysis of a structure for moderately intense earthquakes, it may be plausible to suppose a statistical model of earthquake excitation taking into account the seismicity and the dynamic characteristics of the ground at the site of the structure.

In this paper, as one of the basic studies related to such artificial earthquake excitations as are used in the dynamic aseismic design of structures, the statistical characteristics of the response spectra of a quasi-stationary random excitation, which is defined as the product of a deterministic time-function and a ergodic stationary random process, are discussed.

The random process considerd in this study has the frequency characteristics which are simulated to the dynamic characteristics of the ground at the site. By the simulation of the dynamic characteristics, the frequency characteristics which are given by the microtremor test, the vibration test and etc., are approximated to the sum of some curves of single degree-of-freedom system. This approximation method are used to minimize the sum of squares differens between the test values and the sum of some curves.

The expressions of the mean value and the upper and the lower limits of the response spectra of the quasi-stationary random excitaions are obtained as the products of the root of the maximum value of energy spectral density of a modified quasi-stationary random process, which is approximately equal to the maximum value of the root mean square of the envelope of the output responses of a single degree-of-freedom, damped oscillator applied to the quasi-stationary random excitaitons with a finite duration time, and the relevant multiplication factors which are expressed in terms of the characteristic values of the Rayleigh distribution and the amplitude probability distribution of the maximum value of the normalized random variable associated with a pseudo-stationary envelope of the non-stationary output response of the oscillator.

The analytical expressions of the energy spectral density and power spectral density of the modified quasi-stationary random process are presented for a case where the envelope of the quasi-stationary random process is expressed as the product of an arbitrary deterministic time-function and a cutoff operator intime domain. The iterative method of evaluating the maximum value of the energy spectral density of modified quasi-stationary random process is also discussed. On the other hand, the multiplication factors which give the mean value and the upper and the lower limits of the response spectra, together with the above-mentioned maximum value of the energy spectral density, are determined semi-experimentally by means of the simulation method in the case where the envelope is given by a deterministic time-function $a(t)=A\cdot t\cdot e^{(1-t/t_p)}/t_p$ multipled by the cutoff operator and the spectral density is a rational function multiplied by a band-limiting operator.

1) Research Member, Building Research Institute, Ministry of Construction