EARTHQUAKE RESISTANT DESIGN

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Contents

1. Seismic Coefficient Method

The seismic coefficient method is one of the static procedures for earthquake resistant design of structures. Horizontal and/or vertical forces, which are calculated as products of the seismic coefficients K_H, K_V and the weight of the structures are applied to the structures as shown in Figure 1.

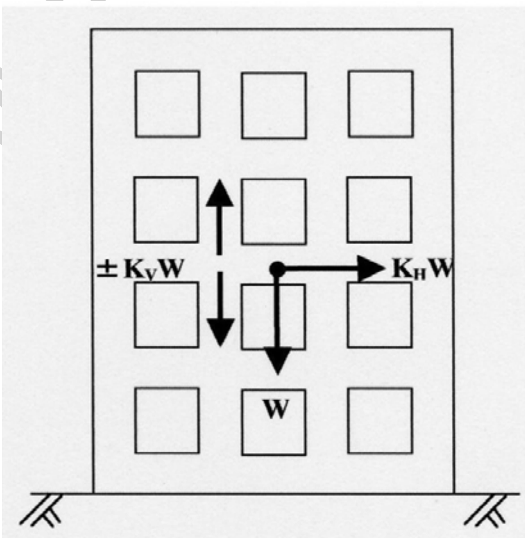

Figure 1. Seismic coefficient method

The stability and the deformation of the structures, and the stress and the strain of each structural member are examined against the horizontal and/or vertical forces in addition to the vertical load due to the weight of the structures.

The seismic coefficients K_{H} and K_{V} are determined by taking the importance level of the structure and the seismic activity of the region into the consideration. Generally, the horizontal seismic coefficient K_{H} is 0.2 – 0.3 for road and railway bridges, around 0.15 for dams, 0.15 – 0.25 for port and harbor facilities and 0.6 for nuclear power plant buildings.

The inertia force *F* acting on a structure during earthquake motions is expressed by the following formula as a product of the total mass of the structure *M* and the acceleration α.

$$F = M \cdot \alpha \tag{1}$$

Equation (1) can be rewritten by using the acceleration of the gravity g as follows:

$$\begin{aligned} F &= \frac{\alpha}{g} \cdot Mg \\ &= \frac{\alpha}{g} \cdot W \end{aligned} \tag{2}$$

Therefore, the seismic coefficient can be recognized as a ratio of the acceleration of structures to the gravity acceleration.

2. Response Spectrum

The dynamic response of a structure against an earthquake ground motion is governed by the natural period and the damping coefficient of the structure, and the predominant components of the ground motion.

The dynamic response of single freedom systems, shown in Figure 2, is written by the following differential equation.

$$\ddot{q}(t) + 2\frac{2\pi}{T} h\, \dot{q}(t) + \left(\frac{2\pi}{T}\right)^2 q(t) = -\ddot{z}(t) \tag{3}$$

where T and h are the natural period and the damping ratio of a single freedom system, and $\ddot{z}(t)$ and $q(t)$ are input earthquake acceleration and response displacement of the system, respectively. The dynamic responses of several single freedom systems with varying natural periods and a same damping ratio against an earthquake motion are changed as illustrated in Figure 2 depending on the natural period of the system.

The acceleration response spectrum is the relationship of the maximum response acceleration S_{ai} with the natural period of the system (T_i), which is illustrated in Figure 3. Similarly, the displacement and velocity response spectra can be obtained as the relationship of the maximum response displacement and velocity with the natural period of the system.

Figure 4 is one of example of acceleration response spectra of the ground motions, which was observed in Kobe City during the 1995 Kobe earthquake.

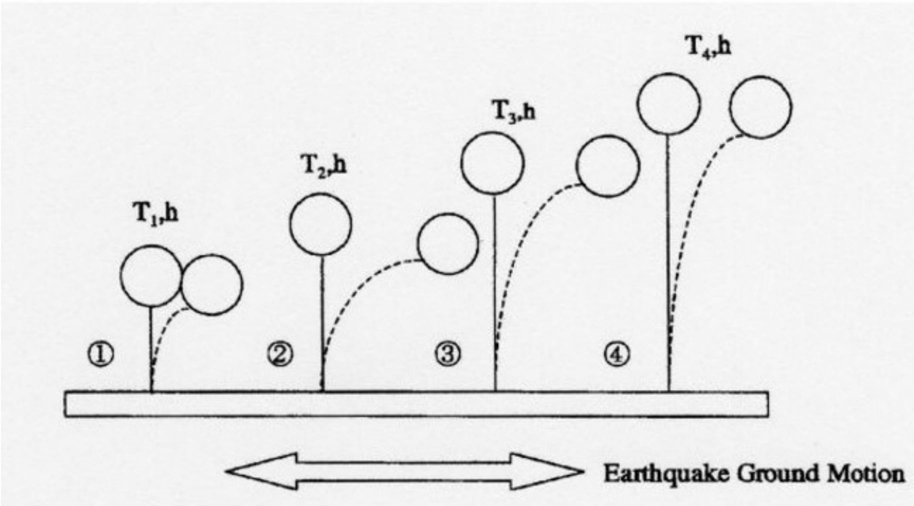

Figure 2. Dynamic response of single degree of freedom systems

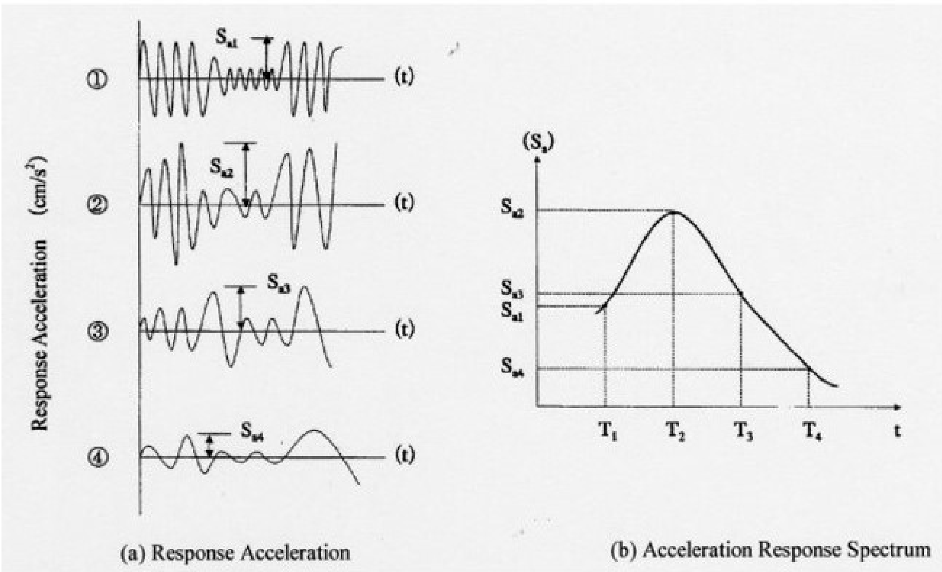

Figure 3. Acceleration response spectrum. (a) Response Acceleration (b) Acceleration Response Spectrum

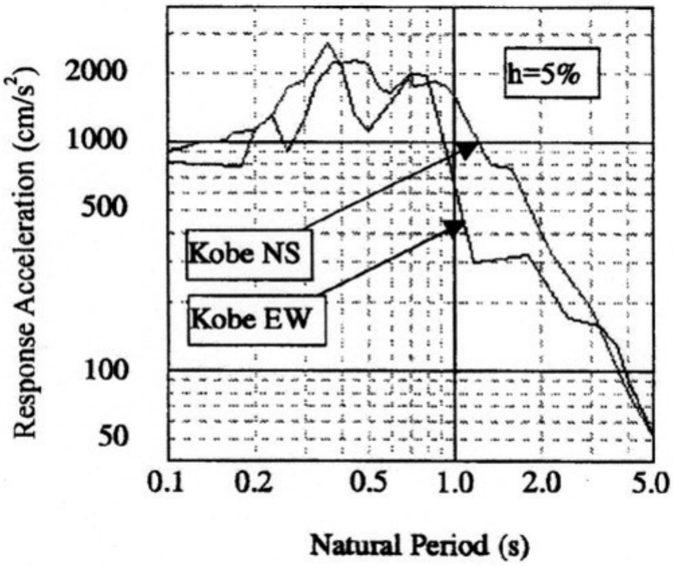

Figure 4. Response acceleration spectrum of earthquake ground motion in Kobe in 1995

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Biographical Sketch

Masanori Hamada was born on October 13, 1943, Yokohama City, Kanagawa, Japan.
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