RESPONSE SPECTRUM TECHNIQUE FOR ASYMMETRIC STRUCTURES

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Horizontal ground motions cause both torques and lateral forces to act on asymmetrical frame structures. To obtain the seismic forces on each individual frames using the response spectrum technique, it is necessary to resolve the torques and lateral loads on the structure into shear forces on the frame according to principles of structural mechanics. Two spproaches for the resolution are possible.

A more conventional approach is to obtain the modal interstorey shear and torque using the response spectrum technique. The total interstorey shear and torque can then be calculated by combining the modal responses in a root sum square (RSS) manner if the natural frequencies are well separated. The total shear and torque on the structure are then resolved to different frames according to their location and stiffnesses.

The drawback in this approach is that in combining the modal responses, the phases between the shear forces and torques are lost in the process. Therefore, when the total shear forces (shear due to lateral loading and torque) acting on each frame are computed, one would normally consider the shear caused by the worst combination of lateral and torque loadings.

The present proposed scheme to include the effect of torsion consists of the following steps. (i) Obtain the modal shear and torque on the building by the response spectrum technique. (ii) Compute the total modal shear forces on each frame by resolving the modal shear and torque on the building according to principles of structural mechanics. The phase relation between the modal shear forces and torques is a function of the coupled mode shapes and is well defined. Therefore, the shear on each frame due to the lateral load effect and torsional effect can be combined algebraically. (iii) Obtain the total shear force on each frame by combining the total modal shears on that frame in a root sum square manner. Since the proper phase relationship between the lateral load effect and torsional effect is accounted for on a modal basis, it is believed the proposed scheme provides a more realistic load estimate on the frames than the first approach.

An example of a simplified mono-symmetrical frame structure is chosen to illustrate the two approaches discussed. The accuracy of each approach is discussed by comparing results obtained with those obtained using dynamic time-history analysis.

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