EFFECT OF EARTHQUAKES ON COLUMNS AND BRIDGE PIERS

A METHOD OF DESIGN

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ABSTRACT

Surveys of disaster areas during the last decade have shown the effects of seismic vibrations on columns and bridge piers. Numerous examples of damage have been seen in Mexico City, Acapulco, Chile and Agadir. Damage at the top of reinforced concrete columns show high concentration of stresses below floors. Concrete piers of bridges have sheared.

Studies of damage, where the 'quake intensity was high, show that structures had been subjected to intense torsional effects. The origin of torsion, according to the present concepts of earthquake engineering, is due to the eccentricity between the centre of mass of a structure and its centre of gravity. The computation of stresses based on this principle leads to rather small torsional stresses which cannot be responsible for the amount of destruction, especially close to an epicentre. The soil under the early shock waves deforms in the direction of least resistance such as water pockets or highly compressible layers. In other cases deep underground foundations may serve as a screen to the path of the shock waves. These differential movements of the soil are responsible for the larger-than-expected torsional effects on buildings.

Strong motion equipment records from the 1957 San Francisco earthquake show increase in vertical acceleration with storey height, the vertical load on the column being much larger than the computed static load.

It is proposed that the seismic coefficients for column design be based on the SEAOC code but that vertical load be increased by a coefficient (1.25 + 0.01N), and that within 40 miles of a fault the torsion moment should be 1.25 x Fx x d (where d is the distance between the centre of mass and the centre of gravity of the floor) and never less than 0.15 x Fx x d_1 (where d_1 is the maximum horizontal building dimension).

Materials for columns should be chosen with respect to the distance of a structure from a fault. For a zone zero to 40 miles from a fault steel frames are the safest solution with the columns encased in concrete to prevent buckling; reinforced concrete should be used only with great care taken against torsional oscillations. For bridge piers steel sections encased in concrete would be a suitable type of construction.

Model tests are described briefly of a beam and column assembly of 4 in. by 4 in. hollow square section subject to static and dynamic loading. The test shows that it is probably adequate to consider earthquake loading of columns in terms of static loading.

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