EFFECT OF FOUNDATION COMPLIANCE AND OF ROTATIONAL COMPONENTS OF EARTHQUAKE ON SEISMIC RESPONSE OF TORSIONALLY COUPLED MULTISTOREY BUILDINGS

By
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Earthquake hazard analysis;
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Dedicated to

Lord Madhur
Shri Ganapathy:

Parents and

S. Chatterjee

CERTIFICATE

This is to certify that the thesis entitled, "**Effect of Foundation Compliance and of Rotational Components of Earthquake on Seismic Response of Torsionally Coupled Multistorey Buildings**", being submitted by Mr. M. K. Mahesh to Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy** in Civil Engineering is a record of original bonafide research work carried out by him. Mr. M. K. Mahesh has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to the best of my knowledge has reached the requisite standard.

The material contained in this thesis has not been submitted, in part or in full to any other University or Institute for the award of any degree or diploma

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ABSTRACT

Multistorey buildings are often supported on raft foundation with piles. The usual assumption that the base motion of a structure is the same as the ground motion is valid for the structures supported on rigid foundations. For a structure having compliant foundation, the motion of the footing is different from that of the soil and also has a rocking component. For symmetric buildings resting on elastic halfspace the effect of foundation compliance has been reported to result in reduced response. Limited research work on the seismic response of torsionally coupled multistorey buildings resting on compliant foundation has been reported in the literature. However, most of the work is confined to a single storey framed building or a multistorey framed building idealised as a single storey framed building resting on elastic halfspace. Recently,some studies have been carried out on the seismic analysis of torsionally coupled multistorey building resting on layered soil stratum. No work has been reported in the literature on the seismic analysis of torsionally coupled multistorey buildings comprising of frames and shearwalls supported on raft foundation with piles passing through homogeneous or layered soil stratum. The present study, in part, is an effort in this direction.

Soil-Pile behaviour based on the plane strain idealisation has been used to determine impedance functions of the raft-pile system. For rigid raft five degrees of freedom (d.o.f), a translation and a rotation about each of the horizontal axes and a rotation about the vertical axis, are considered.

Superstructure comprising of frames and shearwalls in random arrangement in floor plan is idealised as a discrete 3D model. Three global d.o.f at each floor level (two horizontal translations and a rotation about vertical axis) are considered. The lateral stiffness matrices of stiffening elements of size (NxN), are first obtained by condensation and are used to form a global stiffness matrix of size (3Nx3N), where N is the number of floors in building.

For analysis of foundation-superstructure system the substructure method has been used. Equations of motion of the system incorporating foundation impedance functions are written in time domain, converted into frequency domain and the response obtained. Using Inverse Fast Fourier Transform the seismic response is then determined.

Two seismic inputs, at the footing level and at the bedrock level are considered in the present investigation. When the seismic input is at the bedrock level, earthquake is assumed to propagate vertically upwards in shear mode. Time histories of earthquake are generated from the specified response spectra of IS Code in the case of input at the footing level and from the Kanai-Tejimi filter transfer spectral density function, in the case of input at bedrock level.

It is shown that the distribution of storey shears along the height in the building or in the stiffening elements obtained assuming the foundation to be compliant is not the same as that obtained assuming the foundation to be fixed.

Recently the effect of torsional component of earthquake has received attention. In these studies coherency loss in spatially varying ground motion is considered. The studies relate to a single storey framed building. Not much work is reported on the effect of rocking component of earthquakes. In the present work the effect of torsional and rocking component of earthquake on the response of torsionally coupled multistorey buildings comprising of frames and shearwalls is studied. The Superstructure is modelled as described above. The rotational and rocking component of ground motion are generated from the spectrum given by Buchholdt, H.A.

It is shown that the response due to rocking and torsional motions is significant. It is further shown that the variations of responses along the height due to translational and torsional motions are different but are similar for translational and rocking motions.

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