TORSIONAL VIBRATIONS OF CORE WALL STRUCTURES IN TALL BUILDINGS

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SYNOPSIS

A general method based on the concept of thin walled structures is presented for determining the dynamic response of symmetrical and asymmetrical core wall structures having closed or open section, subjected to combined bending and torsion, using finite beam element approach. A consistent mass matrix related to torsion and bi-moment effects has been derived. The formulation of the stiffness matrix of each beam element using this theory, accounts for the warping deformations due to restrained warping. Resonance tests on a model lift shaft structure are shown to compare favourably with the theoretical results.

INTRODUCTION

The thin walled elements which are assembled to form a core wall system in the form of lift shafts, stairwells and sevice ducts etc are very stiff in their own plane, and so the core wall structure is stiff in bending. But the same elements are flexible out of plane, hence their stiffness contribution due to St.Venant torsion is small if the effect of the restrained warping is neglected. It has been shown that for core wall structures, fixed at the base, the stiffness due to torsional component associated with flexural twist is much greater than the St.Venant torsional component. As such the method presented here includes the warping deformations in the derivation of the stiffness matrix in the form of bi-moment.

Due to the presence of a heavy mass moment of inertia at each floor level, arising mainly from the slab, the frequency of the lowest torsional and bending modes of vibrations can be low enough to fall within I-IO Hz range in which most of the energy from the earthquake has been found to lie. To find the dynamic response of these high rise core wall structures subjected to bending and torsion, consistent mass matrix related to torsion and bi-moment, in addition to stiffness matrix, has been developed which make the response calculations simple.

Resonance tests conclude the validity of the proposed theory through close agreement of test and theoretical results of frequencies and mode shapes.

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