CHAPTER I

INTRODUCTION

1.1 General and Statement of Problems

In big cities, high-rise buildings are constructed to make the most benefitial use of land. The increase in the number of stories of modern tall buildings has imposed on engineers the need for a better understanding of the behavior of these structures. The frame - tube system is known to provide an economic solution for high-rise buildings of both steel and concrete when the number of stories exceeds about 40. The basic structural system consists of closely spaced exterior columns connected at each floor level by spandrel beams, forming a system of four orthogonal rigidly jointed framed panels. To make an accurate analysis of these highly redundant structures, a plane frame or a space frame program is required. Such an analysis is too costly for a preliminary design. Therefore, a simple approximate analysis which can quickly predict the response of these structures to within practical accuracy will be invaluable at a preliminary design stage

1.2 Literature Review

A few approximate methods have been suggested in recent years for a quick computation of force distribution among members and lateral displacement of symmetrical rectangular frame-tube structures subjected to symmetrical lateral loading. In these methods, the effect of axial deformation on the force distribution and lateral displacement is considered.

KHAN and AMIN (1) suggested a method for computing axial forces in the columns and shear forces in the spandrel beams by means of the influence curves which were developed based on the results of a number of computer runs on ten story equivalent frame-tubes with linearly varying stiffness ratio of the girders and columns. Various aspect ratios and stiffness factors were considered. In these influence curves all the coefficients are normalized with respect to the corresponding values of the ideal tube. Only the case of uniform loading was given. The lateral displacement of the structure is computed from the superposition of the frame displacement and the tube displacement computed from the ideal tube displacement times the magnification factor which accounts for the effect of openings in the actual structure.

COULL and SUBEDI (2) proposed an equivalent plane frame technique in which the three-dimensional tube is reduced to a system of two-dimensional plane frames connected by horizontal vertical shear transfer members. The accuracy of this method has been found to depend on the stiffness of these transfer members. Similar work has been reported by RUTENBERG (3) and NAKA, et al, (4).

SCHWAIGHOFER and AST (5), employing the equivalent plane frame technique, established a series of tables for the analysis of square frame - tube buildings. The number of stories covered are 40, 50 and 60. All the columns are assumed to be identical except for the corner ones which are L-shaped having twice the area of the interior columns. The same section of the spandrel beams is assumed throughout the structure. The column widths vary from 1.76ft. to 5.94ft. and the beam depths from 2.4ft. to 4.8ft. The ratios of baywidth to story height of 0.8, 1.0 and 1.2 are considered.

Based on a continuum approach, COULL and BOSE (6) proposed another method for analysing a frame - tube structure. The discrete structure is replaced by an equivalent uniform orthotropic plate whose properties are chosen so that the two elastic moduli in the horizontal and vertical directions represent the stiffness of spandrel beams and columns respectively. This method, however, does not readily give the solution for the lateral displacement.

1.3 Objective and Scope of Study

The objective of this study is to develop an approximate method for the analysis of frame - tube structures subjected to lateral loads and compare the results with available solutions. Particular emphasis is placed on simplicity and sufficient generality of the method so that frame - tubes with any variation of the member sections along the height of the structure can be solved manually on electronic calculators.

Only symmetrical rectangular frame - tubes under symmetrical lateral loads are considered. The loading may have uniform, triangular or trapezoidal distribution.