CHAPTER III

NUMERICAL EXAMPLES

In order to illustrate the accuracy of the proposed method, one plane frame and 39 frame-tubes are analysed and the results compared with the solutions obtained by previous investigators.

3.1 Multistory Multibay Plane Frame

The 13 story frame shown in Fig. 5 is analysed for a uniform lateral load of intensity 1 kip /ft. The elastic and shear moduli are $5\text{x}10^5$ kips/ft^2 and $2.25\text{x}10^5$ kips/ft^2, respectively. The same distribution of axial deformation in the columns as assumed by Chan, et al (7) is employed, viz $u_{cj}\ (y,z) = \left[\frac{\sinh\left(\frac{2\ y_j}{D}\right)^2}{\sinh\ (1)}\right] u_{cc}(z)$.

In this case no correction is made of the lateral displacement due to axial deformation. The results of the present analysis, shown in Figs. 6 - 8, compare satisfactorily with the exact solution by the stiffness method and the solution by Chan, et al. Fig. 6 shows the lateral displacement. The proposed method underestimates the displacement at the top by about 5 %.Fig. 7 shows the variation of axial forces in the exterior columns. The maximum axial forces at the base obtained by the present method is less than the exact value by about 12 %. In the upper stories the actual column axial forces change sign whereas the predicted values do not owing to the inherent assumptions in the axial displacement shape. In Fig. 8 the variation of shear forces in the center column is shown. The predicted shears in the upper stories are too low whereas those in the lower stories are too high. The base shear obtained from the present method is about 18 % higher than the exact value.

3.2 Frame-Tubes of SCHWAIGHOFER and AST

A total of thirty eight out of seventy two square frame-tubes analysed by Schwaighofer and Ast (5) were solved using the proposed method. Forty, fifty and sixty story structures with different values of stiffness factor are covered. The ratios of bay width to story height considered are 0.8, 1.0 and 1.2. All structures have a floor-to-floor height of 12 feet and the number of bays is 11 in both the normal and side panels. Each structure has constant geometric properties of spandrel beams and columns throughout the structure, except the corner columns whose areas are twice the interior ones. The analyses are performed for the lateral wind load specified by the national building code of Canada (5).

Analyses were first carried out without applying the correction factor β (i.e. $\beta = 1$) and excessive axial deformation at the top was obtained. This is partly due to the use of the same axial deformation shape throughout the height of the structure.

Consequently the corner column forces will have the same sign throughout the height of the tube whereas in reality a change in the sign of these forces occurs near the upper stories. Information about the axial deformation distribution in normal panels of such frame-tubes is also lacking. Thus, in this study we adopt the results of Khan and Amin(1). Furthermore, the axial deformation distribution given in Table. 1 for the case of equal bay width and story height is employed for frame-tubes of other bay width to story height ratios.

The results of the proposed method are compared with those of Schwaighofer and Ast in Tables 2 - 4 in which the percentage error in the predicted corner column forces, the shear forces and lateral displacement of different frame-tubes are given. It is seen from Tables. 2,3 and 4 that the results are best when the bay width/story height ratio is 1.2 and worst when this ratio is 0.8.

Table 5 summarises the frequency of occurrence of the percentage error in the predicted values for the 38 tubes analysed. It is seen that about 95 % of the corner axial forces and spandrel beam shears predicted can be expected to have an error of less than 30 % whereas 90 % of the lateral displacements predicted agree with the solution of Schwaighofer and Ast to within 30 % when the correction factor, β , is taken as 0.55.

The variations of the column axial forces, the shear forces and lateral displacement along the height of the structure for the specific frame-tube shown in Fig. 9 are given in Figs. 10 - 12 together with the solution of Schwaighofer and Ast (5). It is seen that the axial forces calculated by the proposed method change rather rapidly from the exterior to the interior of the side panel. The discrepancies between the results of the two methods increase along the height of frame-tube. However, good agreement is obtained for the shear forces in the spandrel beams, slightly higher forces being obtained from the proposed method.

3.3 Frame-Tube of Khan and Amin

The 50 story frame-tube whose plan view is shown in Fig. 13 is taken as the last example. The columns are spaced at 10 feet on centers and the floor-to-floor height is 13 feet. Table 6 shows the sectional properties of columns and spandrel beams together with the stiffness factors in each story. The structure is subjected to a uniform lateral load of 1 kip/foot/column.

The results of Khan and Amin, the solution obtained from the computer analysis and the proposed method are shown in Table 7. It is evident that the present method gives sufficiently accurate values of the internal forces and the lateral displacement. The column axial forces in the normal panels at the lowest story differ by 1 - 16 % from the exact solution. The sum of the spandrel beam shear forces in the lowest five stories of the side panel is overestimated by 12 - 18 % and the lateral displacement at the top is underestimated by 6, 14 and 20 % when the correction factor, β , is taken as 0.6, 0.55 and 0.5 respectively.