SHEAR WALL-FRAME INTERACTION
IN A MULTI-STOREY BUILDING

John W. McGrath

A MAJOR TECHNICAL REPORT

in the

Faculty of Engineering

Presented in partial fulfilment of the requirements of
the Degree of Master of Engineering at
Concordia University
Montreal, Canada

November, 1975

ABSTRACT.

ABSTRACT

John W. McGrath

"Shear Wall-Frame Interaction In A Multi-Storey Building"

The interaction of frames and shear walls in a multi-storey building subject to lateral loads is reviewed and the results are applied to a ten-storey building which was previously designed by assuming that arbitrary percentages of the lateral forces were taken by the shear walls. The Portland Cement Association frame-shear wall interaction and flat plate computer programmes are used in the analysis and the results are included in the appendices.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

The purpose of this report is to analyse an existing ten-storey, flat plate, industrial building considering the shear wall-frame interaction and to compare the results to the original design assumption that 75% of the lateral forces were resisted by the shear walls and 25% by the frame.

Two computer programmes, provided by the Portland Cement Association, are used to analyse the structure, one programme is for the flat slab analysis (1) and the other is for the shear wall-frame analysis (2). The print-outs of the results are included in the report.

In many design offices the short time allowed for the design of a structure necessitates many simplifications, for example the lateral forces on the building considered could be assumed to be resisted by either the frame action or the shear walls alone. The use of standard computer programmes for detailed analysis and the economies possible are presented in this report.

CHAPTER 2

CHARACTERISTICS OF SHEAR WALLS AND FRAMES (3), (4), (5)

CHAPTER 2

CHARACTERISTICS OF SHEAR WALLS AND FRAMES

2.1 FRAME AND SHEAR WALL ACTION

The framing was designed to transmit lateral loads to the foundation in multi-storey buildings until recent times. Conservative estimates of the behaviour of the whole building were obtained by using elastic methods of frame design. The strength and stiffness of the building was clearly provided by the walls and frame but results obtained by calculating the composite action varied widely because of the different but justifiable assumptions. At the present time the need to allow for the effects of walls becomes more important with the construction of increasingly taller buildings.

The walls can be considered to resist all the horizontal loads and the frame to take the vertical loads only, but this again is a simplification. When the building is very tall, however, the shear wall flexural deformations become very pronounced and hence induce deformations in the frame which must be allowed for in the design analysis.

The composite action of the combined structure causes the frame to restrain the shear wall in the upper storeys and the shear wall to restrain the frame in the lower storeys, hence reducing the free deflection and improving the overall efficiency of the structural system. Figure 1(a) shows the shear mode deflection of a frame which can be defined as a system of inter-connected vertical columns and horizontal elements. Figure 1(b) shows the predominantly bending mode deformation of a shear wall or simple cantilever. The behaviour of stair wells, elevator shafts and walls normally conform to this mode. Figure 1(c) shows the interaction forces between a frame and a shear wall.

The modes of deformation are not always easy to categorise, for example a row or rows of openings in a shear wall may change the deflection characteristics from a bending to a shear mode, and conversely an infilled frame will tend to deform in a bending mode.

If the height to depth ratio of a shear wall is low, for example less than one, the shear deformation can be more important than the bending deformation.

The arrangement of the structural members is usually restricted by the architectural requirements but there still remains ample scope for the engineer to design an economic structure. Figure 2 shows how the cost of construction varies with the height and the oportion of the cost which is required for wind or lateral loads.

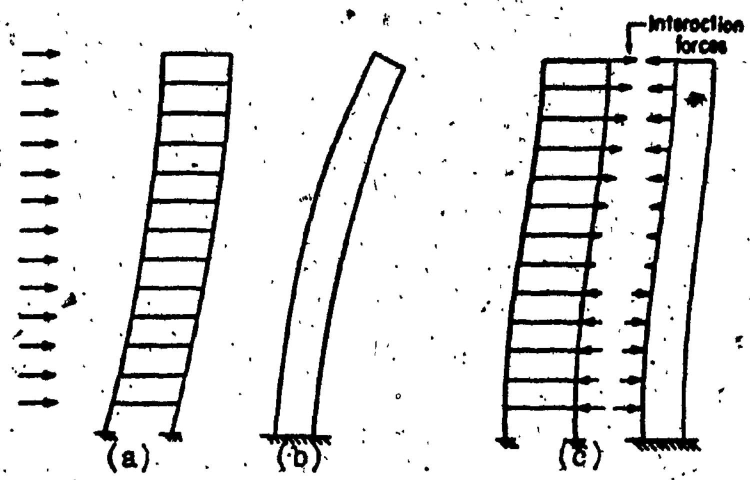


Fig. 1 Deformation Modes

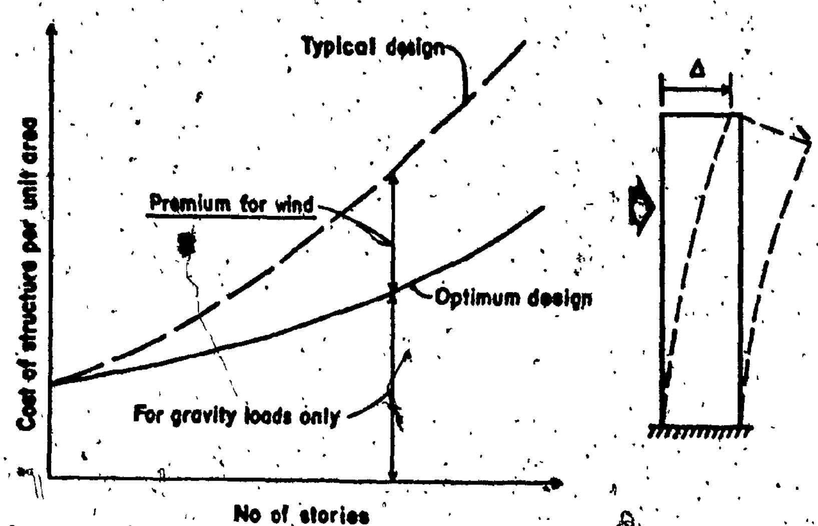


Fig. 2 Cost of Construction: Height

The lateral drift or deflection is often the design criteria in high slender buildings and may determine the type of structural system employed.

The distribution of applied horizontal load on a frame-shear wall structure can be demonstrated as shown in Figure 3 where the variation of shears carried by the elements are indicated. It should be noted that the total shear carried by the frame at the top storeys can exceed the applied storey shear at these levels. Distributing the applied shear to the resisting elements in proportion to their relative stiffness can lead to erroneous results. The large variation in the shears at the lower storeys is caused by the shear wall being carried by columns and indicate the force concentrations which occur in regions of shear wall discontinuities.

The arrangement of the structural elements may easily modify the mode of deflection as indicated in Figure 4.

Lateral load analysis is comparatively simple if all the vertical components of a structure behave in a similar manner due to lateral load. For example, if they are all shear walls or all rigid frames the load can be distributed directly to the units in proportion to their stiffness. When walls and frames are combined in a structure, non-uniform interacting forces are developed by

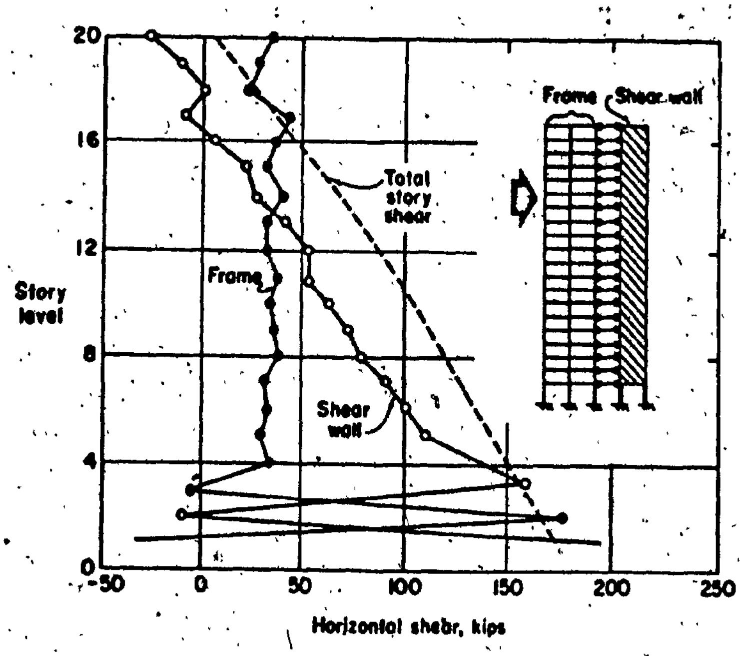


Fig. 3 Distribution of applied horizontal load between frame and shear wall (Ref. 3)

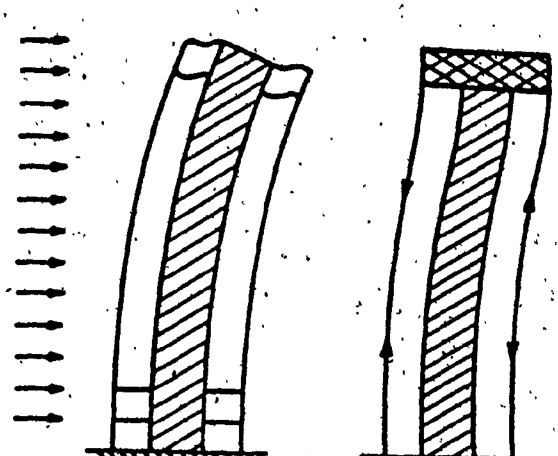


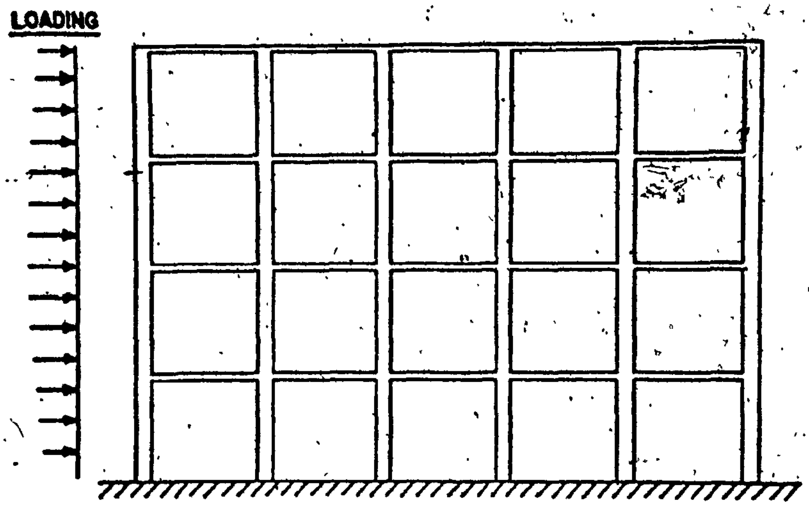
Fig. 4 Tying core with exterior columns

the difference in response under lateral load in combination with the in-plane rigidity of the floor slabs. It is the non-uniform interacting forces which make the analysis more complex.

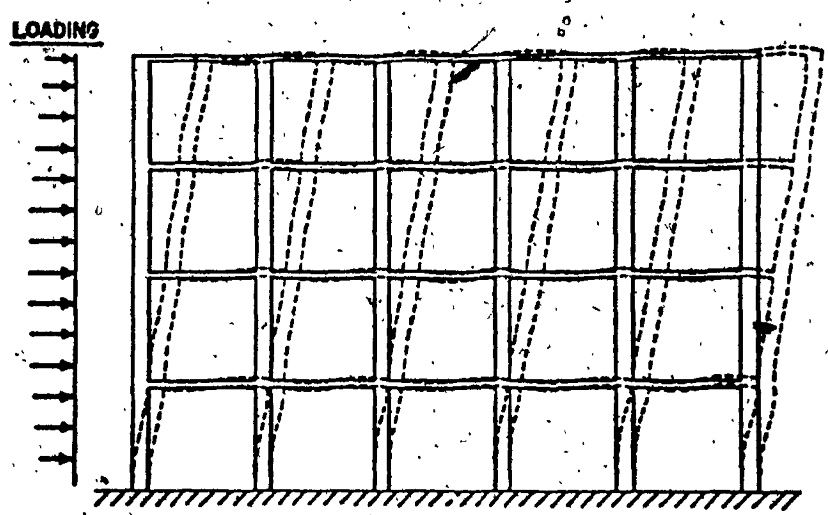
Flat slab buildings consist of reinforced concrete floors of uniform thickness or with drop panels at the columns, supported by columns. The flat slab building in its most regular form thus becomes a structure consisting of a series of parallel plates pierced by a series of uniform columns. In reality, the flat slab building departs from this simple definition due to such features as stiffening beams either around the perimeter or around interior openings and irregular column size and layout.

Floor slabs are usually considered to be fully rigid within their own planes for analysis, which means that there will be no relative movement between the vertical units at each storey level. It is possible to allow for in-plane deformation of the slabs but this deformation is seldom of any significant importance.

Figure 5 (a) shows the geometry of a frame before lateral load is applied; Figure 5 (b) shows the displaced position of the frame due to lateral loading. The columns and girders, or the columns and floor slabs in the case of a flat slab structure, combine to resist the load by bending and take the displaced profile of the classic



a) BUILDING SUBJECTED TO LATERAL LOADS



b) FRAME ACTION OF LOADED BUILDING

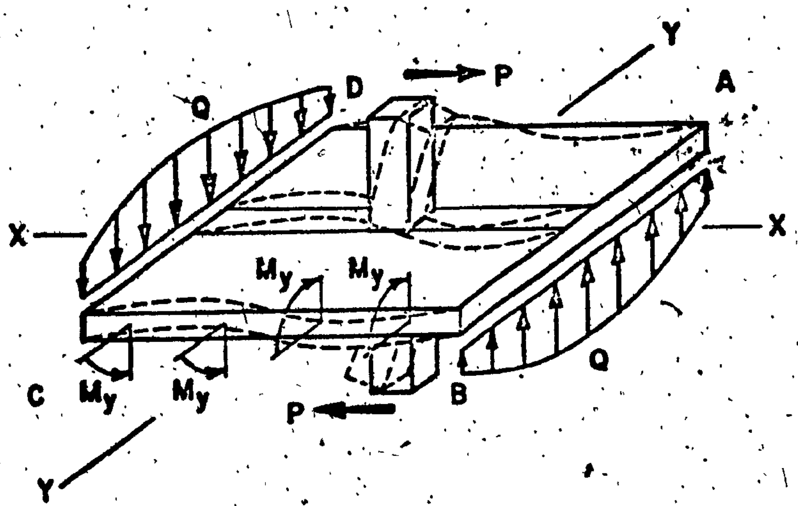
Fig. 5 Building frame deformation

"frame action".

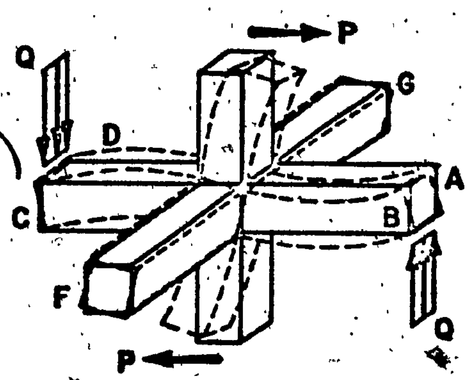
A typical frame joint is shown in Figure 6; the columns are cut at mid-height above and below the joint and the girders and slabs at mid-span. The deflected positions are indicated by dashed lines and the unloaded position by solid lines.

Figure 6 (a) shows the fundamentally two-dimensional action of the slab in the flat plate building. Maximum deflections occur at the X-X axis and deflections of points on any cross section parallel to Y-Y vary along the section. The lines of inflection AB and CD show how the shear Q varies across the section. Some moment, MY on the panel centre lines BC and AD is transferred to adjoining units.

The fundamentally one-dimensional character of the column and girders is contrasted in Figure 6 (b) from points AB and CD to the column. Moments and deflections are considered constant across any transverse section of the girder and the end shear Q is evenly distributed. The perpendicular girder FG rotates with the joint but due to the assumed symmetry does not twist and hence does not apply a moment to the unit. Hence for the column and girder structure it can be assumed that there is no transverse interaction between various units of the frame or transverse variation of deflection moment or shear within an element of the floor system.



a) FLAT PLATE



b) COLUMN AND GIRDER

Fig. 6 Units from loaded buildings

2.2 METHODS OF SOLUTION

Methods of solution are easily formulated for the relatively simple behaviour of the column and girder frame as opposed to the complexity of the flat plate analysis. Slope deflection equations form the basis for a method of solution which is well suited for the analysis of frames for gravity and lateral loads; this method is readily adaptable for electronic computer computation.

The simple methods available for a two-dimensional analysis of a column and girder frame have led to repeated attempts to reduce the basically three-dimensional plate structure to an approximately equivalent two-dimensional frame. The current A.C.I. building code uses this approach and represents the flat plate as a two-dimensional mathematical model. A row of columns and that portion of the slab within the panel centre lines on either side is considered the equivalent structure. One of the provisions included is that joints can be considered rigid, with the rigidity extending in the slab and column to the limits of the cross-sectional area common to both. The code has only one direct reference to lateral load design, which reads in part: "A slab width between lines that are $c/2 + 1.5t$ each side of the column centre line may be considered effective for transfer of bending moment between column and slab, where t is the thickness of the slab at the column and c is the width of the column". Successful field experience is evidently the basis of this provision.

The problem of "effective width", see Figure 7, has produced many experimental and analytical studies which have considered the column to panel width ratio as the governing variable and have recommended effective slab width ratios ranging from 0.5 to values greater than unity. As the column to panel width ratio increases, the effective width increases. However, there may be other factors which have significant effects on the effective slab width, such as the slab stiffness, the slab span to width ratio, and the dimensions of the column in the plane of the frame relative to the slab span. Adjustments may be necessary in the values of both stiffness and carryover factors of the equivalent beam when adjacent frames differ significantly in the spacing or stiffness of the vertical elements.

To properly model the action of a slab, for use in a plane frame analysis, the stiffness properties of an "equivalent frame" must be determined (6). A distinction has to be drawn between the criterion of equivalence to be used depending on the object of the analysis. Thus an analysis undertaken to provide values of slab design moments may require different equivalence criteria compared to an analysis intended to serve as a basis for column design or

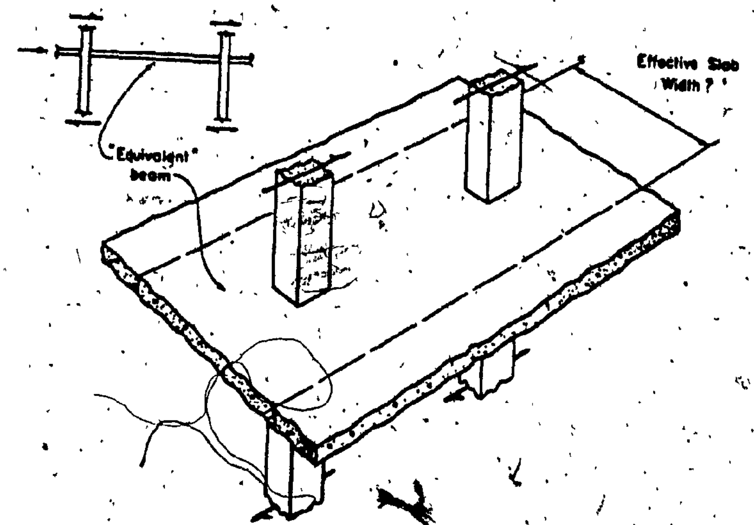


Fig. 7 Effective width of slab

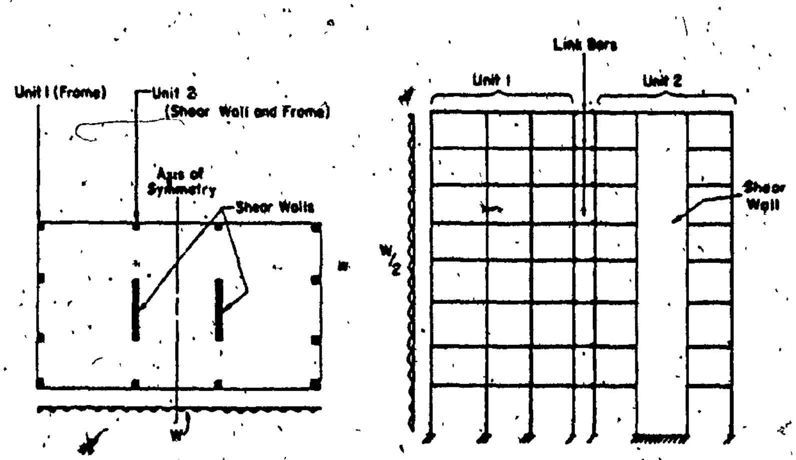


Fig. 8 Idealisation for plane-frame analysis

an analysis of overall frame deformation. For the purposes of this report the effective width has been assumed to be the distance between the panel centre lines on each side of the column.

A plane frame computer programme can be used to analyse a shear wall-frame structure, provided in-plane deformation of floor slabs and torsion can be neglected. The basic idealisation is shown in Figure 8. The vertical units are connected at each floor level by link bars that simulate the effect of the floor slabs in transmitting the loads in their own plane.

The effect of the parameter $\lambda = (E_c I_c/h)/(E_b I_b/\ell)$ the ratio of the column to beam stiffness is shown in Figure 9. If λ is low, the beams are stiff and the frame deflects in shear mode, Figure 9(a). As λ increases, the beams become less effective until, when they have no bending stiffness and the load is resisted by the columns alone, as in Figure 9(b).

If torsion is considered in the design of a building framework, a space frame analysis must be carried out. The in-plane stiffness of the floors can be idealised as shown in Figure 10. The properties of the link bars can be established on the basis of a framework analogy. An analysis of this type is beyond the scope of this report.

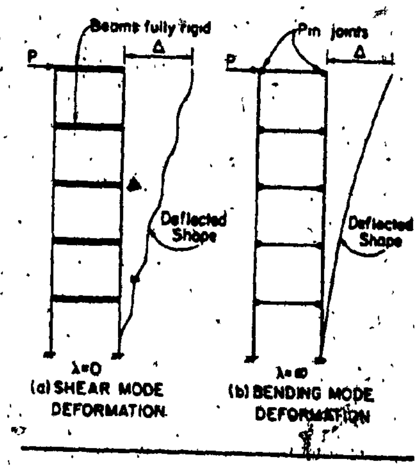


Fig. 9 Effect of λ on frame deformation

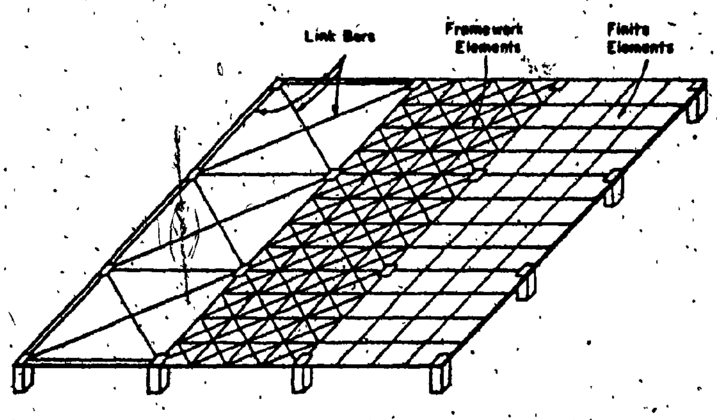


Fig. 10 Floor slab idealisations

CHAPTER 3

COMPUTER PROGRAMMES

CHAPTER 3

COMPUTER PROGRAMMES

The flat plate (1) and frame-shear wall interaction (2) programmes supplied by the Portland Cement Association are the basic tools used in this report and are described at length in this chapter.

The flat plate programme is not very complex, the analysis part could be carried out using any frame analysis procedure, for example matrix analysis, slope deflection or Hardy-Cross. The bulk of the programme time is used to calculate the number and size of reinforcing bars and to check the code requirements.

The frame-shear wall interaction programme (STMFR-60) is very complex and a study of the theoretical basis would be a major investigation in itself. The programme is not documented in detail but has been based on reference (7) which is mainly concerned with the manipulation of large matrices.

The programmes are written for an I.B.M. 360 computer and the time of solution was 1 minute 12 seconds for the flat plate programme and 4 minutes 33 seconds for the frame-shear wall interaction programme.

There is a supplementary programme CK DAT-60 available which checks the input data for the frame-shear wall interaction programme.

3.1 FLAT PLATE PROGRAMME DESCRIPTION (1)

This programme is capable of analysing and designing flat plates, flat slabs (flat plates with drop panels), waffle slabs and continuous frames. It can combine vertical and horizontal loads and design the structure in accordance with the A.C.I.-318 1971 code.

The equivalent frame method of analysis is the basis of the programme in accordance with section 13.4 of the A.C.I. code. The structure is considered divided into a series of bents, each consisting of a strip of slab supported by columns.

The programme input consists of the physical dimensions of the structure, conditions of loading, properties of the concrete and reinforcing steel, specification of design method and lateral loads, if the combination of lateral and vertical loads is required.

Two types of structure can be analysed, either flat slabs and columns or beams and columns. The programme also allows the user to choose between lightweight and normal weight concrete and between ultimate strength and working stress design. The sequence of operations is in accordance with the pertinent design criteria of the code.

The carryover factors, fixed end moments and stiffness factors, are calculated using numerical integration. The elimination method is used to solve the set of simultaneous equations for each bent. Punching shear and moment transfer shear are treated together under the heading "shear stress"; it is assumed that each type of shear acts on the same critical section. The A.C.I. code defines the critical section as a peripheral vertical surface through the slab located at a constant distance of $d/2$ from the face of support, where d is the thickness of the slab or drop panel at the column.

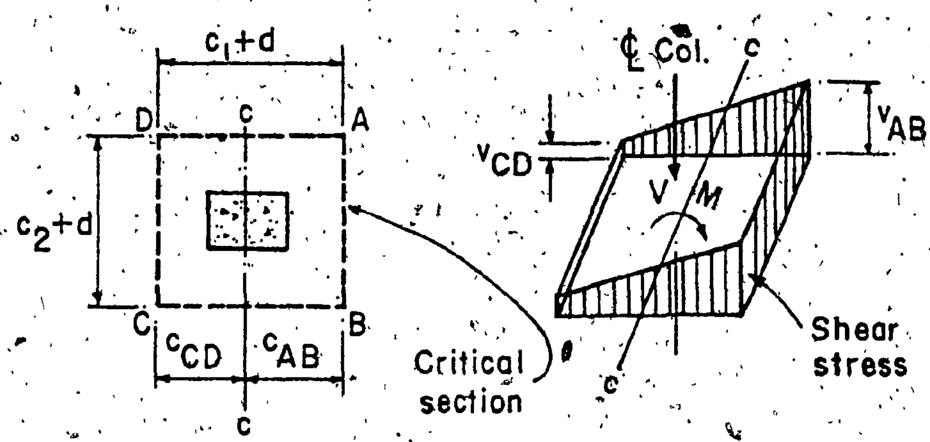
At an interior joint the algebraic difference between the end moments of the two continuous members is the unbalanced moment, whereas at an exterior joint it is the member end moment. Tests have shown that for square columns 60% of the moment should be considered transferred by flexure across the periphery of the critical section and 40% by eccentricity of the shear about the centroid of the critical section. The A.C.I. code states for the general case of square or rectangular columns that the portion of the moment transferred by flexure increases to a fraction given by $1/\left(1+\frac{2}{3}\sqrt{\frac{c_1+d}{c_2+d}}\right)$, where (c_2+d) is the width of the face of the critical section resisting the moment and (c_1+d) is the width of the face at right angles to (c_2+d) The remaining moment produces shear stresses in the same peripheral area used for the punching shear calculations at the supports. The shear stresses resulting from transfer of moment are of opposite sign and are added or subtracted from the punching shear stresses as appropriate, see Figure 11.

The lateral loads can be entered as direct forces or as moments at the joints. The programme will generate the lateral load moments internally with the stiffness matrix method based on the assumption that points of inflection are at the mid-height of the columns; the idealised structure is shown in Figure 12. This assumption produces reasonable results for the intermediate floors with similar storey height and floor thicknesses. The columns outside the simplified frame are disregarded and the value of ½ I is taken for the moment of inertia of the floors above and below to compensate for this assumption.

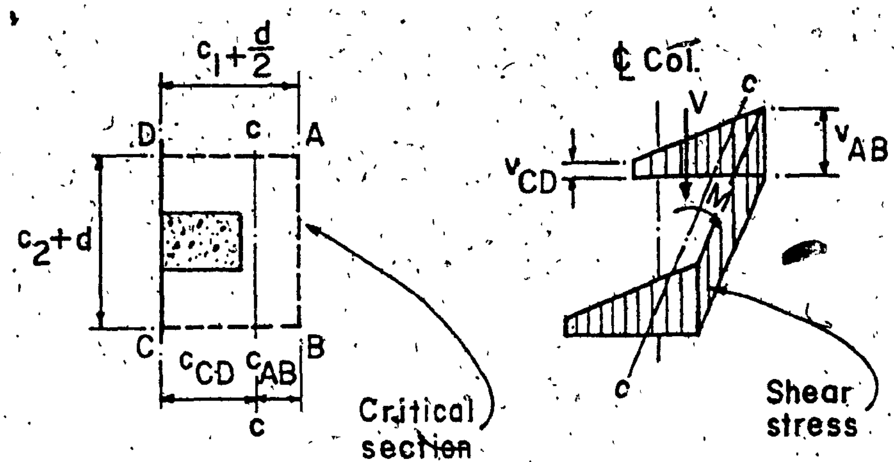
At the top and bottom of the building the lateral load moments should be used as direct input.

The programme consists of three main line programmes, fourteen sub-routines, and three function sub-programmes.

The operations performed by the components are in general as follows:



a) INTERIOR COLUMN



b) EDGE COLUMN

Fig. 11 Assumed distribution of shear stress

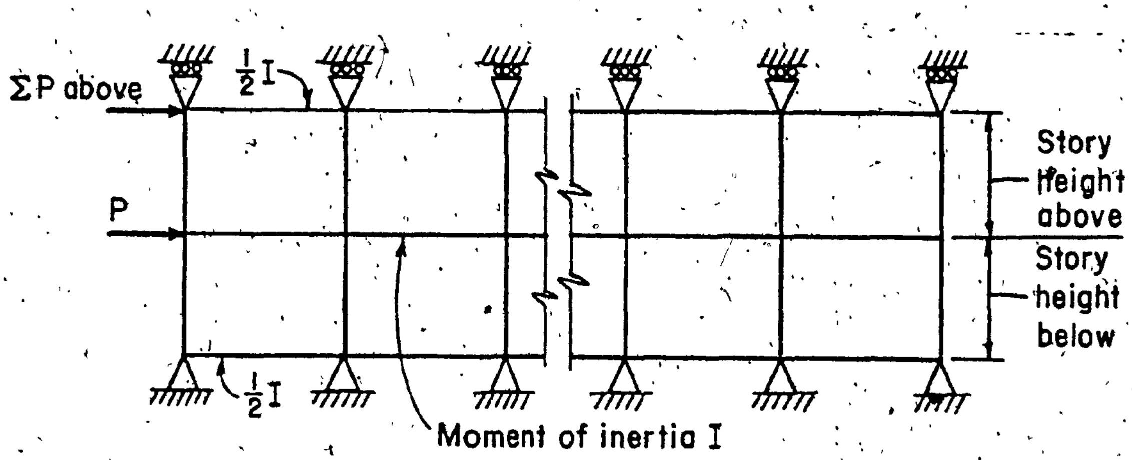


Fig. 12 Idealised structure for wind load analysis

PLAT 1 reads input data, sorts data and prints out echo of data.

PLAT 2 determines stiffnesses, carryovers, and fixed end moments.

PLAT 3 determines loading to be used in each loading pattern, uses sub-routine SALAD to determine end moments in slabs and columns, and computes end shears for all cases.

PLAT 4 determines reactions, shears, unit shears, and outputs results and optional table of statics.

PLAT 5 determines negative moment, points of contra-flexure, area of top reinforcing required for column and middle strips, and outputs results.

PLAT 6 determines positive moment, points of contra-flexure, and area of bottom reinforcing required for column and middle bands and outputs results.

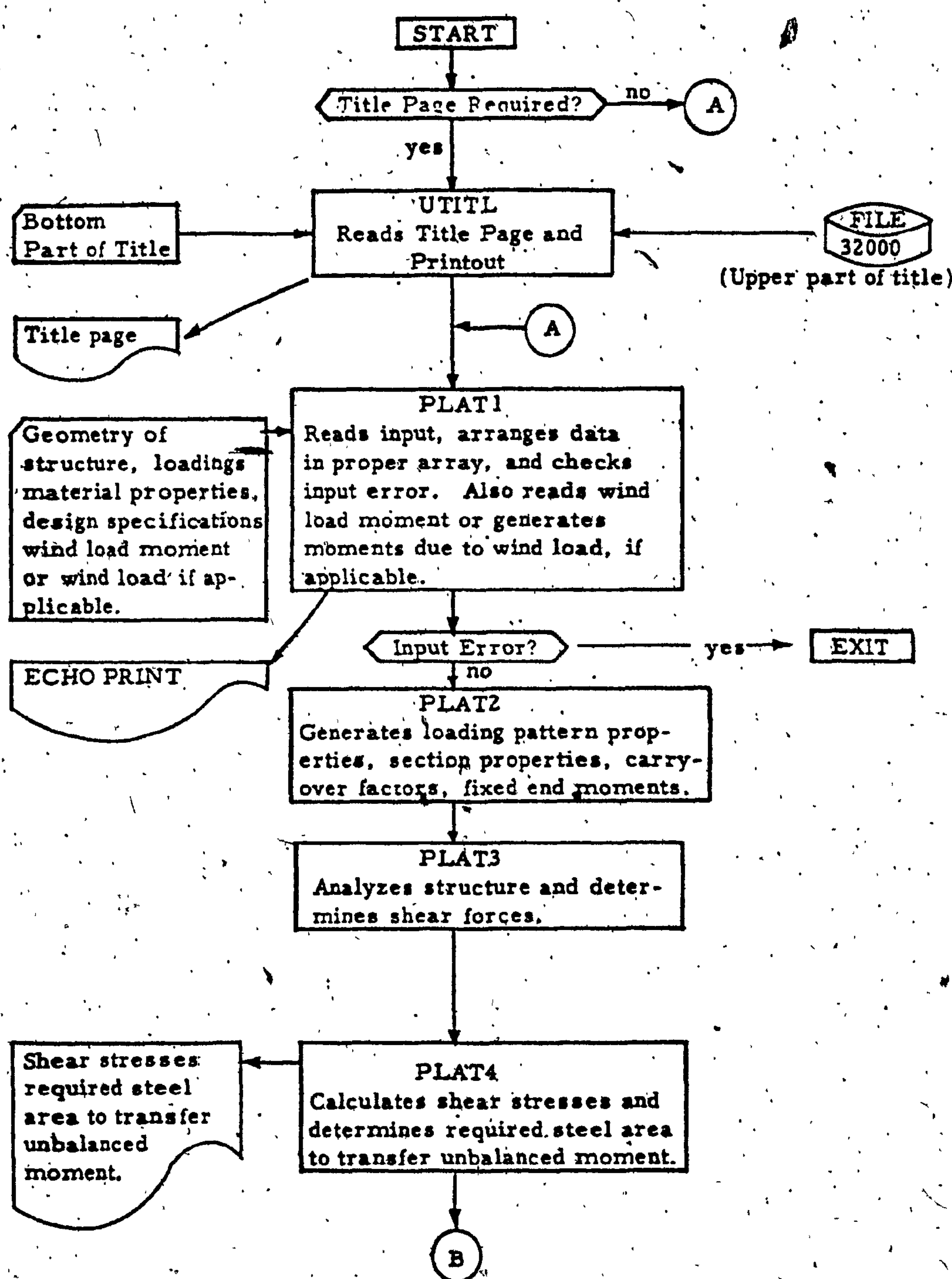
PLAT 7 details reinforcing steel over columns.

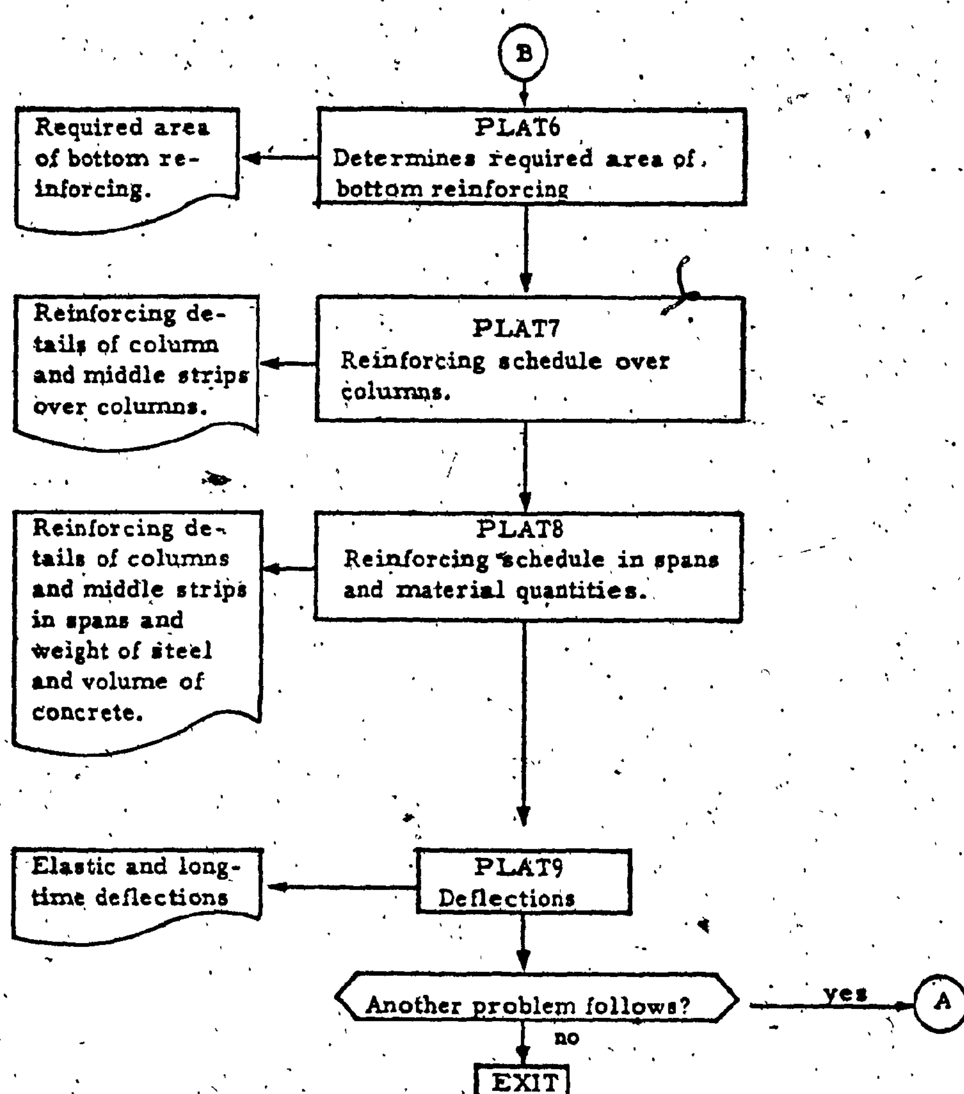
PLAT 8 details bottom reinforcing, calculates weight of reinforcing and volume of concrete.

PLAT 9 computes deflections, checks against code requirements.

A flow chart for the programme is shown in Figure 13, which also indicates data interfaces.

Fig. 13 Flow chart of the flat plate programme




B
PLAT6
Determines required area of bottom reinforcing
Required area of bottom reinforcing.
PLAT7
Reinforcing schedule over columns.
Reinforcing details of column and middle strips over columns.
PLAT8
Reinforcing schedule in spans and material quantities.
Reinforcing details of columns and middle strips in spans and weight of steel and volume of concrete.
PLAT9
Deflections
Elastic and long-time deflections
Another problem follows?
yes
A
no
EXIT

3.2 LATERAL LOAD ANALYSIS OF MULTI-STOREY FRAMES WITH SHEAR WALLS

Programme Description (2)

This programme performs a static analysis to obtain member end forces and joint displacements of a linear, elastic, rigid jointed frame, or several frames linked together, subjected to gravity and/or lateral loads. Equal lateral deflections, imposed by the assumption of rigid floors, is modeled by using hinged rigid links to tie the frames together; see Figure 14. Fictitious members with negligible stiffness can be used to accommodate irregular frames.

The programme can analyse a structure with a maximum of three linked frames, each having a maximum of sixty storeys and ten column lines. The loads may consist of vertical loads, uniformly loaded, and one concentrated load on each beam span combined with concentrated lateral loads at the floor levels.

The following options are included in the programme:

1) Finite widths of members can be considered, particularly useful when frames inter-connected with shear walls are being considered.
2) The effect of shear deformation in columns can be considered. This may be desirable for the analysis of shear walls.

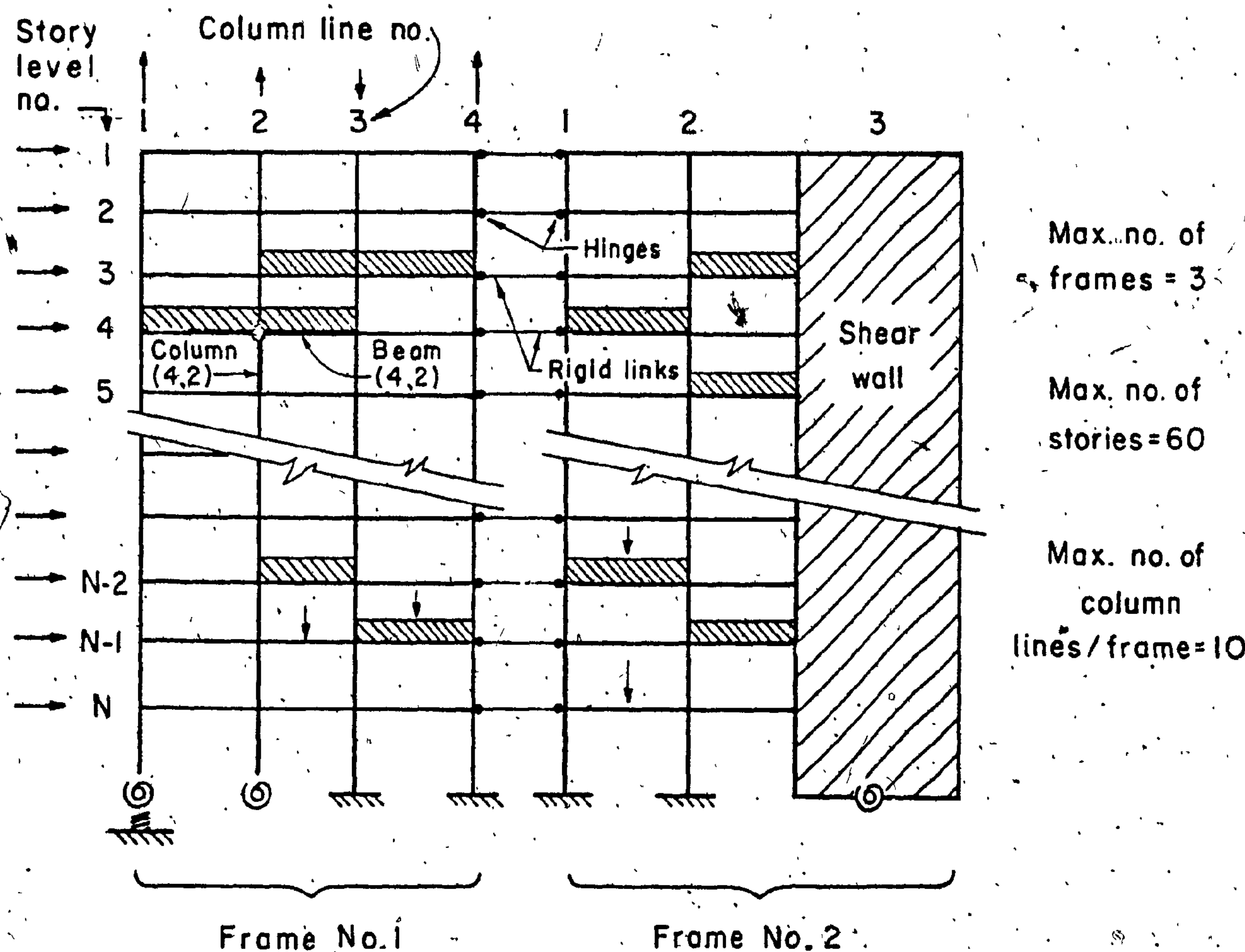


Fig. 14 Typical linked frames

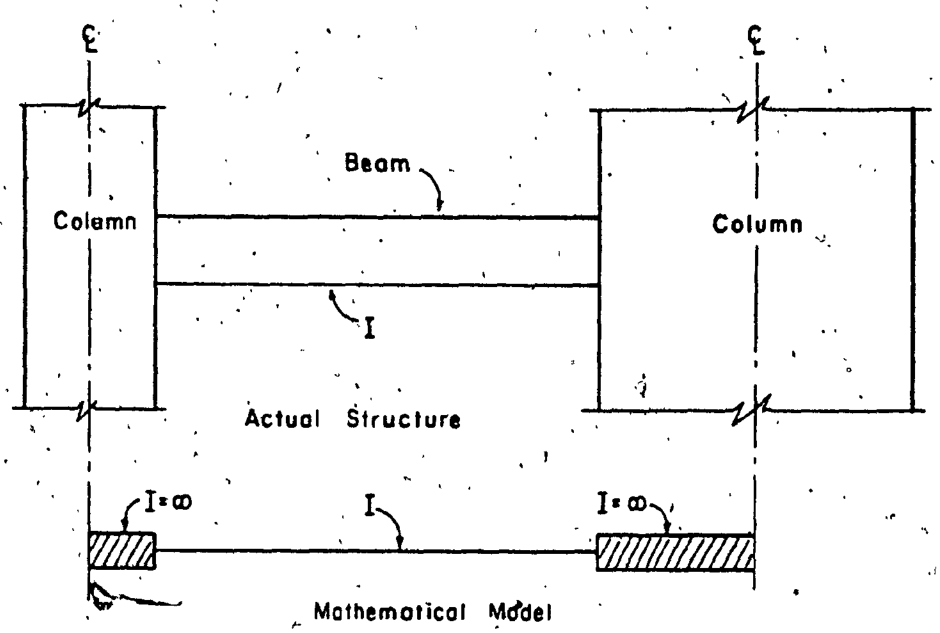


Fig. 15 Effect of finite width of members

3) Partial fixity factors with respect to rotation and vertical displacement can be specified for the bases of the lowest storey columns. Settling of bases can be handled using this option.

4) Concentrated vertical loads, moments, and a single concentrated horizontal load applied to the top storey joints can be specified. This option may be used when a structure is segmented.

3.2.1 PROGRAMME LIMITATIONS AND ASSUMPTIONS

a) The frame to be analysed must be rectangular, i.e., the columns are vertical and the beams horizontal.

b) Maximum number of frames = 3.

c) Maximum number of storey levels = 60.

d) Maximum number of column lines per frame = 10.

e) Axial deformation in the beams is neglected, i.e., the beams are assumed to be infinitely stiff with respect to axial deformation. Axial deformation in columns is considered.

f) The frame members are assumed to be of uniform cross-section throughout their entire length, i.e., for a column in a storey level or a beam between two adjacent columns.

g) The effect of the finite width of members is considered by assuming the segments from the face of the member to its centre line as having infinite flexural stiffness (see Figure 15).

h) The types of loads in the plane of the frame are limited to uniformly distributed vertical loads on entire span of beams, one concentrated vertical load per beam span and concentrated lateral loads at the floor levels.

3.2.2 THE METHOD OF SOLUTION

Irrespective of the procedures employed, the determination of the interaction of shear walls and frames in a multi-storey building resolves to the task of making the lateral displacements of the frame or frames and the shear walls compatible at each floor level. The structural analysis of large building frames constitutes an important field of application for digital computers because of the large number of computations required to evaluate their complete stress and deflection distribution. To analyse such large structural systems efficiently it is necessary to use special techniques to take advantage of the sparse nature of the stiffness matrices. The basic technique is to use the displacement method of structural analysis, arrange the stiffness matrix in the form of a tri-diagonal system of submatrices, and then obtain the solution by means of a recursion equation. This method has the advantage that manipulations (i.e. inversions, etc.) of matrices involve relatively small-sized matrices, the size being dependent on the number of column lines in each frame. The final lateral stiffness matrix is an N x N matrix, where N is the total number of storey levels.

Standard plane frame programmes are available that will determine the member forces and joint displacements in an arbitrary plane frame, given only the nodal point geometry, the member properties and the applied loads. However, the difficulty arises not from any deficiencies in the theory, but in the size of the computational problem. A typical plane frame analysis is generally limited by the storage capacity of the computer to the direct analysis of frames having fifty joints; this number of joints would lead to a stiffness matrix of 150th order, composed of 22,500 elements. On the other hand, a practical large scale building frame analysis programme should permit treatment of at least 1,000 joints, for example fifty storeys by twenty column lines. Thus the building analysis programme involves an entirely different order of magnitude in the volume of data to be considered, and hence the development of new methods of solution to take advantage of the special characteristics of the rectangular plane frame.

The large size of the typical building frame analysis problem causes two distinct types of difficulties: First, the definition of the problem requires the specification of a tremendous volume of data; and second, the simultaneous equation system is large and its solution is a major computational task. Fortunately, the regular nature of the rectangular building frame makes possible great simplifications of both these problems.

Because the reduction of the frame stiffness matrix involves the inversion of relatively small matrices, the round-off errors that characterise the direct solution of large systems of equations is avoided. A reasonable solution time as well as good accuracy is obtained as a result. The programme lists if desired the unbalanced forces at each joint and storey level, which is a measure of the accuracy obtained for a particular problem. The values of the unbalanced forces must be close to zero to satisfy the equilibrium check.

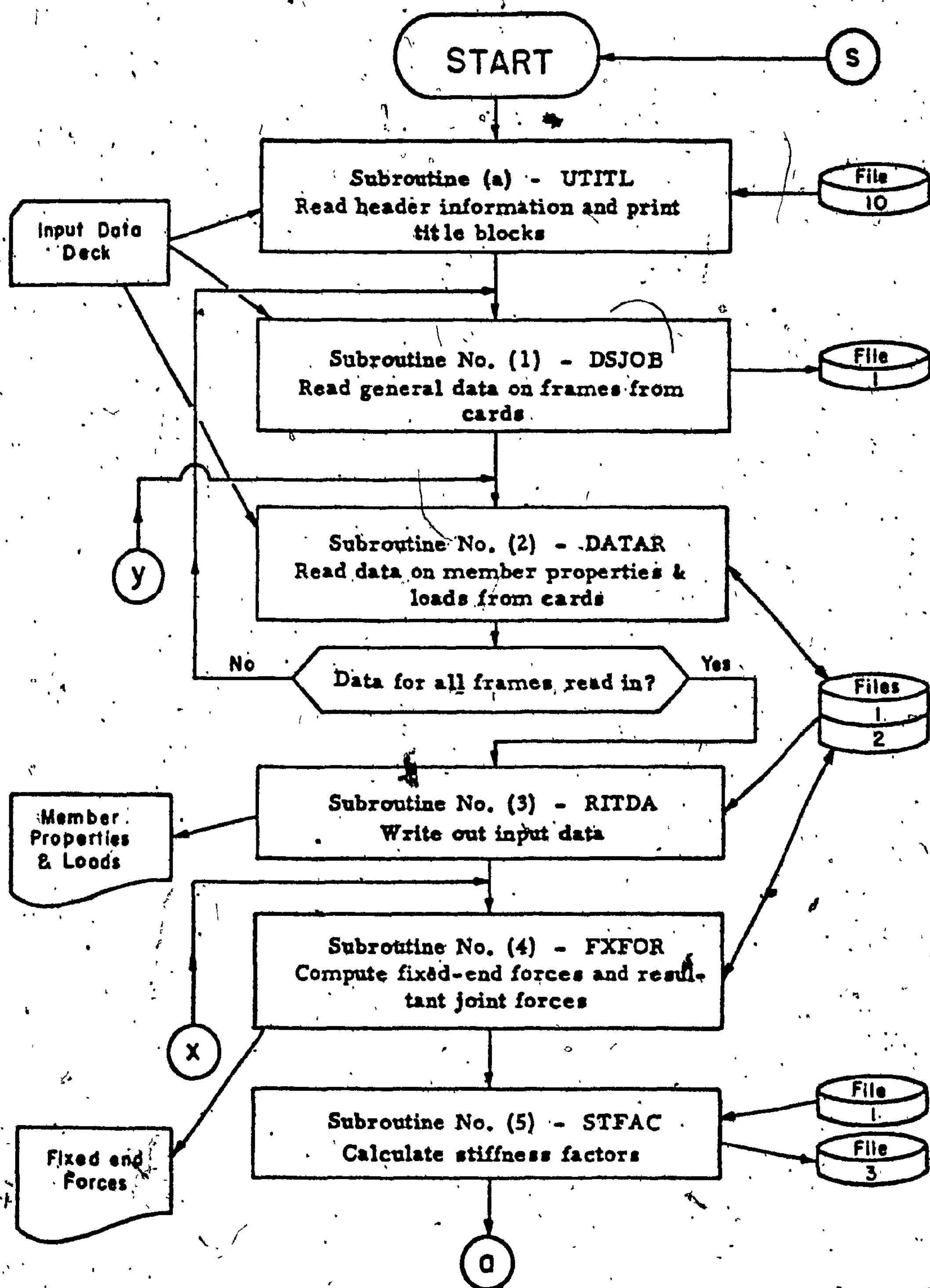
The flow chart of the frame programme is shown in Figure 16.

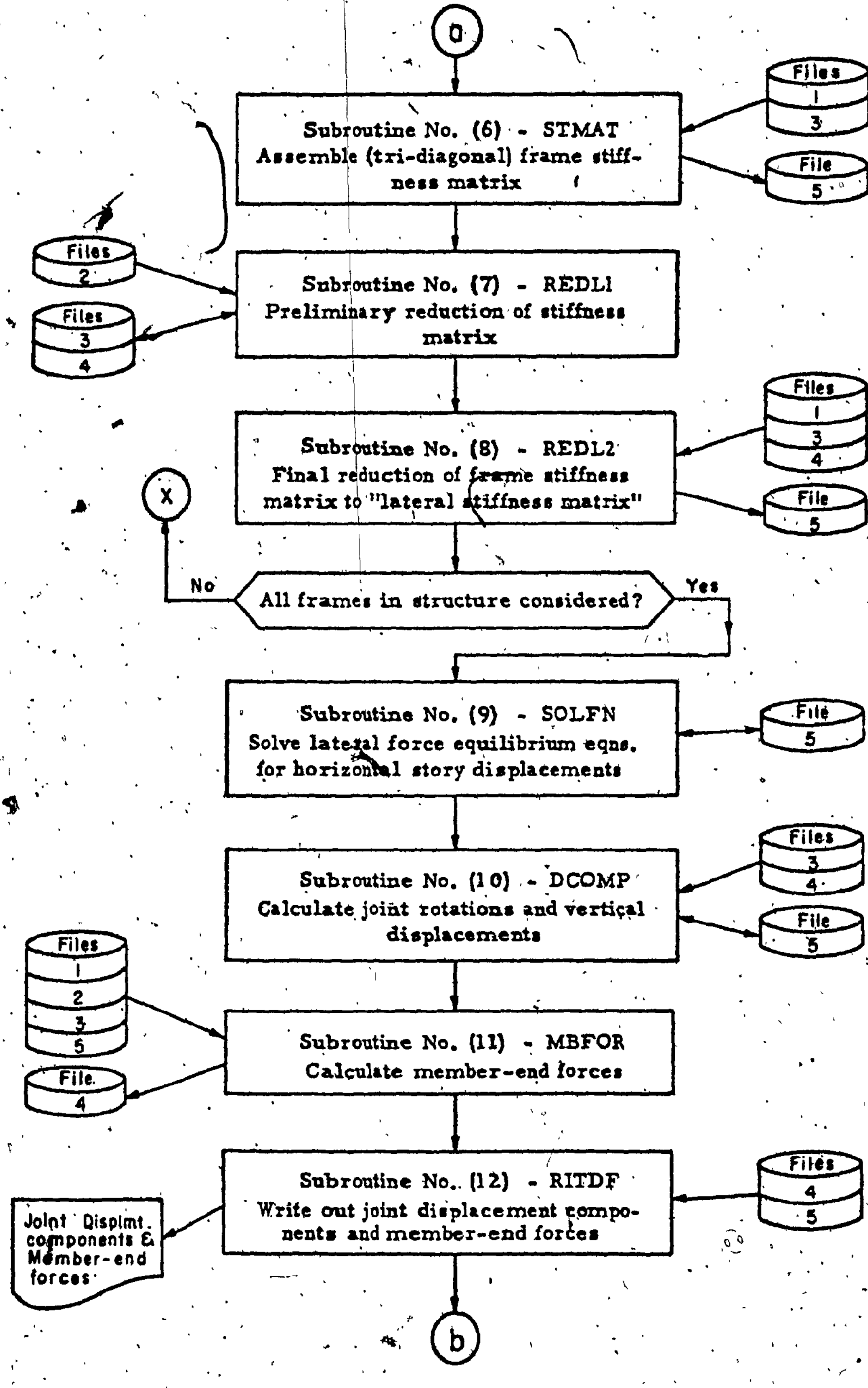
The method of analysis used in the P.C.A. Program STMFR-60, for the analysis of multi-storey frames, the formulation and method of solution of the equilibrium equations is discussed in detail in reference (7).

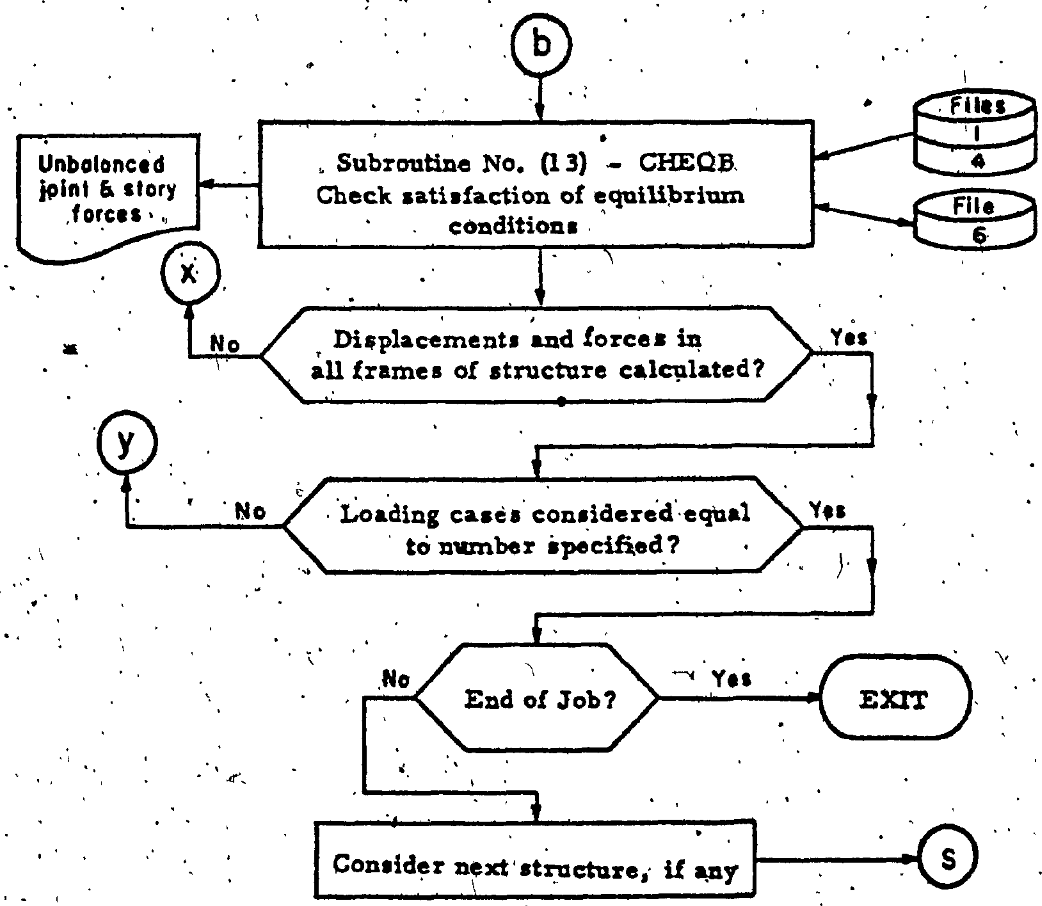
3.2.3. DESCRIPTION OF OUTPUT

The output consists of tabulations of the following pricipal items:

Fig. 16 Flow chart for frame-shear wall programme




a
Files
1
3
Subroutine No. (6) - STMAT
Assemble (tri-diagonal) frame stiffness matrix
File
5
Files
2
Subroutine No. (7) - REDL1
Preliminary reduction of stiffness matrix
Files
3
4
Files
1
3
4
Subroutine No. (8) - REDL2
Final reduction of frame stiffness matrix to "lateral stiffness matrix"
File
5
X
No
All frames in structure considered?
Yes
Subroutine No. (9) - SOLFN
Solve lateral force equilibrium eqns. for horizontal story displacements
File
5
Files
3
4
Subroutine No. (10) - DCOMP
Calculate joint rotations and vertical displacements
File
5
Files
1
2
3
5
Subroutine No. (11) - MBFOR
Calculate member-end forces
File.
4
Files
4
5
Subroutine No. (12) - RITDF
Write out joint displacement components and member-end forces
Joint Displmt. components & Member-end forces
b


b
Subroutine No. (13) - CHEQB
Check satisfaction of equilibrium conditions
Unbalanced joint & story forces
Files
1
4
File
6
x
No
Displacements and forces in all frames of structure calculated?
Yes
y
No
Loading cases considered equal to number specified?
Yes
No
End of Job?
Yes
EXIT
Consider next structure, if any
S

a) Frame dimensions and member properties

b) Applied loads

c) Fixed end forces and resultant joint forces

d) Lateral displacement or "drift"

e) Joint displacement components

f) Member-end forces (i.e., moments, shears and axial forces in columns)

g) Unbalanced joint forces and storey shears.

The output can be controlled and any of the above items in the output may be suppressed.

Sign Convention

The sigh conventions used for the principal output items are explained at the beginning of the listing for each item:

a) Sign convention for joint displacement components:

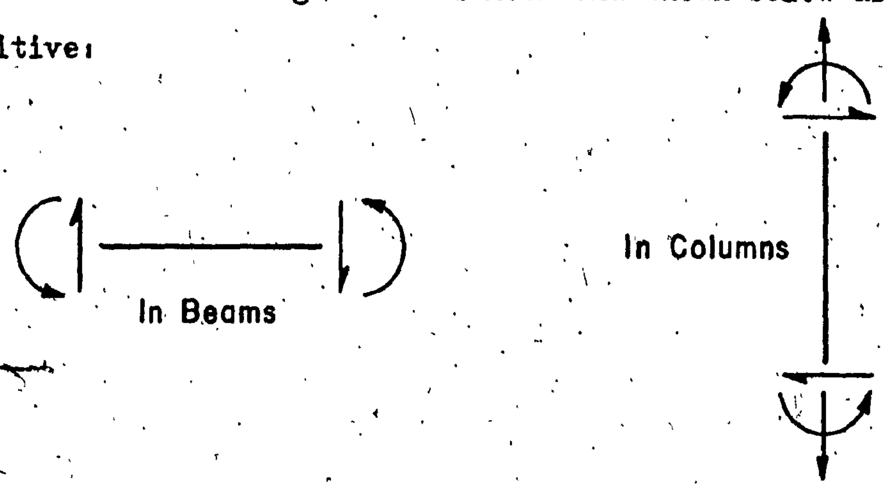
Horizontal component, u - positive when directed to right

Vertical component, v - positive when directed upward

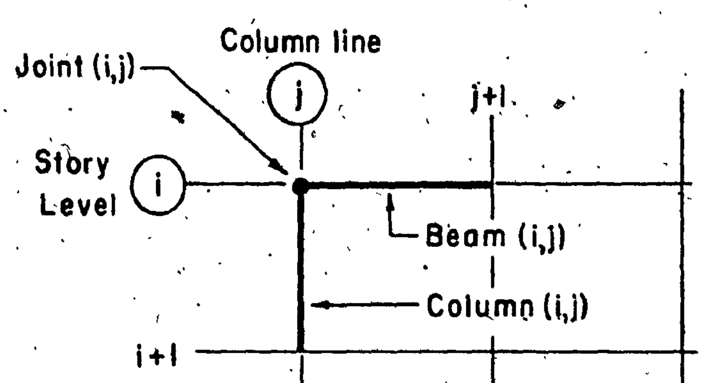
Rotation, ω - positive when directed clockwise

b) Sign convention for member-end forces:

All the forces acting on the member-end shown below are positive:



A column is identified by the pair of indices (i,j) denoting "Storey Level" number, and "Column Line" number respectively, attached to the joint at its upper end, while a beam is identified by the indices describing the joint at its left end.



CHAPTER 4

ANALYSIS OF EXISTING STRUCTURE

4.1 DESCRIPTION OF BUILDING

The building analysed is located in the city of Montreal. The dimensions of the building together with a cross-section showing the main structural details are shown in figures 17 and 18. The building is orientated so that its longest axis runs east-west, in the north-south direction there are seven bays and in the east-west direction thirteen bays on a 24'-0 grid. The building is ten storeys high with a mechanical penthouse on the roof and a full basement. The storey heights are 13'-6 from the ground to second floor and 12'-6 from the second floor to the roof. A ten inch wall extends from the ground floor to the foundations to enclose the basement.

The structural framework consists of a combined system of a frame and shear walls, both constructed in reinforced concrete. The frames consist of a flat plate (the slab is 8" thick with drop panels 8'-0 x 8'-0 x 12" thick around the columns) and columns (interior columns are 24" x 24" and the exterior columns are 20" x 20"). There are no perimeter beams. As shown in figure 17 the shear walls consist of the shafts for the elevators and stairs. The walls of all the shafts are 8" thick and are reinforced to resist the moments and shears produced by the lateral loads.

The shear walls are grouped close to the centre of the building and because of the large number of frames it is not considered necessary to include an analysis for torsion. Based on the cross-sectional areas of the concrete sections, the ratio of the sum of moments of inertia of the shear walls to that of the sum of the individual columns is of the order of 50/1 in the N-S direction.

The flat plate floor can be considered as a system of connecting members between the columns in two directions, hence the number of horizontal members is 2000, vertical members 1080 and number of joints 1188. The cost of analysing this structure as a three- dimensional space frame would be prohibitive therefore the advantage of using a specialised programme becomes apparent.

The slab concrete strength is 3,000 p.s.i. at 28 days and the concrete in the columns and shear walls from 5,000 p.s.i. at the ground floor to 3,000 p.s.i. at the roof. The reinforcing yield stress is 60,000 p.s.i. for all structural elements.

The column and shear wall foundations are bearing on rock, therefore differential settlement could be ignored. The conditon at the ground floor will be considered as "fixed", as it can be assumed that the basement perimeter walls are very still and the vertical elements are not free to displace horizontally due to the in-plane rigidity of the ground floor.

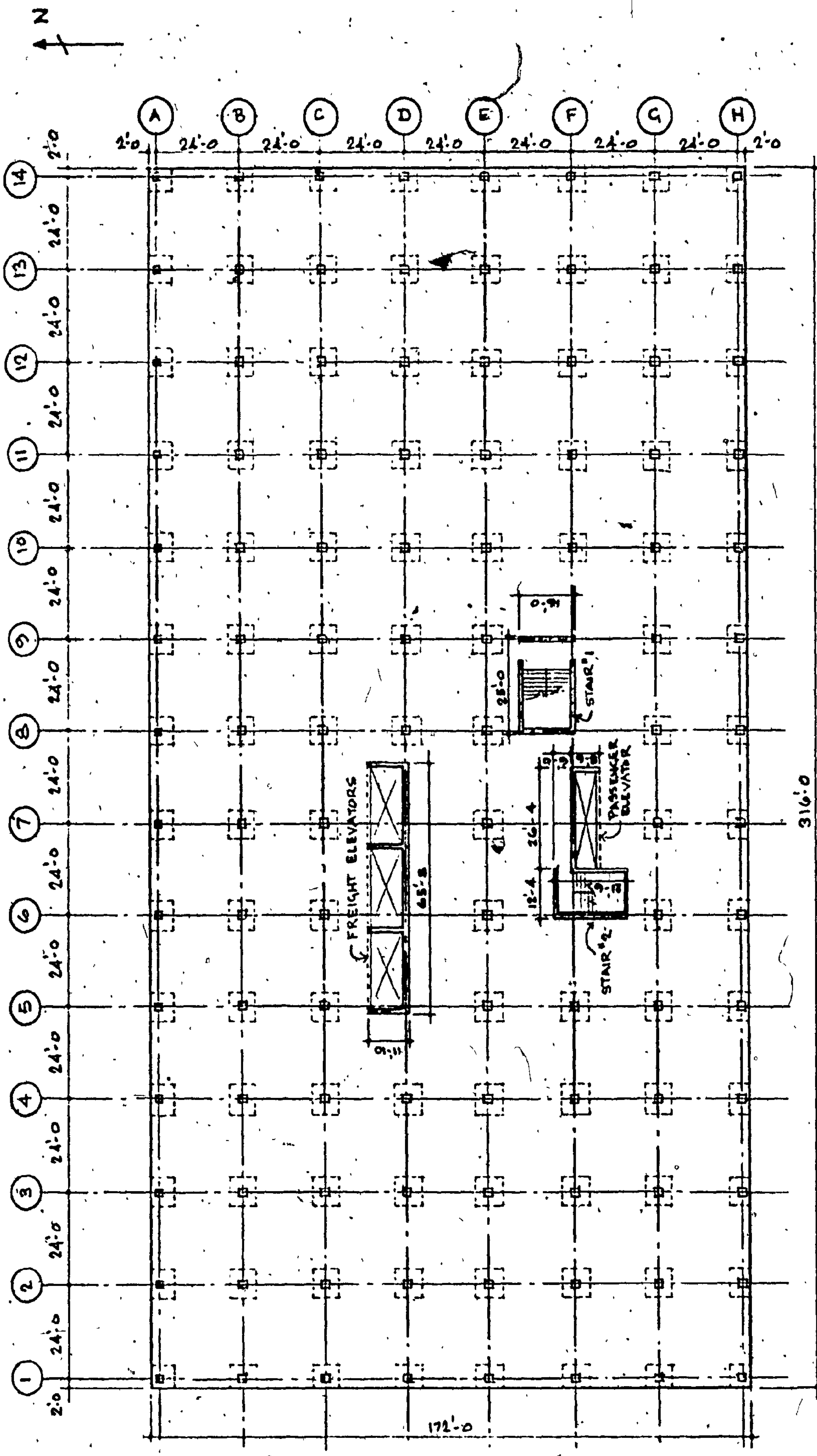


Fig. 17 Typical floor plan

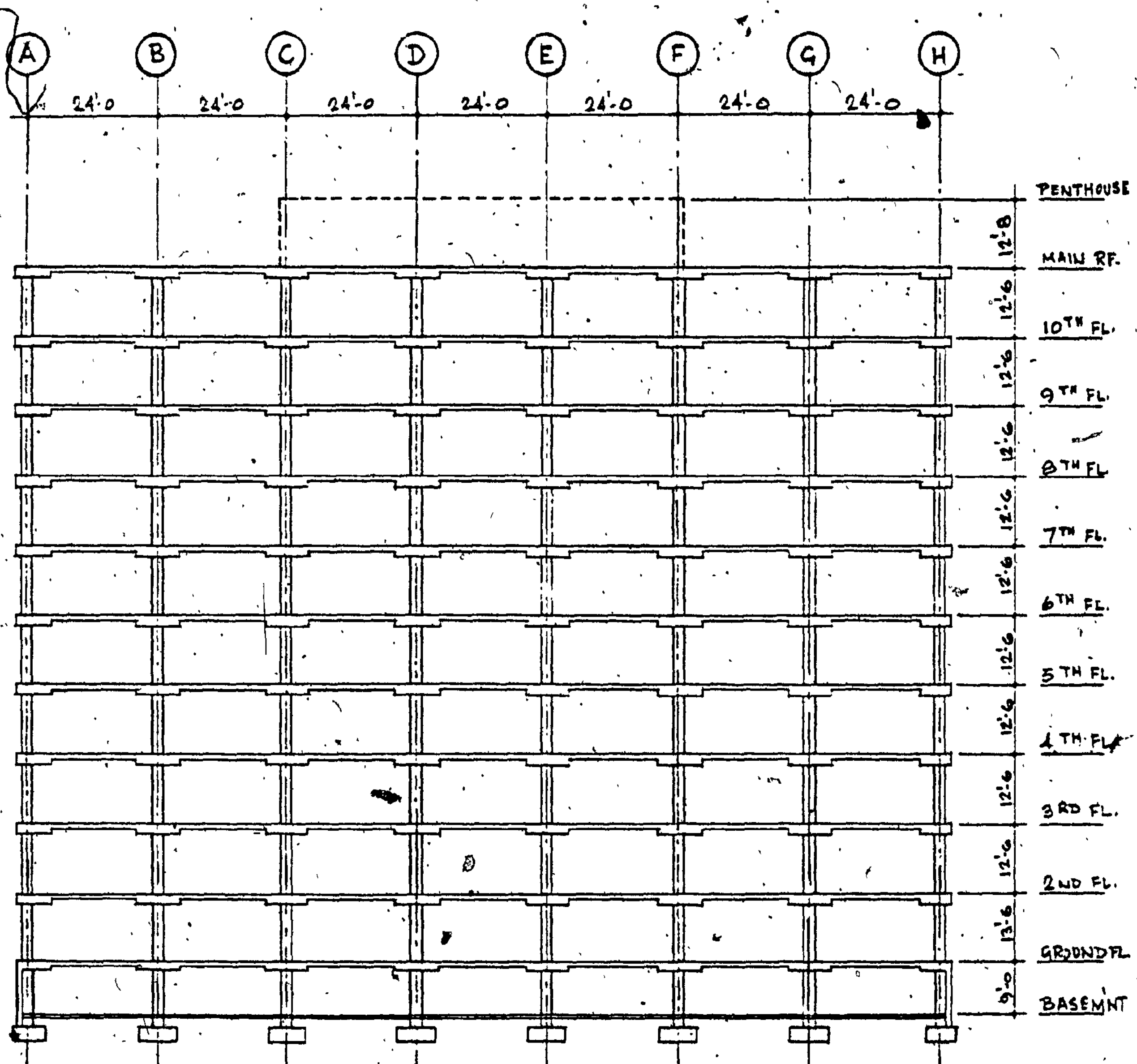


Fig. 18 Typical cross-section

4.2 DESIGN LOADS

The floor live load was 125.0 p.s.f. for light industrial occupancy. The lateral load analysis was carried out using the National Building Code of Canada (1970) and the earthquake lateral loads governed in each direction.

The earthquake loads were calculated using the static analysis factors as follows:

R = 2.0 - Seismic regionalisation factor

K = 1.0 - Numerical coefficient that reflects type of construction

I = 1.0 - Importance factor

F = 1.0 - Foundation factor

LEVEL	FORCE (KIPS)
Main Roof	465.8
10th Floor	352.0
9th "	313.9
8th "	275.7
7th "	236.4
6th "	197.8
5th "	158.9
4th "	119.4
3rd "	79.9
2nd "	40.4

4.3 INPUT DATA FOR PROGRAMMES

The structure was idealised as three frames for input into the programme. The first (Frame #1) consisted of a combination of all the columns and slabs, lines 1 to

5 and 10 to 14; this is the portion of the structure that does not include a shear wall. The second frame (Frame #2) consisted of the stair and elevator shafts and columns on lines 6 and 7, and the third frame (Frame #3) consisted of the stair shaft and columns on lines 8 and 9.

The frame-shear wall interaction programme does not have the capacity to incorporate members having a variable moment of inertia, hence the additional joint stiffness due to the drop panels cannot be included. The input data for the frame-shear wall programme includes the dimensions and properties of the members and the dimensions of storey heights and bay widths. The lateral forces due to earthquake, described in section 4.2 are the only input loads for the frame-shear wall interaction programme. The moments in the slabs, due to the lateral loads, are obtained from the frame-shear wall interaction programme and are then used as part of the input data for the flat plate programme. The remainder of the input consists of the floor live load and the physical properties of the members and steel and concrete strengths. The flat plate programme combines the dead, live and earthquake loads and applies the necessary factors to obtain the ultimate moments and shears in the slabs and columns at one floor level.

The earthquake analysis was only considered in the N-S direction for the purposes of this report.

CHAPTER 5

DISCUSSION OF RESULTS AND CONCLUSION

CHAPTER 5

DISCUSSION OF RESULTS AND CONCLUSION

The moments and shears in the slabs and columns of one typical frame are shown in Figures 19 and 20; the maximum values occur at the sixth floor and these values are used to analyse the floor slab. The maximum moment in the slab is 48.6 kip-ft (65.6 kip-ft ultimate) which is combined with 460.5 kip-ft, the ultimate moment due to dead and live loads, in the flat plate programme. The results from the flat plate programme (Figures 21(a) and 21(b)) show that the design moments due to dead and live loads are almost the same as the combined dead + live + earthquake loads in this example. The weight of reinforcing steel is 1.475 pounds per square foot for dead + live loads, compared to 1.478 pounds per square foot for dead + live + earthquake loads; this is an insignificant increase.

The effects of the lateral loads on the frame columns are shown in Figure 20, and the maximum axial force is 34.4 kips on the exterior columns at the ground floor. The additional axial load on the column is not great compared to the combined dead and live load of 840.0 kips and can be carried by the column without modifying the reinforcing steel.

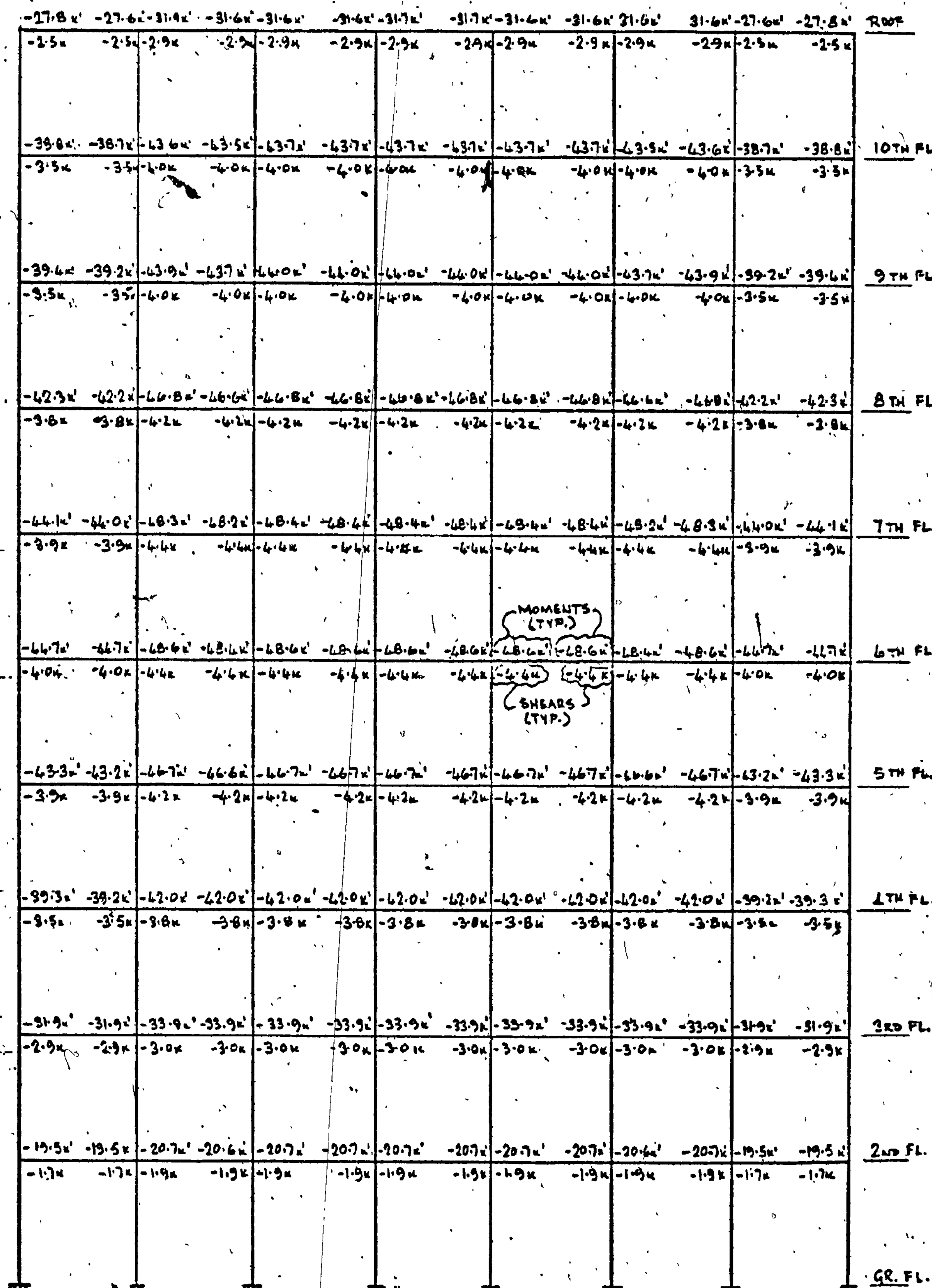
An important aspect to be considered in the analysis of the columns is the definition of a "braced" as opposed to an unbraced frame. The A.C.I. code defines a braced column as a member in a storey in which the bracing elements have a total stiffness resisting lateral movement at least six times the sum of the stiffnesses of all columns resisting lateral movement. For the building considered in this report the shear walls are more than six times stiffer than the columns, therefore the frame is braced and the slenderness factor is not significant, but the slenderness of the columns must be carefully checked in all buildings where the columns are part of the lateral load resisting frame.

The results show that the moments and shears in the shear walls are reduced considerably by including the frame in the analysis. The moment at the ground floor in the freight elevator shaft, for example, (Figures 22 and 23) is reduced from 24,739.3 kip-ft to 13,733.7 kip-ft, a reduction of 45% and hence a reduction in the quantity of reinforcing steel required for bending. The shear (Figures 24 and 25) taken by the walls above the first storey is reduced by including the frame. In the first storey the shear is higher for the combined frame and shear wall by approximately 20%, this increase in shear is not significant as the shear capacity of the walls can easily be modified by increasing the concrete strength.

The most significant aspect of the frame programme results in the non uniform distribution of the shear forces and bending moments between the shear walls and the frame. The percentage of shears and moments taken by the frames increases with height, as seen in Figures 23 and 24, as opposed to the original design which assumed a fixed percentage of the total shear assigned to the elements at each floor. The frame programme results show the percentage of the total shear taken by the frames varies from 6% at the base to 57% at the tenth floor, while at the roof level the frame induces forces in the walls which cause reverse bending in the walls as shown in Figure 1(c). These results demonstrate that the frame action becomes dominant in the upper floors.

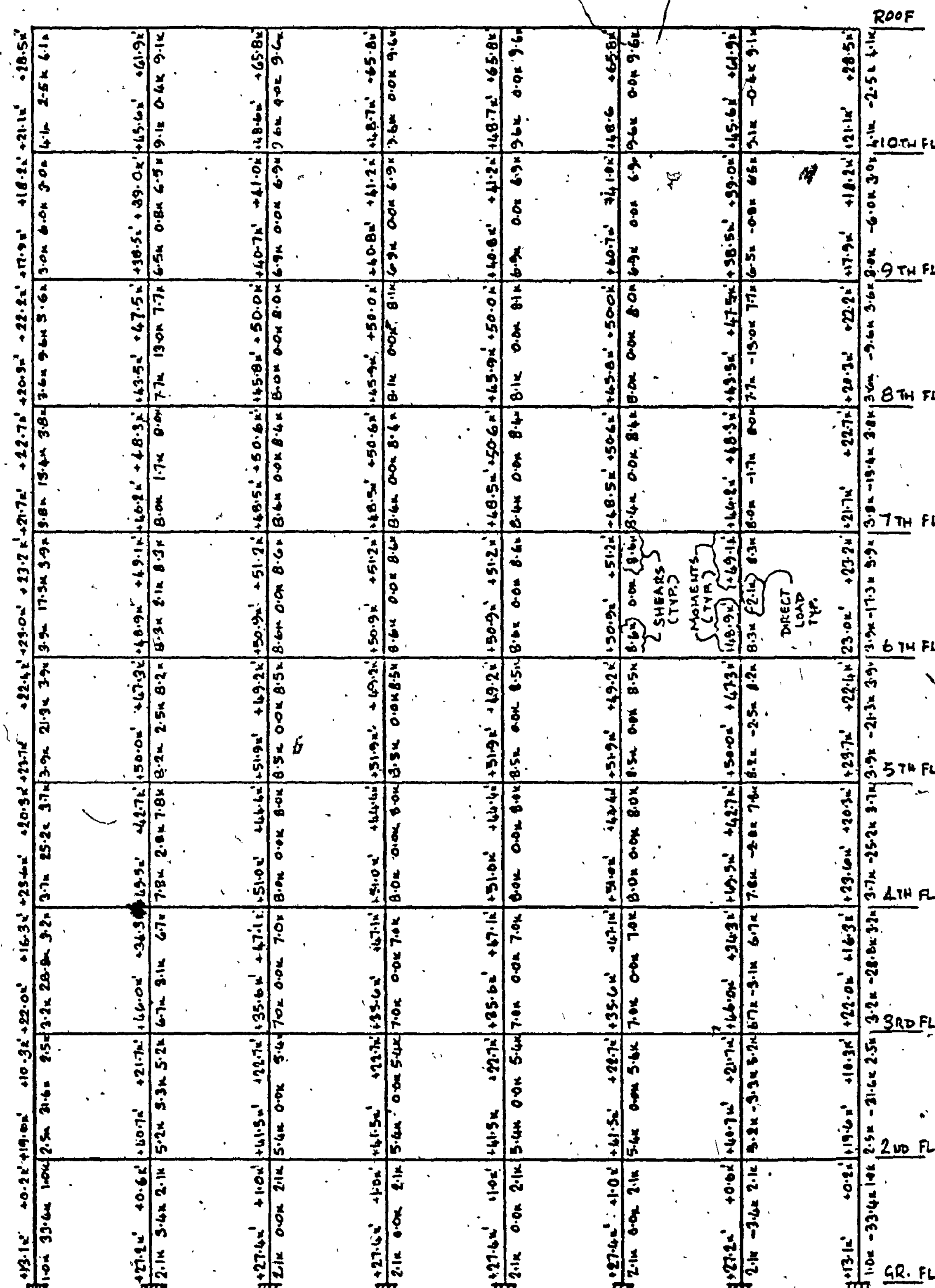
The results from the frame and flat plate programmes clearly show the economies possible by considering the frame interacting with the shear walls. It would be impractical to calculate the interaction forces by manual methods because of the large number of joints to be considered.

This report has demonstrated that the frame action should be considered in buildings to resist lateral loads in order to take advantage of the inherent strength of the joints in reinforced concrete construction.



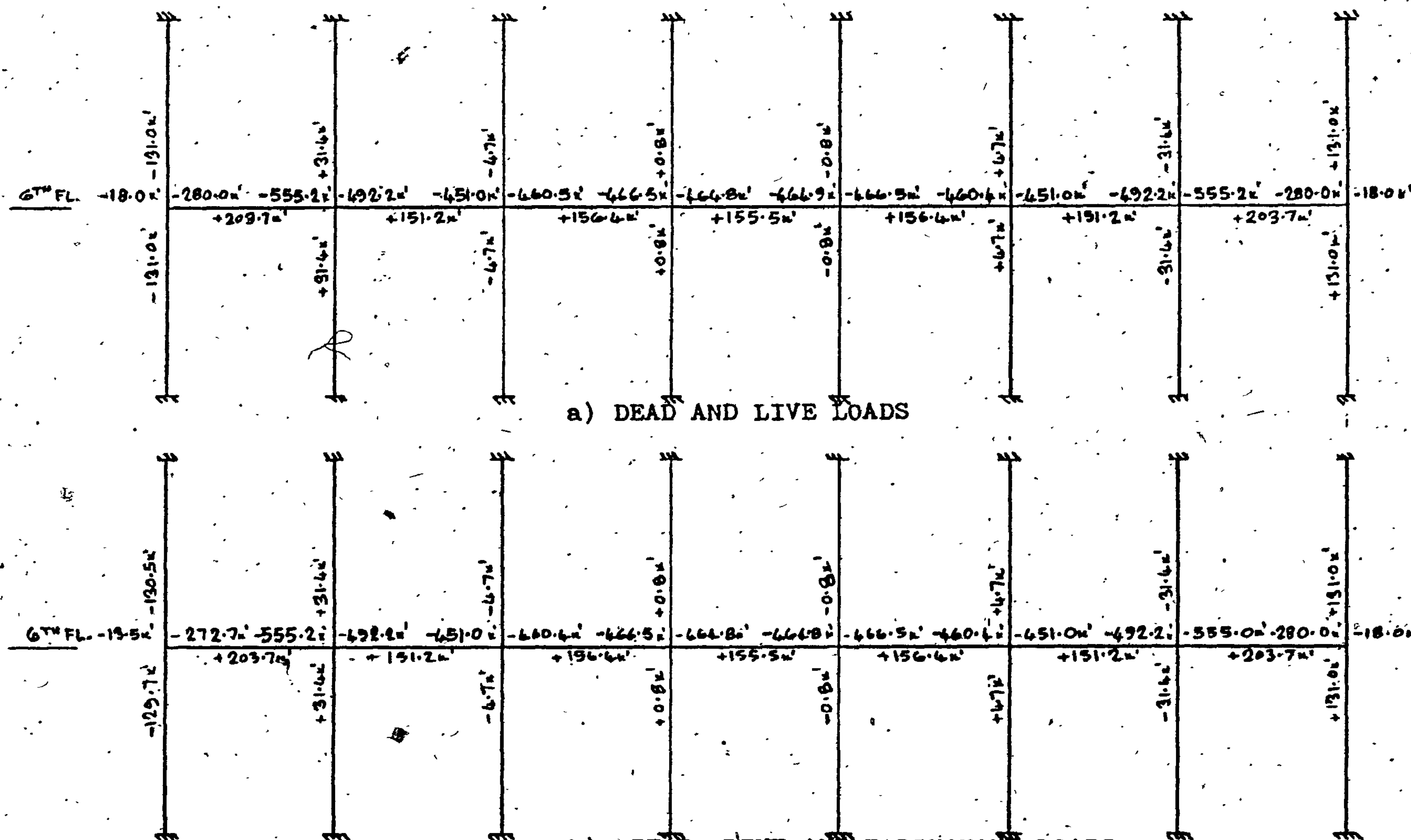
Frame #1 (columns and slabs only) - Slab moments and shears per frame

Fig. 19



Frame #1 (columns and slabs only) - Column moments, shears and direct loads per frame

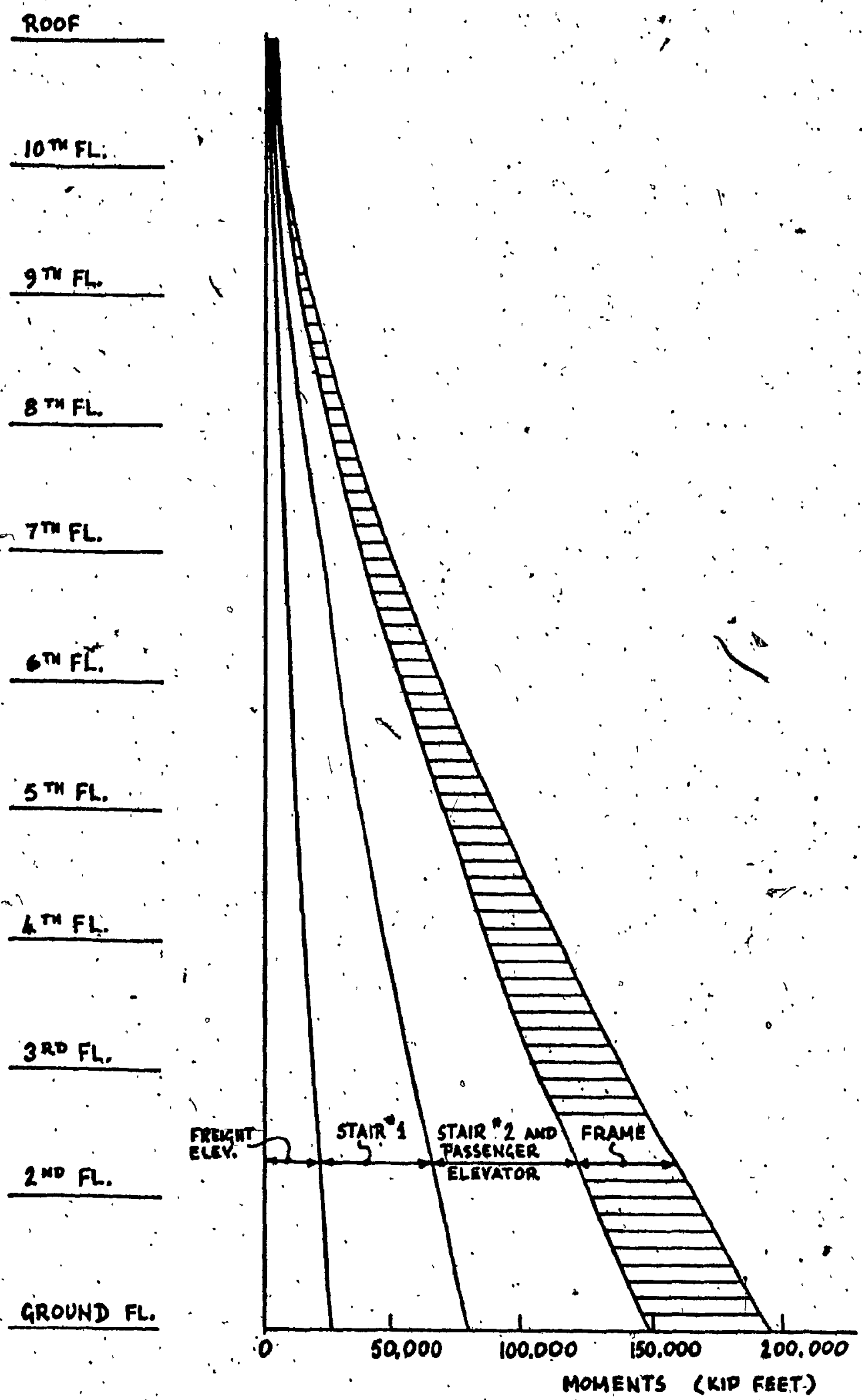
Fig. 20



a) DEAD AND LIVE LOADS

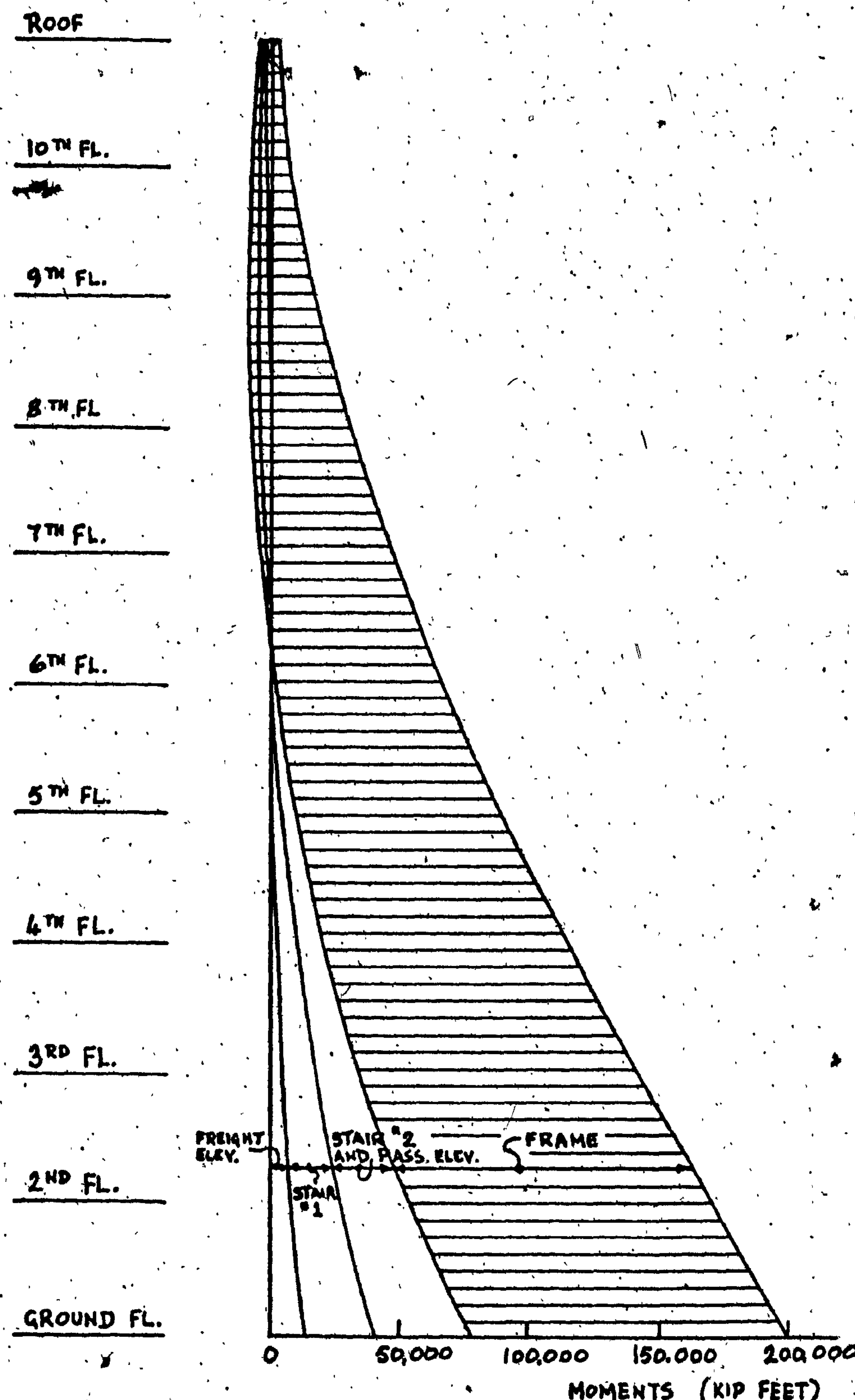
b) DEAD, LIVE AND EARTHQUAKE LOADS

Fig. 21 Ultimate moments in slabs and columns for 6th typical floor



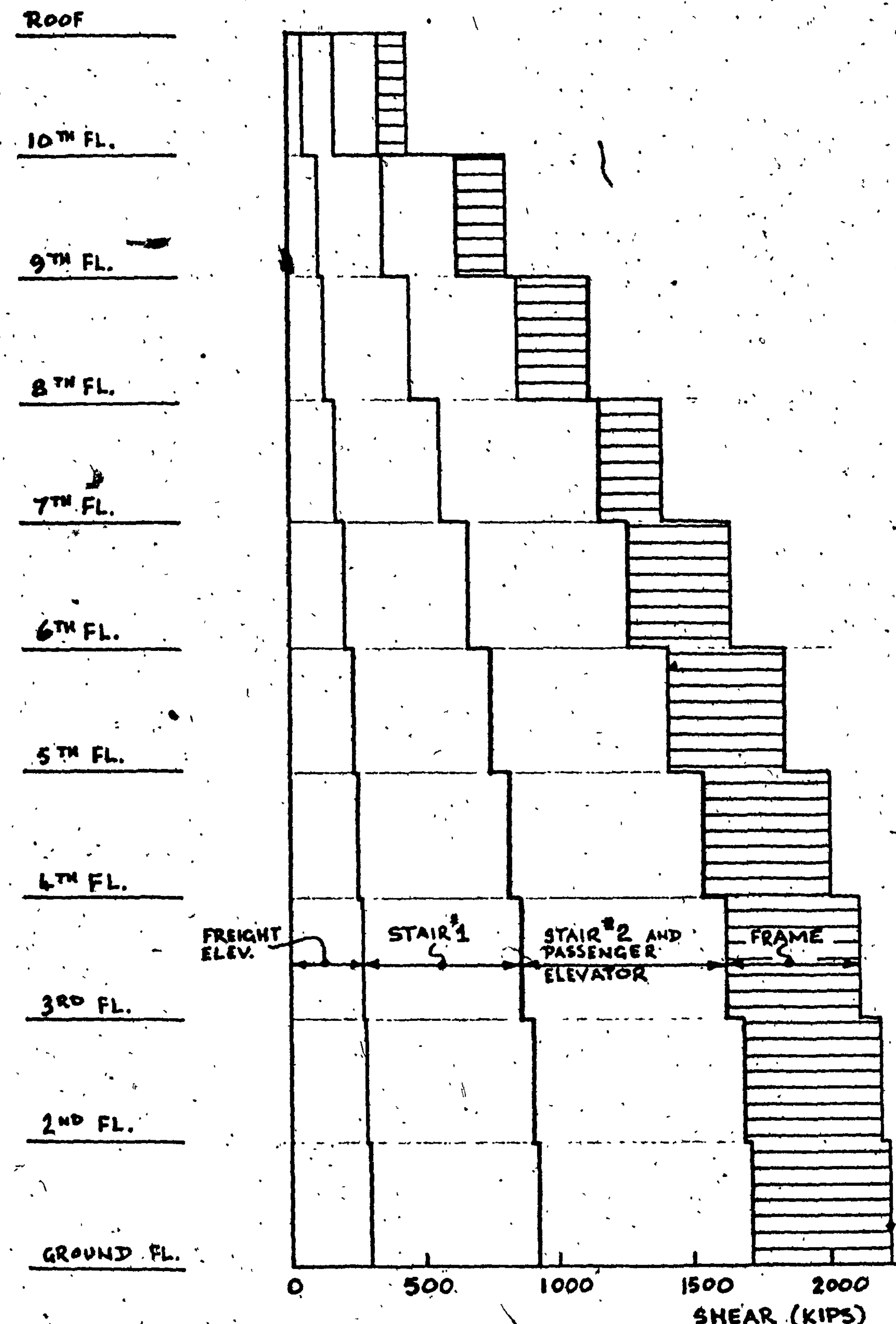
Moments in frame and shear walls with arbitrary distribution of 75% to shear walls and 25% to frame

Fig. 22



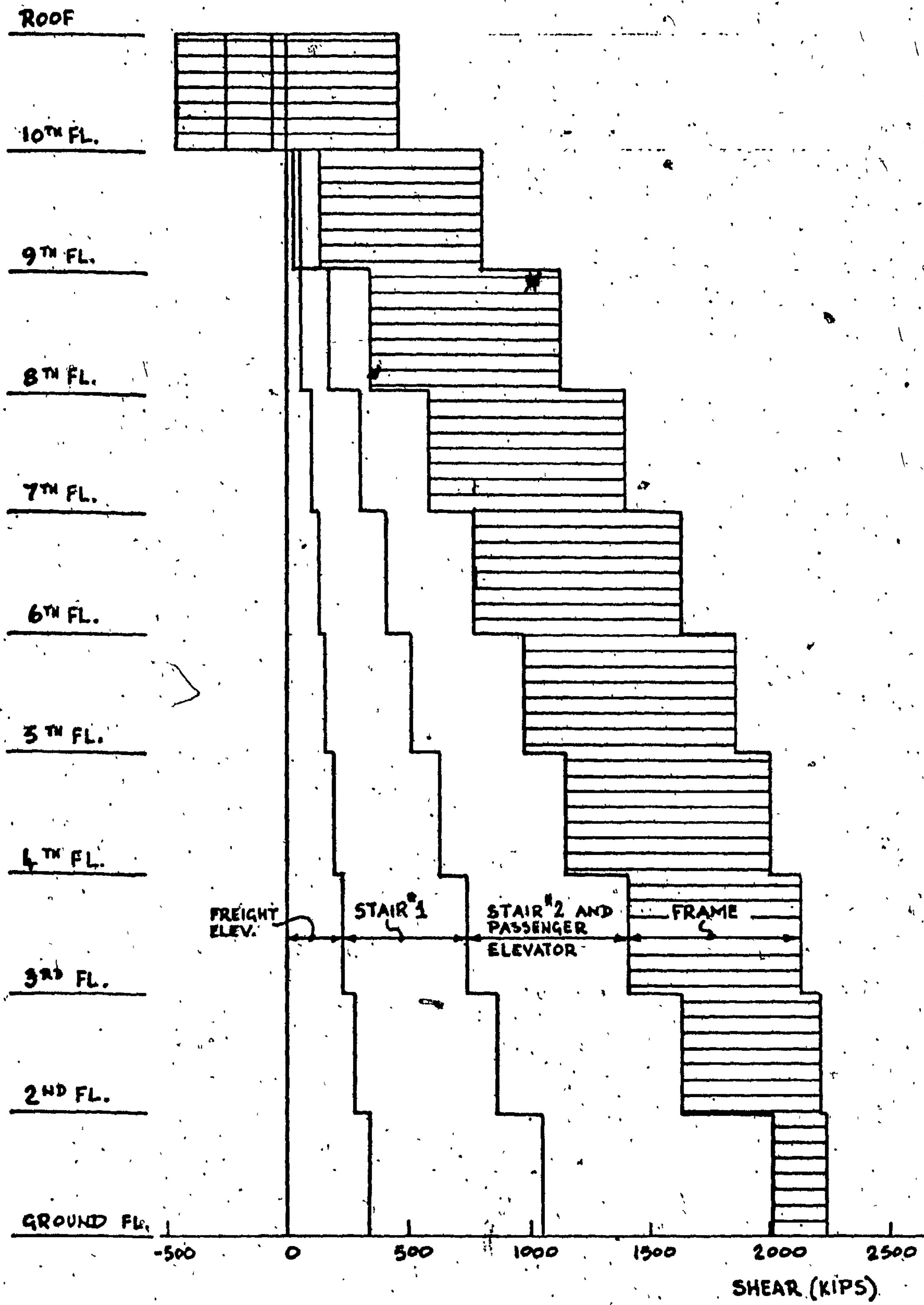
Distribution of moments in frame and shear walls from frame-shear wall programme.

Fig. 23



Shear in frame and shear walls with arbitrary distribution of 75% to shear walls and 25% to frame

Fig. 24



Distribution of shear in frame and shear walls from frame-shear wall programme

Fig. 25

REFERENCES

REFERENCES

(1) Lee, B., Analysis and Design of Flat Plates, Flat Slabs, Waffle Slabs and Continuous Frames, Portland Cement Association, (1972).

(2) Derecho, A.T., Analysis of Plane Multistorey Frame-Shear Wall Structures Under Lateral and Gravity Loads, Portland Cement Association, (1971).

(3) Derecho, A.T., "Frames and Frame-Shear Wall Systems: Response of Multistorey Concrete Structures to Lateral Loads", Publication SP-36, American Concrete Institute, (1973).

(4) Carpenter, J., Flexural Characteristics of Flat Plate Floors in Buildings, Purdue University Ph.D. thesis, (1965).

(5) MacLeod, I.A., Shear Wall-Frame Interaction, Portland Cement Association, (1971).

(6) Simmonds, S.H., and Misic, J., "Design Factors for the Equivalent Frame Method", American Concrete Institute Journal, (November, 1971).

(7) Clough, R.W., King, I.P., and Wilson, E.L., "Structural Analysis of Multi Storey Buildings", Journal of the Structural Division, ASCE, (June, 1964).

APPENDIX A

FRAME-SHEAR WALL COMPUTER PROGRAMME RESULTS

****** PORTLAND CEMENT ASSOCIATION PROGRAM (STPFR-74) ******

STATIC ELASTIC ANALYSIS OF RIGID-JOINTED PLANE RECTANGULAR FRAMES

STRUCTURE DESIGNATION -- TEN STORY FRAME   NO. OF FRAMES = 3   NO. OF STORY LEVELS = 10

NO. OF LOADING CASES = 1   MOD. OF ELASTICITY (KSI) = 3000.   TOTAL HEIGHT (FT) = 126.31

****** FRAME NO. (1) - FRAME DIMENSIONS AND MEMBER PROPERTIES - - - - NO. OF COL. LINES = 8

STORY LEVEL	COL. LINE	STORY HEIGHT (FT)	BAY WIDTH (FT)	BEAM DEPTH (IN)	BEAM MOM. OF INERTIA (IN-4)	COLUMN WIDTH (IN)	COLUMN AREA (IN-2)	COL. MOM. OF INERTIA (IN-4)	EFF. COL. SHR AREA FACTOR
*****	****	********	*******	*******	************	********	********	************	**********
1	1	12.50	24.00	8.0	110592.	20.0	4000.	133333.	0.0
	2		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	3		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	4		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	5		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	6		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	7		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	8					20.0	4000.	133333.	0.0
2	1	12.50	24.00	8.0	110592.	20.0	4000.	133333.	0.0
	2		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	3		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	4		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	5		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	6		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	7		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	8					20.0	4000.	133333.	0.0
3	1	12.50	24.00	8.0	110592.	20.0	4000.	133333.	0.0
	2		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	3		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	4		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	5		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	6		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	7		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	8					20.0	4000.	133333.	0.0
4	1	12.50	24.00	8.0	110592.	20.0	4000.	133333.	0.0
	2		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	3		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	4		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	5		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	6		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	7		24.00	8.0	110592.	24.0	5760.	276480.	0.0
	8					20.0	4000.	133333.	0.0
5	1	12.50	24.00	8.0	110592.	20.0	4000.	133333.	0.0

STORY LEVEL	COL. LINE	STORY HEIGHT (FT)	BAY WIDTH (FT)	BEAM DEPTH (IN)	BEAM MOM. OF INERTIA (IN-4)	COLUMN WIDTH (IN)	COLUMN AREA (IN-2)	COL. MOM. OF INERTIA (IN-4)	EFF. COL. SHR AREA FACTOR
	2		24.00	8.0	12288.	24.0	576.	27648.	0.0
	3		24.00	8.0	12288.	24.0	576.	27648.	0.0
	4		24.00	8.0	12288.	24.0	576.	27648.	0.0
	5		24.00	8.0	12288.	24.0	576.	27648.	0.0
	6		24.00	8.0	12288.	24.0	576.	27648.	0.0
	7		24.00	8.0	12288.	24.0	576.	27648.	0.0
	8					20.0	400.	13333.	0.0
6	1	12.50	24.00	8.0	12288.	20.0	400.	13333.	0.0
	2		24.00	8.0	12288.	24.0	576.	27648.	0.0
	3		24.00	8.0	12288.	24.0	576.	27648.	0.0
	4		24.00	8.0	12288.	24.0	576.	27648.	0.0
	5		24.00	8.0	12288.	24.0	576.	27648.	0.0
	6		24.00	8.0	12288.	24.0	576.	27648.	0.0
	7		24.00	8.0	12288.	24.0	576.	27648.	0.0
	8					20.0	400.	13333.	0.0
7	1	12.50	24.00	8.0	12288.	20.0	400.	13333.	0.0
	2		24.00	8.0	12288.	24.0	576.	27648.	0.0
	3		24.00	8.0	12288.	24.0	576.	27648.	0.0
	4		24.00	8.0	12288.	24.0	576.	27648.	0.0
	5		24.00	8.0	12288.	24.0	576.	27648.	0.0
	6		24.00	8.0	12288.	24.0	576.	27648.	0.0
	7		24.00	8.0	12288.	24.0	576.	27648.	0.0
	8					20.0	400.	13333.	0.0
8	1	12.50	24.00	8.0	12288.	20.0	400.	13333.	0.0
	2		24.00	8.0	12288.	24.0	576.	27648.	0.0
	3		24.00	8.0	12288.	24.0	576.	27648.	0.0
	4		24.00	8.0	12288.	24.0	576.	27648.	0.0
	5		24.00	8.0	12288.	24.0	576.	27648.	0.0
	6		24.00	8.0	12288.	24.0	576.	27648.	0.0
	7		24.00	8.0	12288.	24.0	576.	27648.	0.0
	8					20.0	400.	13333.	0.0
9	1	12.50	24.00	8.0	12288.	20.0	400.	13333.	0.0
	2		24.00	8.0	12288.	24.0	576.	27648.	0.0
	3		24.00	8.0	12288.	24.0	576.	27648.	0.0
	4		24.00	8.0	12288.	24.0	576.	27648.	0.0
	5		24.00	8.0	12288.	24.0	576.	27648.	0.0
	6		24.00	8.0	12288.	24.0	576.	27648.	0.0
	7		24.00	8.0	12288.	24.0	576.	27648.	0.0
	8					20.0	400.	13333.	0.0
10	1	12.50	24.00	8.0	12288.	20.0	400.	13333.	0.0
	2		24.00	8.0	12288.	24.0	576.	27648.	0.0
	3		24.00	8.0	12288.	24.0	576.	27648.	0.0
	4		24.00	8.0	12288.	24.0	576.	27648.	0.0
	5		24.00	8.0	12288.	24.0	576.	27648.	0.0
	6		24.00	8.0	12288.	24.0	576.	27648.	0.0
	7		24.00	8.0	12288.	24.0	576.	27648.	0.0
	8					20.0	400.	13333.	0.0

---- STORY HEIGHTS AND BAY WIDTHS ARE CENTER-TO-CENTER DISTANCES ----

---- FINITE WIDTHS OF MEMBERS TO BE CONSIDERED ----

**** ALL COLUMN BASES AT LOWEST STORY LEVEL ARE FULLY FIXED - - - - -

****** FRAME NO. (2) - FRAME DIMENSIONS AND MEMBER PROPERTIES - - - - NO. OF COL. LINES = 8

STORY LEVEL	COL. LINE	STORY HEIGHT (FT)	BAY WIDTH (FT)	BEAM DEPTH (IN)	BEAM MOM. OF INERTIA (IN-4)	COLUMN WIDTH (IN)	COLUMN AREA (IN-2)	COL. MOM. OF INERTIA (IN-4)	EFF. COL. SHR AREA FACTOR
1	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	182.0	11760.	19008592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10416.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
2	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	182.0	11760.	19008592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10416.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1452.	55296.	0.0
	8					20.0	800.	26667.	0.0
3	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	182.0	11760.	19008592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10416.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
4	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	182.0	11760.	19008592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10416.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
5	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	182.0	11760.	19008592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10416.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
6	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	182.0	11760.	19008592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10416.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0

concordia university — computing centre Loyola campus

STORY LEVEL	COL. LINE	STORY HEIGHT (FT)	BAY WIDTH (FT)	BEAM DEPTH (IN)	BEAM MOM. OF INERTIA (IN-4)	COLUMN WIDTH (IN)	COLUMN AREA (IN-2)	COL. MOM. OF INERTIA (IN-4)	EFF. COL. SHR. AREA FACTOR
	0					20.0	800.	26667.	0.0
7	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	142.0	11360.	19088592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10814.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
8	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	142.0	11360.	19088592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10814.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
9	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	142.0	11360.	19088592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10814.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
10	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		21.02	8.0	24576.	24.0	1152.	55296.	0.0
	4		27.02	8.0	24576.	142.0	11360.	19088592.	0.0
	5		27.53	8.0	24576.	24.0	1152.	55296.	0.0
	6		20.53	8.0	24576.	288.0	10814.	53385472.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0

---- STORY HEIGHTS AND BAY WIDTHS ARE CENTER-TO-CENTER DISTANCES - - - -

---- FINITE WIDTHS OF MEMBERS TO BE CONSIDERED - - - -

**** ALL COLUMN BASES AT LOWEST STORY LEVEL ARE FULLY FIXED - - - - -

****** FRAME NO. (3) = FRAME DIMENSIONS AND MEMBER PROPERTIES = = = = NO. OF COL. LINES = 8

STORY LEVEL	COL. LINE	STORY HEIGHT (FT)	BAY WIDTH (FT)	BEAM DEPTH (IN)	BEAM MOM. OF INERTIA (IN-4)	COLUMN WIDTH (IN)	COLUMN AREA (IN-2)	COL. MOM. OF INERTIA (IN-4)	EFF. COL. SHR AREA FACTOR
1.	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
2	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
3	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
4	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
5	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
6	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0

STORY LEVEL	COL. LINE	STORY HEIGHT (FT)	BAY WIDTH (FT)	BEAM DEPTH (IN)	BEAM MOM. OF INERTIA (IN**4)	COLUMN WIDTH (IN)	COLUMN AREA (IN**2)	COL. MOM. OF INERTIA (IN**4)	EFF. COL. SHR AREA FACTOR
	8					20.0	800.	26667.	0.0
7	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
8	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
9	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0
10	1	12.50	24.00	8.0	24576.	20.0	800.	26667.	0.0
	2		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	3		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	4		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	5		14.50	8.0	24576.	24.0	1152.	55296.	0.0
	6		31.50	8.0	24576.	192.0	12192.	37453824.	0.0
	7		24.00	8.0	24576.	24.0	1152.	55296.	0.0
	8					20.0	800.	26667.	0.0

---- STORY HEIGHTS AND BAY WIDTHS ARE CENTER-TO-CENTER DISTANCES ----

---- FINITE WIDTHS OF MEMBERS TO BE CONSIDERED ----

**** ALL COLUMN BASES AT LOWEST STORY LEVEL ARE FULLY FIXED -----

****** LOADING CASE NO. 1 ---- LOADING DESIGNATION NO. 1 -- NAME - LATERAL LOADS ONLY

---- NO EXTERNAL FORCES APPLIED AT TOP OF FRAME NO. (1) ----

*** NO GRAVITY LOADS ON FRAME NO. (1) - - - - - - - - -

*** NO EXTERNAL FORCES APPLIED AT TOP OF FRAME NO. (2) - - - -

*** NO GRAVITY LOADS ON FRAME NO. (2) - - - - - - - - -

*** NO EXTERNAL FORCES APPLIED AT TOP OF FRAME NO. (3) - - - -

*** NO GRAVITY LOADS ON FRAME NO. (3) - - - - - - - - -

**** CONCENTRATED LATERAL LOADS (FOR ALL FRAMES) - - - - - - - -

STORY LEVEL (FROM TOP)	LATERAL LOAD (KIPS)
1	465.80
2	352.60
3	313.90
4	275.70
5	236.40
6	197.60
7	158.90
8	119.40
9	79.90
10	40.40

****** LATERAL DISPLACEMENT OR DRIFT. (SAME FOR ALL FRAMES) - - - - LOADING CASE NO. 1

STORY LEVEL (FROM TOP)	RELATIVE DISPLMT. (INCHES)	TOTAL DISPLMT. (INCHES)
1	0.1103063E+00	0.1049183E+01
2	0.1158701E+00	0.9588771E+00
3	0.1226790E+00	0.8430070E+00
4	0.1282049E+00	0.7203760E+00
5	0.1308498E+00	0.5921130E+00
6	0.1288229E+00	0.4612634E+00
7	0.1292495E+00	0.3324207E+00
8	0.1032163E+00	0.2121512E+00
9	0.7532961E-01	0.1089149E+00
10	0.3358928E-01	0.3358928E-01

------ (DRIFT AT TOP)/(TOTAL HT.) = 0.0007052

concordia university

computing centre Loyola campus

****** FRAME NO. (1) - VALUES OF DISPLACEMENT COMPONENTS OF JOINTS (INCHES, RADIANS) **** LOAD CASE NO. 1

---- SIGN CONVENTION = HOR. COMP. (U) IS POSITIVE TO THE RIGHT
= VERT. COMP. (V) IS POSITIVE UPWARD
= ROTATION (W) IS POSITIVE CLOCKWISE

STORY LEVEL (FROM TOP)	COL. LINE (FROM LEFT)	HOR. COMP. * U *	VERT. COMP. * V *	ROTATION * W *
1	1	0.106918E+01	0.228314E-01	0.489644E-03
	2		0.131054E-02	0.477834E-03
	3		0.242057E-04	0.461820E-03
	4		-0.701451E-04	0.461915E-03
	5		0.706327E-04	0.461914E-03
	6		-0.242421E-04	0.461829E-03
	7		-0.131054E-02	0.477834E-03
	8		-0.228317E-01	0.489650E-03
2	1	0.958877E+00	0.225593E-01	0.648084E-03
	2		0.177365E-02	0.644759E-03
	3		0.251901E-04	0.638528E-03
	4		-0.770134E-04	0.638055E-03
	5		0.774974E-04	0.638055E-03
	6		-0.251270E-04	0.638574E-03
	7		-0.177368E-02	0.644751E-03
	8		-0.225558E-01	0.648040E-03
3	1	0.843007E+00	0.218459E-01	0.659748E-03
	2		0.170869E-02	0.649493E-03
	3		0.247781E-04	0.641577E-03
	4		-0.750318E-04	0.641332E-03
	5		0.758552E-04	0.641342E-03
	6		-0.247750E-04	0.641530E-03
	7		-0.170973E-02	0.649491E-03
	8		-0.218462E-01	0.654743E-03
4	1	0.720978E+00	0.207168E-01	0.694970E-03
	2		0.160258E-02	0.690874E-03
	3		0.235840E-04	0.683073E-03
	4		-0.724752E-04	0.683171E-03
	5		0.728500E-04	0.683172E-03
	6		-0.235560E-04	0.683871E-03
	7		-0.160257E-02	0.690869E-03
	8		-0.207171E-01	0.694967E-03
5	1	0.592133E+00	0.191362E-01	0.716524E-03
	2		0.146080E-02	0.712952E-03
	3		0.215453E-04	0.705769E-03
	4		-0.664260E-04	0.705530E-03
	5		0.667251E-04	0.705528E-03
	6		-0.215838E-04	0.705770E-03
	7		-0.146041E-02	0.712934E-03
	8		-0.191348E-01	0.716523E-03
6	1	0.441284E+00	0.170850E-01	0.718401E-03
	2		0.128552E-02	0.715370E-03
	3		0.180139E-04	0.708931E-03
	4		-0.583969E-04	0.708719E-03
	5		0.586415E-04	0.708717E-03
	6		-0.180124E-04	0.708932E-03
	7		-0.128550E-02	0.715364E-03
	8		-0.170853E-01	0.718402E-03
7	1	0.332821E+00	0.145964E-01	0.694520E-03
	2		0.121040E-02	0.691163E-03
	3		0.157065E-04	0.681529E-03
	4		-0.[illegible]	[illegible]

	5		0.888118E-04	0.681357E-03
	6		-0.157058E-04	0.681323E-03
	7		-0.107904E-02	0.687151E-03
	8		-0.145971E-01	0.684817E-03
8	1	0.212151E+00	0.115465E-01	0.619788E-03
	2		0.845118E-03	0.618083E-03
	3		0.121507E-04	0.613469E-03
	4		-0.376551E-04	0.613387E-03
	5		0.377870E-04	0.613387E-03
	6		-0.121507E-04	0.613469E-03
	7		-0.845135E-03	0.618080E-03
	8		-0.115466E-01	0.619747E-03
9	1	0.108919E+00	0.815700E-02	0.499361E-03
	2		0.586850E-03	0.498811E-03
	3		0.838842E-03	0.485073E-03
	4		-0.259035E-04	0.484941E-03
	5		0.259761E-04	0.484991E-03
	6		-0.838814E-03	0.485073E-03
	7		-0.588868E-03	0.498811E-03
	8		-0.815709E-02	0.499360E-03
10	1	0.335899E-01	0.440701E-03	0.303960E-03
	2		0.314919E-03	0.303558E-03
	3		0.440569E-03	0.301523E-03
	4		-0.136878E-03	0.301490E-03
	5		0.136758E-04	0.301890E-03
	6		-0.440568E-03	0.301524E-03
	7		-0.314985E-03	0.303558E-03
	8		-0.440704E-03	0.303981E-03

concordia university

computing centre Loyola campus

***** FRAME NO. (1) - MEMBER-END FORCES (IN-KIPS, KIPS) - - - - LOADING CASE NO. 1

---- SIGN CONVENTION - MOMENTS - ARE POSITIVE WHEN COUNTERCLOCKWISE ON MEMBER ENDS
- SHEARS (A) IN COLUMNS ARE POSITIVE AT TOP WHEN DIRECTED TO RIGHT
AND AT BOTTOM WHEN DIRECTED TO LEFT
(B) IN BEAMS ARE POSITIVE AT LEFT END WHEN DIRECTED UPWARD
AND AT RIGHT WHEN DIRECTED DOWNWARD
- AXIAL FORCES (IN COLUMNS) ARE POSITIVE WHEN TENSILE

STORY LEVEL	COL. LINE	BEAM MOMENTS LEFT	BEAM MOMENTS RIGHT	BEAM SHEARS LEFT	BEAM SHEARS RIGHT	COLUMN MOMENTS TOP	COLUMN MOMENTS BOTTOM	COLUMN SHEARS TOP	COLUMN SHEARS BOTTOM	COL. AXIAL FORCE
1	1	-177.42	-170.88	-1.31	-1.31	183.70	58.22	1.70	1.70	1.31
	2	-255.71	-248.55	-1.91	-1.91	447.84	148.74	4.34	4.34	0.60
	3	-250.45	-250.40	-1.90	-1.90	523.53	276.69	5.28	5.28	-0.01
	4	-250.58	-250.50	-1.90	-1.90	525.22	234.33	5.32	5.32	0.00
	5	-250.40	-250.45	-1.90	-1.90	525.22	239.35	5.32	5.32	-0.00
	6	-248.55	-255.71	-1.91	-1.91	523.85	226.69	5.28	5.28	0.01
	7	-170.89	-177.43	-1.31	-1.31	447.85	145.79	4.34	4.34	-0.60
	8					183.71	58.25	1.70	1.70	-1.31
2	1	-383.28	-381.22	-2.87	-2.87	392.14	189.63	3.68	3.68	4.18
	2	-478.99	-476.07	-3.62	-3.62	714.59	426.86	8.09	8.09	1.30
	3	-482.36	-482.08	-3.65	-3.65	762.94	474.59	8.72	8.72	0.03
	4	-481.96	-481.96	-3.65	-3.65	766.05	477.14	8.76	8.76	-0.00
	5	-482.08	-482.36	-3.65	-3.65	766.05	477.15	8.76	8.76	0.00
	6	-476.04	-478.97	-3.62	-3.62	762.93	474.57	8.72	8.72	-0.02
	7	-381.20	-383.25	-2.87	-2.87	714.60	426.89	8.08	8.08	-1.30
	8					392.23	189.69	3.68	3.68	-4.18
3	1	-611.40	-608.65	-4.59	-4.59	472.15	306.23	5.20	5.20	6.77
	2	-707.08	-703.12	-5.34	-5.34	930.85	667.88	11.24	11.24	2.10
	3	-708.05	-707.90	-5.36	-5.36	982.30	718.38	11.98	11.98	0.08
	4	-707.92	-707.92	-5.36	-5.36	994.36	720.52	12.01	12.01	-0.00
	5	-707.90	-708.05	-5.36	-5.36	994.33	720.48	12.01	12.01	0.00
	6	-703.13	-707.08	-5.34	-5.34	982.29	718.37	11.99	11.98	-0.08
	7	-608.69	-611.40	-4.59	-4.59	930.65	667.89	11.24	11.24	-2.10
	8					472.15	306.22	5.20	5.20	[illegible]
4	1	-815.81	-813.55	-6.12	-6.12	523.64	413.65	6.60	6.60	[illegible]
	2	-913.67	-909.89	-6.91	-6.91	1114.83	885.64	14.09	14.09	2.08
	3	-914.67	-914.30	-6.93	-6.93	1148.96	935.74	14.80	14.80	0.04
	4	-914.29	-914.29	-6.93	-6.93	1147.03	937.71	14.83	14.83	-0.09
	5	-914.30	-914.67	-6.93	-6.93	1147.01	937.68	14.83	14.83	0.00
	6	-909.89	-913.67	-6.91	-6.91	1148.96	935.76	14.80	14.80	-0.04
	7	-813.59	-815.81	-6.12	-6.12	1114.84	885.66	14.09	14.09	-2.89
	8					523.65	413.69	6.60	6.60	-14.80
5	1	-996.54	-996.59	-7.48	-7.48	600.10	508.01	7.81	7.81	22.58
	2	-1093.64	-1089.89	-8.27	-8.27	1249.28	1076.64	16.52	16.52	3.67
	3	-1093.78	-1093.65	-8.29	-8.29	1318.61	1125.37	17.22	17.22	0.09
	4	-1093.65	-1093.65	-8.29	-8.29	1320.31	1126.98	17.24	17.24	-0.00
	5	-1093.65	-1093.79	-8.29	-8.29	1320.30	1126.97	17.24	17.24	0.00

STORY LEVEL	COL. LINE	BEAM MOMENTS LEFT	BEAM MOMENTS RIGHT	BEAM SHEARS LEFT	BEAM SHEARS RIGHT	COLUMN MOMENTS TOP	COLUMN MOMENTS BOTTOM	COLUMN SHEARS TOP	COLUMN SHEARS BOTTOM	COL. AXIAL FORCE
	6	-5788.61	-5802.37	-83.89	-83.89	4184.50	4189.55	86.33	86.33	-0.32
	7	-5287.98	-5291.18	-39.79	-39.79	5692.89	5843.39	82.81	82.81	-21.35
	8					2779.97	2769.39	39.09	39.09	-173.39
6	1	-5347.02	-5359.46	-40.32	-40.32	2678.32	2651.08	39.02	39.02	213.71
	2	-5824.95	-5813.77	-84.11	-84.11	5678.36	6008.10	82.32	82.32	~~25.13~~
	3	-5830.39	-5829.86	-84.17	-84.17	5906.52	6276.77	85.47	85.47	0.39
	4	-5829.83	-5829.83	-84.17	-84.17	5913.82	6273.55	85.57	85.57	-0.01
	5	-5824.85	-5830.39	-84.17	-84.17	5913.86	6273.57	85.57	85.57	0.01
	6	-5813.76	-5829.93	-84.10	-84.10	5906.52	6276.80	85.47	85.47	-0.39
	7	-5359.44	-5347.02	-40.32	-40.32	5678.48	6008.18	82.32	82.32	-25.13
	8					2678.34	2651.11	39.02	39.02	-213.71
7	1	-5200.23	-5194.33	-39.07	-39.07	2435.40	2628.59	37.08	37.08	252.78
	2	-5605.94	-5591.82	-82.42	-82.42	5128.81	5935.93	77.94	77.94	26.49
	3	-5605.17	-5604.75	-82.46	-82.46	5328.36	6119.64	80.61	80.61	0.43
	4	-5604.76	-5604.76	-82.46	-82.46	5330.00	6128.73	80.69	80.69	-0.01
	5	-5604.75	-5605.16	-82.46	-82.46	5330.00	6128.74	80.69	80.69	0.01
	6	-5591.80	-5605.94	-82.42	-82.42	5324.80	6119.65	80.61	80.61	-0.43
	7	-5194.30	-5200.21	-39.07	-39.07	5128.84	5936.01	77.94	77.94	-26.49
	8					2435.43	2628.61	37.08	37.08	-252.78
8	1	-4714.50	-4710.35	-35.43	-35.43	1962.14	2680.49	32.42	32.42	288.20
	2	-5087.25	-5095.65	-38.19	-38.19	4121.59	5520.00	67.92	67.92	31.29
	3	-5085.59	-5085.24	-38.22	-38.22	4276.24	5659.76	69.99	69.99	0.45
	4	-5085.31	-5085.31	-38.22	-38.22	4280.29	5643.38	70.05	70.05	-0.01
	5	-5085.28	-5085.59	-38.22	-38.22	4280.30	5643.38	70.05	70.05	0.01
	6	-5095.68	-5087.27	-38.19	-38.19	4276.24	5659.80	69.99	69.99	-0.45
	7	-4710.33	-4714.49	-35.43	-35.43	4121.65	5520.05	67.92	67.92	-31.28
	8					1942.17	2680.48	32.42	32.42	-288.21
9	1	-3850.02	-3827.60	-28.78	-28.78	1246.46	2347.62	25.32	25.32	316.90
	2	-4073.75	-4065.36	-30.83	-30.83	2613.63	4890.61	52.84	52.84	33.29
	3	-4071.92	-4071.71	-30.85	-30.85	2720.69	4982.49	54.26	54.26	0.49
	4	-4071.73	-4071.73	-30.85	-30.85	2723.15	4988.31	54.29	54.29	-0.01
	5	-4071.71	-4071.91	-30.85	-30.85	2723.14	4988.32	54.29	54.29	0.01
	6	-4065.35	-4073.74	-30.83	-30.83	2720.73	4982.49	54.26	54.26	-0.49
	7	-3827.59	-3850.01	-28.78	-28.78	2615.64	4890.60	52.84	52.84	-33.29
	8					1246.44	2347.60	25.32	25.32	-316.90
10	1	-2346.35	-2345.29	-17.64	-17.64	73.25	1572.00	10.14	10.14	334.62
	2	-2482.34	-2477.22	-18.79	-18.79	78.14	3244.47	21.15	21.15	34.48
	3	-2480.06	-2479.98	-18.79	-18.79	172.89	3287.89	21.59	21.58	0.49
	4	-2480.02	-2480.02	-18.79	-18.79	173.20	3287.82	21.58	21.58	-0.01
	5	-2479.98	-2480.04	-18.79	-18.79	173.21	3287.82	21.58	21.58	0.01
	6	-2477.23	-2482.34	-18.79	-18.79	172.48	3287.88	21.58	21.58	-0.48
	7	-2345.30	-2346.34	-17.64	-17.64	78.15	3244.46	21.15	21.15	-34.44
	8					73.23	1571.99	10.14	10.14	-334.63

****** MAXIMUM RATIOS OF UNBALANCED JOINT FORCES TO SUM OF ABSOLUTE VALUES OF CORRESPOR JOINT FORCES ----

JOINT MOMENT = 0.274943E-04
JOINT VERT. FORCE = 0.183037E-04

****** FRAME NO. (2) - VALUES OF DISPLACEMENT COMPONENTS OF JOINTS (INCHES, RADIANS) ---- LD-6, CASE NO. 1

---- SIGN CONVENTION - HOR. COMP. (U) IS POSITIVE TO THE RIGHT
- VERT. COMP. (V) IS POSITIVE UPWARD
- ROTATION (W) IS POSITIVE CLOCKWISE

STORY LEVEL (FROM TOP)	COL. LINE (FROM LEFT)	HOR. COMP. * U *	VERT. COMP. * V *	ROTATION * W *
1	1	0.106918E+01	0.246817E-01	0.477518E-03
	2		0.383978E-02	0.445961E-03
	3		0.349848E-01	0.313926E-03
	4		-0.246873E-02	0.725071E-03
	5		0.239589E-01	0.143817E-03
	6		0.690303E-02	0.725921E-03
	7		-0.979807E-01	0.298398E-03
	8		-0.317264E-01	0.343829E-03
2	1	0.958877E+00	0.283300E-01	0.637132E-03
	2		0.377062E-02	0.623189E-03
	3		0.348982E-01	0.548808E-03
	4		-0.283567E-02	0.784219E-03
	5		0.234809E-01	0.370189E-03
	6		0.685734E-02	0.749819E-03
	7		-0.970701E-01	0.595709E-03
	8		-0.312779E-01	0.590519E-03
3	1	0.843007E+00	0.235710E-01	0.643654E-03
	2		0.341253E-02	0.627457E-03
	3		0.358111E-01	0.537926E-03
	4		-0.236878E-02	0.798201E-03
	5		0.224209E-01	0.495474E-03
	6		0.672861E-02	0.794874E-03
	7		-0.988223E-01	0.496359E-03
	8		-0.301994E-01	0.586494E-03
4	1	0.770378E+00	0.223989E-01	0.682729E-03
	2		0.337210E-02	0.648852E-03
	3		0.336803E-01	0.583272E-03
	4		-0.225967E-02	0.837857E-03
	5		0.217754E-01	0.527573E-03
	6		0.699860E-02	0.837759E-03
	7		-0.909963E-01	0.511153E-03
	8		-0.285089E-01	0.633264E-03
5	1	0.592133E+00	0.206580E-01	0.703728E-03
	2		0.305812E-02	0.691328E-03
	3		0.312338E-01	0.609098E-03
	4		-0.210297E-02	0.867083E-03
	5		0.201433E-01	0.542102E-03
	6		0.612528E-02	0.867303E-03
	7		-0.852594E-01	0.508147E-03
	8		-0.241860E-01	0.659325E-03
6	1	0.441284E+00	0.184087E-01	0.705318E-03
	2		0.246472E-02	0.694952E-03
	3		0.280129E-01	0.601262E-03
	4		-0.189298E-02	0.870959E-03
	5		0.180524E-01	0.584501E-03
	6		0.559238E-02	0.871164E-03
	7		-0.773090E-01	0.492269E-03
	8		-0.235353E-01	0.667459E-03
7	1	0.352421E+00	0.197227E-01	0.676751E-03
	2		0.221934E-02	0.656608E-03
	3		0.239824E-01	0.575754E-03
	4		[illegible]	[illegible]
	5		0.156569E-01	0.523087E-03
	6		[illegible]	[illegible]

	7		-0.673027E-02	0.640767E-03
	8		-0.133940E-01	0.675871E-03
8	1	0.212151E+00	-0.129930E-01	0.608325E-03
	2		0.970107E-03	0.606213E-03
	3		0.516780E-04	0.600261E-03
	4		0.312130E-02	0.585924E-03
	5		0.693139E-01	0.358256E-03
	6		-0.646710E-02	0.734490E-03
	7		-0.500834E-02	0.576072E-03
	8		-0.125461E-01	0.607714E-03
9	1	0.108918E+00	0.881153E-02	0.490016E-03
	2		0.675354E-03	0.487498E-03
	3		0.346173E-04	0.484471E-03
	4		0.227443E-02	0.474300E-03
	5		0.506027E-01	0.257835E-03
	6		-0.474754E-02	0.408073E-03
	7		-0.351097E-02	0.465048E-03
	8		-0.884537E-02	0.489481E-03
10	1	0.375497E-01	0.475080E-02	0.297668E-03
	2		0.341421E-03	0.297087E-03
	3		0.200725E-04	0.294378E-03
	4		0.114954E-02	0.291085E-03
	5		0.282352E-01	0.117837E-03
	6		-0.243467E-02	0.301673E-03
	7		-0.189479E-02	0.279875E-03
	8		-0.477736E-02	0.280493E-03

****** FRAME NO. (2) - MEMBER-END FORCES (IN-KIPS, KIPS) - - - - LOADING CASE NO. 1

---- SIGN CONVENTION - MOMENTS - ARE POSITIVE WHEN COUNTERCLOCKWISE ON MEMBER ENDS
- SHEARS (A) IN COLUMNS ARE POSITIVE AT TOP WHEN DIRECTED TO RIGHT
AND AT BOTTOM WHEN DIRECTED TO LEFT
(B) IN BEAMS ARE POSITIVE AT LEFT END WHEN DIRECTED UPWARD
AND AT RIGHT WHEN DIRECTED DOWNWARD
- AXIAL FORCES (IN COLUMNS) ARE POSITIVE WHEN TENSILE

STORY LEVEL	COL. LINE	BEAM MOMENTS LEFT	BEAM MOMENTS RIGHT	BEAM SHEARS LEFT	BEAM SHEARS RIGHT	COLUMN MOMENTS TOP	COLUMN MOMENTS BOTTOM	COLUMN SHEARS TOP	COLUMN SHEARS BOTTOM	COL. AXIAL FORCE
1	1	-709.77	-692.28	-5.27	-5.27	726.61	586.71	6.97	6.97	5.27
	2	-981.86	-888.11	-6.84	-6.84	1695.77	1281.58	20.97	20.97	1.59
	3	-1422.91	-1781.18	-18.98	-18.98	2477.68	1852.79	30.72	30.72	12.08
	4	-1607.95	-1277.09	-11.96	-11.96	9800.02	-13722.94	-55.79	-55.79	-6.99
	5	-1709.54	-2120.81	-19.70	-19.70	3208.60	2399.10	39.50	39.50	7.78
	6	-1926.62	-1387.39	-29.78	-29.78	11048.50	-81734.50	-216.12	-216.12	10.05
	7	-991.41	-1027.53	-7.59	-7.59	2642.00	2130.62	33.74	33.74	-22.17
	8					1051.40	795.54	13.01	13.01	-7.59
2	1	-1009.79	-1002.02	-7.56	-7.56	476.15	868.80	6.66	6.66	12.83
	2	-1312.18	-1281.61	-9.82	-9.82	1095.89	1085.38	15.37	15.37	3.85
	3	-1469.59	-2127.04	-24.21	-24.21	1548.43	1612.47	22.38	22.38	26.47
	4	-1691.32	-1791.42	-15.13	-15.13	20607.09	-15682.94	34.73	34.73	-16.06
	5	-2358.53	-2504.82	-28.91	-28.91	1908.79	2012.82	27.62	27.62	17.53
	6	-2573.80	-2275.00	-83.20	-83.20	55808.50	-84097.50	68.38	68.38	28.58
	7	-1397.61	-1493.53	-10.68	-10.68	1993.77	1972.60	27.31	27.31	-94.72
	8					695.29	659.60	9.24	9.24	-18.23
3	1	-1023.95	-1015.09	-7.66	-7.66	574.06	530.02	7.78	7.78	20.49
	2	-1298.56	-1284.02	-9.67	-9.67	1303.94	1208.15	17.70	17.70	5.89
	3	-2036.29	-2250.92	-25.38	-25.38	1903.61	1816.21	26.20	26.20	42.18
	4	-1933.35	-1748.73	-15.29	-15.29	29347.78	-19551.22	49.09	49.09	-26.19
	5	-2371.48	-2605.79	-25.60	-25.60	2353.24	2255.38	32.84	32.84	27.84
	6	-2801.19	-2803.38	-88.78	-88.78	60011.25	-37418.75	159.19	159.19	51.51
	7	-1353.08	-1403.21	-10.36	-10.36	2343.31	2308.50	32.77	32.77	-93.18
	8					748.33	719.85	10.45	10.45	-28.59
4	1	-1101.58	-1093.74	-8.25	-8.25	590.35	566.68	8.15	8.15	28.75
	2	-1341.19	-1315.21	-10.18	-10.18	1328.15	1271.16	18.28	18.28	7.78
	3	-2821.99	-2881.72	-27.56	-27.56	1959.29	1922.86	27.35	27.35	-54.56
	4	-2029.89	-1880.08	-16.08	-16.08	19840.67	-8809.33	106.08	106.08	-37.67
	5	-2387.02	-2782.30	-27.81	-27.81	2359.68	2355.72	33.83	33.83	39.29
	6	-3375.21	-2938.97	-57.19	-57.19	52395.75	-18278.25	248.54	248.54	81.29
	7	-1386.10	-1453.78	-10.67	-10.67	2555.74	2542.74	36.06	36.06	-139.86
	8					740.83	731.46	10.51	10.51	-39.26
5	1	-1189.08	-1182.20	-8.61	-8.61	602.05	600.24	8.47	8.47	37.34
	2	-1385.19	-1374.69	-10.30	-10.30	1375.11	1326.63	18.75	18.75	9.49
	3	-2359.51	-2582.44	-29.15	-29.15	2013.84	2012.24	28.34	28.34	78.81
	4	-2078.39	-1879.78	-16.41	-16.41	11347.09	8211.09	137.98	137.98	-50.41
	5	-2680.98	-2897.63	-28.58	-28.58	2443.22	2497.43	34.38	34.38	51.38

****** FRAME NO. (9) - VALUES OF DISPLACEMENT COMPONENTS OF JOINTS (INCHES, RADIANS) ---- LD-G. CASE NO. 1

---- SIGN CONVENTION - HOR. COMP. (U) IS POSITIVE TO THE RIGHT
- VERT. COMP. (V) IS POSITIVE UPWARD
- ROTATION (W) IS POSITIVE CLOCKWISE

STORY LEVEL (FROM TOP)	COL. LINE (FROM LEFT)	HOR. COMP. * U *	VERT. COMP. * V *	ROTATION * W *
1	1	0.106913E+01	0.286872E-01	0.477275E-03
	2		0.206111E-02	0.442994E-03
	3		0.735088E-04	0.447024E-03
	4		0.778214E-02	0.353819E-03
	5		0.104932E+00	0.509864E-03
	6		-0.987380E-02	0.727051E-03
	7		-0.102740E-01	0.384589E-03
	8		-0.287815E-01	0.479839E-03
2	1	0.958877E+00	0.283334E-01	0.637769E-03
	2		0.208378E-02	0.631082E-03
	3		0.853445E-04	0.623354E-03
	4		0.758915E-02	0.599198E-03
	5		0.105150E+00	0.581712E-03
	6		-0.989235E-02	0.749585E-03
	7		-0.100733E-01	0.616595E-03
	8		-0.288761E-01	0.631010E-03
3	1	0.843007E+00	0.235730E-01	0.648063E-03
	2		0.196318E-02	0.637949E-03
	3		0.888351E-04	0.627962E-03
	4		0.722720E-02	0.587411E-03
	5		0.108854E+00	0.572583E-03
	6		-0.985797E-02	0.798802E-03
	7		-0.970394E-02	0.602335E-03
	8		-0.237118E-01	0.681931E-03
4	1	0.720978E+00	0.223598E-01	0.693134E-03
	2		0.188087E-02	0.674218E-03
	3		0.880162E-04	0.656826E-03
	4		0.670248E-02	0.634837E-03
	5		0.103367E+00	0.541850E-03
	6		-0.970898E-02	0.837767E-03
	7		-0.915090E-02	0.685284E-03
	8		-0.224818E-01	0.679989E-03
5	1	0.592135E+00	0.206578E-01	0.704128E-03
	2		0.167784E-02	0.609629E-03
	3		0.834088E-04	0.690475E-03
	4		0.603012E-02	0.658973E-03
	5		0.998818E-01	0.537209E-03
	6		-0.936818E-02	0.847176E-03
	7		-0.840629E-02	0.644589E-03
	8		-0.201708E-01	0.701952E-03
6	1	0.441784E+00	0.188172E-01	0.705478E-03
	2		0.147419E-02	0.701903E-03
	3		0.784678E-04	0.693586E-03
	4		0.532788E-02	0.566375E-03
	5		0.938585E-01	0.497815E-03
	6		-0.875918E-02	0.870880E-03
	7		-0.746588E-02	0.667168E-03
	8		-0.185418E-01	0.705900E-03
7	1	0.332421E+00	0.157209E-01	0.677061E-03
	2		0.125869E-02	0.674112E-03
	3		0.647003E-04	0.646877E-03
	4		[illegible]	[illegible]
	5		0.834803E-01	0.439307E-03
	6		[illegible]	[illegible]

STORY LEVEL	COL. LINE	BEAM MOMENTS LEFT	BEAM MOMENTS RIGHT	BEAM SHEARS LEFT	BEAM SHEARS RIGHT	COLUMN MOMENTS TOP	COLUMN MOMENTS BOTTOM	COLUMN SHEARS TOP	COLUMN SHEARS BOTTOM	COL. AXIAL FORCE
*****	****	********	********	********	********	********	********	********	********	*********
	6	-3003.43	-3323.70	-44.54	-44.54	30057.50	21381.50	342.12	342.12	117.30
	7	-1377.27	-1461.05	-10.67	-10.67	2741.25	2778.37	36.89	36.89	-193.55
	8					752.16	782.58	10.53	10.53	-89.93
6	1	-1144.61	-1158.87	-8.73	-8.73	594.01	616.21	8.45	8.45	86.09
	2	-1371.76	-1319.43	-10.19	-10.19	1252.16	1383.73	18.50	18.50	10.69
	3	-2411.41	-2646.95	-29.90	-29.90	1473.93	2033.58	28.23	28.23	86.12
	4	-2059.38	-1859.88	-16.33	-16.33	-13378.12	25384.87	149.03	149.03	-63.98
	5	-2682.07	-2929.19	-28.87	-28.87	2393.67	2433.09	33.98	33.98	43.92
	6	-4110.90	-3604.81	-49.89	-49.89	-5270.50	69745.50	454.37	454.37	158.32
	7	-1352.50	-1424.83	-10.39	-10.38	2806.30	2689.08	40.12	40.12	-253.06
	8					708.46	732.08	10.15	10.15	-60.32
7	1	-1128.83	-1124.31	-8.47	-8.47	531.37	608.80	8.03	8.03	58.56
	2	-1301.39	-1284.53	-9.66	-9.66	1155.08	1311.00	17.38	17.38	12.08
	3	-2363.77	-2502.10	-29.29	-29.29	1837.36	1947.17	26.73	26.73	117.74
	4	-1473.75	-1781.35	-15.57	-15.57	-19081.36	87589.68	200.84	200.84	-77.70
	5	-2595.20	-2834.03	-27.93	-27.93	2201.28	2325.83	31.69	31.69	76.28
	6	-4213.07	-3700.11	-71.71	-71.71	-54538.00	132246.00	549.00	549.00	202.11
	7	-1255.03	-1300.38	-9.68	-9.68	2709.72	2651.15	39.17	39.17	-315.09
	8					627.38	695.07	9.32	9.32	-70.00
8	1	-1023.78	-1020.54	-7.68	-7.68	431.58	544.82	7.02	7.02	62.28
	2	-1156.77	-1108.53	-8.59	-8.58	931.87	1203.07	15.08	15.08	12.48
	3	-2145.45	-2373.69	-26.83	-26.83	1531.88	1746.81	23.23	23.23	135.99
	4	-1764.35	-1589.88	-13.91	-13.91	-42289.27	75939.69	237.07	237.07	-90.62
	5	-2350.01	-2546.54	-25.29	-25.29	1846.92	2056.45	27.50	27.50	87.64
	6	-4015.46	-3576.53	-68.41	-68.41	-118838.75	211921.25	655.69	655.69	245.23
	7	-1071.35	-1176.92	-8.45	-8.45	2382.44	2588.53	34.99	34.99	-375.05
	8					497.59	621.85	7.89	7.89	-70.45
9	1	-831.95	-824.49	-6.25	-6.25	279.67	496.46	5.47	5.47	68.49
	2	-922.55	-883.06	-6.68	-6.68	600.08	1083.90	11.58	11.58	13.37
	3	-1775.62	-1963.81	-21.98	-21.99	1075.52	1471.13	17.93	17.93	151.13
	4	-1412.82	-1273.14	-11.18	-11.18	-73270.06	111625.99	277.27	277.27	-101.47
	5	-1906.55	-2079.90	-20.51	-20.51	1308.74	1680.82	21.06	21.06	97.08
	6	-3810.96	-3011.98	-58.18	-58.18	-202356.25	312026.75	772.56	772.56	282.90
	7	-873.70	-926.11	-6.61	-6.61	1728.48	2123.43	27.56	27.56	-426.61
	8					315.31	521.37	5.89	5.89	-85.06
10	1	-509.04	-508.42	-3.82	-3.82	20.31	321.48	2.16	2.16	72.32
	2	-552.08	-523.64	-4.07	-4.07	46.94	649.13	4.53	4.53	13.82
	3	-1101.27	-1219.09	-13.71	-13.71	246.87	788.13	6.66	6.66	140.77
	4	-845.70	-748.03	-6.77	-6.77	-110563.19	165240.62	346.20	346.20	-108.41
	5	-1170.86	-1291.65	-12.67	-12.67	375.98	839.64	7.69	7.69	102.93
	6	-2298.80	-1918.85	-37.35	-37.35	-309275.06	462220.50	987.77	987.77	307.58
	7	-473.24	-583.75	-3.82	-3.82	512.69	942.34	9.97	9.97	-640.18
	8					28.11	325.52	2.24	2.28	-46.84

****** MAXIMUM RATIOS OF UNBALANCED JOINT FORCES TO SUM OF ABSOLUTE VALUES OF CORRESPOND JOINT FORCES ----

JOINT MOMENT = 0.224410E-03
JOINT VERT. FORCE = 0.198179E-09

	7		-0.659149E-01	0.496891E-03
	8		-0.196408E-01	0.648938E-03
	1	0.212151E+00	0.178051E-01	0.608053E-03
	2		0.132949E-02	0.602318E-03
	3		0.191461E-01	0.519034E-03
	4		-0.130288E-02	0.785118E-03
	5		0.122036E-01	0.469740E-03
	6		0.305492E-02	0.755212E-03
	7		-0.539715E-01	0.396349E-03
	8		-0.155249E-01	0.596847E-03
	1	0.108919E+00	0.881331E-02	0.489932E-03
	2		0.116972E-02	0.486279E-03
	3		0.135401E-01	0.419868E-03
	4		-0.825368E-03	0.608574E-03
	5		0.869286E-02	0.380084E-03
	6		0.284068E-02	0.608421E-03
	7		-0.395457E-01	0.309878E-03
	8		-0.108844E-01	0.476592E-03
18	1	0.395897E-01	0.476202E-02	0.291882E-03
	2		0.632158E-03	0.296368E-03
	3		0.735200E-02	0.245848E-03
	4		-0.502714E-03	0.390440E-03
	5		0.870479E-03	0.220819E-03
	6		0.155968E-02	0.380451E-03
	7		-0.210420E-01	0.169554E-03
	8		-0.595302E-02	0.293771E-03

7

****** FRAME NO. (3) - MEMBER-END FORCES (IN-KIPS, KIPS) - - - - LOADING CASE NO. 1

---- SIGN CONVENTION - MOMENTS - ARE POSITIVE WHEN COUNTERCLOCKWISE ON MEMBER ENDS
- SHEARS (A) IN COLUMNS ARE POSITIVE AT TOP WHEN DIRECTED TO RIGHT
AND AT BOTTOM WHEN DIRECTED TO LEFT
(B) IN BEAMS ARE POSITIVE AT LEFT END WHEN DIRECTED UPWARD
AND AT RIGHT WHEN DIRECTED DOWNWARD
- AXIAL FORCES (IN COLUMNS) ARE POSITIVE WHEN TENSILE ;

STORY LEVEL	COL. LINE	BEAM MOMENTS LEFT	BEAM MOMENTS RIGHT	BEAM SHEARS LEFT	BEAM SHEARS RIGHT	COLUMN MOMENTS TOP	COLUMN MOMENTS BOTTOM	COLUMN SHEARS TOP	COLUMN SHEARS BOTTOM	COL. AXIAL FORCE
1	1	-704.21	-701.29	-5.30	-5.30	726.40	545.51	8.96	8.96	5.30
	2	-824.03	-815.62	-6.21	-6.21	1585.41	1185.80	19.52	19.52	0.41
	3	-807.99	-785.43	-5.92	-5.92	1695.77	1275.77	20.86	20.86	-0.29
	4	-1359.64	-1884.38	-10.62	-10.62	2205.48	1632.01	27.03	27.03	4.79
	5	71.87	-423.19	-5.32	-5.32	1685.65	1284.09	19.51	19.51	-5.31
	6	-1053.28	-1246.25	-10.07	-10.07	8170.19	-31491.86	-192.79	-192.79	4.76
	7	-640.85	-713.24	-5.14	-5.14	2011.46	1469.28	28.52	28.52	-4.91
	8					778.64	558.25	9.07	9.07	-5.14
2	1	-1006.43	-1004.37	-7.56	-7.56	674.16	447.06	6.63	6.63	12.86
	2	-1139.72	-1135.79	-8.61	-8.61	1017.15	1007.87	18.26	18.26	1.45
	3	-1171.76	-1158.27	-8.83	-8.83	1094.23	1083.64	15.34	15.34	-0.07
	4	-1704.79	-1705.61	-12.94	-12.98	1314.22	1301.29	18.71	18.71	8.81
	5	-654.17	-1016.79	-25.87	-25.47	1358.76	1433.47	19.88	19.88	7.21
	6	-1035.89	-1563.28	[illegible]	-11.85	38319.99	-33318.09	55.24	55.24	-8.84
	7	-1028.92	-1036.91	-7.77	-7.77	1192.13	1225.45	17.03	17.03	-6.99
	8					892.64	880.33	6.85	6.85	-12.93
3	1	-1020.59	-1017.20	-7.66	-7.66	572.59	528.56	7.76	7.76	20.52
	2	-1187.91	-1182.33	-8.68	-8.68	1229.58	1135.66	16.64	16.64	2.98
	3	-1367.59	-1185.05	-8.76	-8.76	1303.56	1209.66	17.70	17.70	0.01
	4	-1684.24	-1675.84	-12.73	-12.73	1584.77	1876.40	21.58	21.58	12.75
	5	-1131.27	-1627.75	-41.80	-41.80	1843.99	1870.01	26.14	26.14	36.29
	6	-1708.89	-1599.78	-12.24	-12.24	81333.09	-24681.09	103.25	103.25	-38.41
	7	-1021.25	-1043.20	-7.75	-7.76	1486.56	1356.15	20.24	20.24	-13.47
	8					581.59	578.69	7.89	7.89	-20.69
4	1	-1098.50	-1095.78	-8.25	-8.25	588.91	545.25	8.13	8.13	28.77
	2	-1222.29	-1216.71	-9.28	-9.28	1256.48	1206.45	17.35	17.35	3.97
	3	-1242.28	-1223.63	-9.39	-9.39	1328.38	1276.38	18.35	18.35	0.11
	4	-1727.38	-1696.49	-12.93	-12.93	1570.89	1514.48	21.73	21.73	16.37
	5	-1749.34	-2346.67	-42.34	-42.34	2237.04	2283.70	31.93	31.93	85.72
	6	-1805.88	-1700.77	-12.99	-12.99	34935.11	-9617.89	182.47	182.47	-87.78
	7	-1099.72	-1118.93	-8.38	-8.38	1905.75	1440.54	20.90	20.90	-18.12
	8					599.07	574.29	8.27	8.27	-29.03
5	1	-1196.17	-1183.68	-8.61	-8.61	600.65	596.98	8.45	8.45	37.37
	2	-1262.97	-1251.69	-9.55	-9.55	1276.93	1271.52	17.95	17.95	4.41
	3	-1279.91	-1242.32	-9.63	-9.63	1342.71	1335.40	18.87	18.87	[illegible]
	4	-1722.73	-1684.72	-12.79	-12.79	1565.15	1547.65	21.93	21.93	19.53
	5	-2356.09	-3093.28	-82.57	-82.57	2595.59	2677.66	37.08	37.08	155.59

STORY LEVEL	COL. LINE	BEAM MOMENTS LEFT	BEAM MOMENTS RIGHT	BEAM SHEARS LEFT	BEAM SHEARS RIGHT	COLUMN MOMENTS TOP	COLUMN MOMENTS BOTTOM	COLUMN SHEARS TOP	COLUMN SHEARS BOTTOM	COL. AXIAL FORCE
*****	****	********	********	********	********	********	********	********	********	*********
	6	-1869.54	-1798.90	-13.44	-13.44	22000.33	14135.33	248.67	248.67	-156.91
	7	-1142.20	-1142.90	-8.66	-8.66	1535.79	1529.77	21.59	21.59	-24.89
	8					608.00	605.78	8.55	8.55	-37.69
6	1	-1152.00	-1159.93	-8.73	-8.73	582.80	615.05	8.44	8.44	46.10
	2	-1268.93	-1264.26	-9.60	-9.60	1274.18	1299.18	17.85	17.85	5.78
	3	-1283.28	-1268.08	-9.66	-9.66	1283.19	1355.61	18.66	18.66	0.26
	4	-1671.11	-1576.98	-12.30	-12.30	1482.40	1533.46	21.24	21.24	22.17
	5	-2686.95	-3720.86	-100.11	-100.11	2828.00	2460.98	80.75	80.75	283.30
	6	-1879.39	-1760.09	-13.51	-13.51	-2031.02	50824.98	343.75	343.75	-283.51
	7	-1158.52	-1178.88	-8.76	-8.74	1480.10	1549.80	21.40	21.40	-27.65
	8					528.42	620.01	8.51	8.51	-46.85
7	1	-1126.58	-1124.90	-8.46	-8.46	530.31	607.28	8.02	8.02	54.56
	2	-1220.21	-1216.17	-9.23	-9.23	1119.38	1278.06	16.89	16.89	6.58
	3	-1231.83	-1219.35	-9.28	-9.28	1169.66	1325.30	17.58	17.58	0.32
	4	-1550.18	-1435.50	-11.31	-11.31	1319.98	1461.62	19.59	19.58	24.20
	5	-3266.83	-4154.25	-112.40	-112.40	2892.27	3081.47	82.08	82.08	386.40
	6	-1808.28	-1700.80	-13.00	-13.00	-35673.98	95239.08	418.50	418.50	-362.92
	7	-1116.06	-1135.52	-8.46	-8.46	1358.24	1509.47	20.20	20.20	-32.18
	8					573.85	610.67	8.04	8.04	-54.91
8	1	-1021.81	-1020.64	-7.68	-7.63	470.72	544.06	7.01	7.01	62.24
	2	-1098.58	-1095.23	-8.31	-8.31	906.68	1181.18	14.71	14.71	7.15
	3	-1107.68	-1098.55	-8.36	-8.36	946.37	1217.03	15.24	15.24	0.37
	4	-1383.01	-1216.96	-9.70	-9.70	1051.82	1308.04	16.62	16.62	25.58
	5	-3383.65	-4249.35	-115.95	-115.95	2699.92	2934.61	79.69	79.69	450.65
	6	-1629.47	-1531.92	-11.71	-11.71	-80720.69	151366.25	497.69	497.68	-487.16
	7	-1009.50	-1027.04	-7.64	-7.64	1113.55	1373.02	17.52	17.52	-36.23
	8					432.56	565.59	7.03	7.03	-62.57
9	1	-830.52	-829.81	-6.24	-6.24	279.02	495.81	5.46	5.46	68.48
	2	-886.64	-884.25	-6.71	-6.71	586.22	1034.15	11.41	11.41	7.68
	3	-895.34	-887.66	-6.75	-6.75	613.98	1058.32	11.78	11.75	0.40
	4	-1037.62	-916.72	-7.40	-7.40	670.79	1098.05	12.46	12.45	26.19
	5	-3111.79	-3884.30	-106.15	-106.15	2166.51	2484.63	32.83	32.83	549.40
	6	-1313.71	-1235.59	-9.48	-9.48	-130358.75	221451.19	578.44	578.44	-593.87
	7	-819.13	-832.78	-6.21	-6.21	735.20	1178.06	13.55	13.55	-39.87
	8					279.38	493.33	5.46	5.46	-68.77
10	1	-508.02	-507.70	-3.82	-3.82	19.92	321.28	2.16	2.16	72.30
	2	-539.16	-537.63	-4.08	-4.08	43.83	647.51	4.50	4.50	7.90
	3	-583.72	-582.12	-4.11	-4.11	55.77	673.70	4.62	4.62	0.48
	4	-595.96	-496.75	-4.13	-4.13	66.24	680.16	4.74	4.74	26.21
	5	-2098.33	-2675.30	-72.18	-72.18	876.75	1073.26	12.02	12.02	611.64
	6	-618.41	-759.64	-5.83	-5.83	-215539.12	325027.48	682.79	682.79	-610.22
	7	-497.07	-507.16	-3.77	-3.77	118.88	706.39	5.22	5.22	-81.52
	8					19.13	320.87	2.15	2.15	-72.55

****** MAXIMUM RATIOS OF UNBALANCED JOINT FORCES TO SUM OF ABSOLUTE VALUES OF CORRESPONDING JOINT FORCES ****

JOINT MOMENT = 0.125860E-02
JOINT VERT. FORCE = 0.592217E-03

****** STORY SHEARS CARRIED BY EACH FRAME (KIPS) - (ALSO, PERCENTAGES OF TOTAL) - - - - - -

STORY LEVEL (FROM TOP)	FRAME (1)		FRAME (2)		FRAME (3)		TOTAL STORY SHEAR
1	652.82	(180)	-124.99	(-24)	-63.32	(-13)	465.80
2	460.05	(57)	211.70	(25)	137.97	(16)	810.40
3	549.84	(48)	355.61	(31)	221.21	(19)	1132.30
4	570.59	(40)	508.82	(34)	319.11	(22)	1408.00
5	580.38	(35)	639.67	(38)	405.08	(24)	1644.40
6	584.77	(31)	742.70	(41)	480.40	(26)	1802.20
7	557.46	(27)	892.34	(44)	550.91	(27)	2001.10
8	480.75	(22)	1008.62	(47)	615.50	(29)	2130.50
9	378.87	(16)	1179.31	(51)	671.39	(30)	2250.90
10	140.93	(6)	1387.22	(60)	728.19	(32)	2260.80

APPENDIX B

FLAT PLATE COMPUTER PROGRAMME RESULTS

```
****************************************************************************
MULTIPLE ACCESS   P C A P L I   2.0   MOD.2 DECEMBER 1974
ANALYSIS AND DESIGN OF FLAT PLATES, FLAT SLABS,
WAFFLE SLABS, AND CONTINUOUS FRAMES
****************************************************************************
```

INPUT DATA ARE AS FOLLOWS

MARK NUMBER UGL4EU

NO. OF SPANS= 7 REINF. YIELD(PSI)= 60000.0 CONC. STRESS(PSI)= 3000.0
TENS.SPL.HT.= -0.0 CONC.RATIO= 1.00

SPAN NO.	LENGTH (FT)	LIVE LD. (PSF)	SUPERIMP. DL (PSF)	PARTIAL LL. (LB/LIN.FT)	C1 (FT)	C2 (FT)	PARTIAL DL. (LB/LIN.FT)	C1 (FT)	C2 (FT)
1	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
2	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
3	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
4	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
5	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
6	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
7	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

CANTILEVERS,IF ANY SPANDREL BEAMS,IF ANY

END	LENGTH (FT)	WIDTH AT END (FT)	LIVELOAD (PSF)	SUPIMP. DL (PSF)	LINE LL (PLF)	LINE DL (PLF)	DEPTH (IN)	WIDTH (IN)	ECCENTRICITY (IN)
LEFT	2.0	24.0	125.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
RIGHT	2.0	24.0	125.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

COLUMN NUMBER	COLUMN ABOVE SLAB IN DIRECTION OF SPAN (IN)	COLUMN ABOVE SLAB PERPENDICULAR TO SPAN (IN)	COLUMN BELOW SLAB IN DIRECTION OF SPAN (IN)	COLUMN BELOW SLAB PERPENDICULAR TO SPAN (IN)	SLAB WIDTH AT COL.LINE (FT)	DROP PANEL LEFT (FT)	DROP PANEL RIGHT (FT)	DROP PANEL WIDTH (FT)	DROP PANEL DEPTH (IN)	COL. CAP. DIA. (IN)	COL. CAP. DEPTH (IN)
1	20.0	24.0	20.0	20.0	24.0	2.0	4.0	8.0	4.0	-0.0	-0.0
2	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
3	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
4	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
5	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
6	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
7	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
8	20.0	20.0	20.0	20.0	24.0	4.0	2.0	8.0	4.0	-0.0	-0.0

STORY HEIGHT ABOVE(FT)= 12.5 STORY HEIGHT BELOW(FT)= 12.5
CONCR.WEIGHT(PCF)= 150.0 SLAB THICKNESS(IN)= 8.0
(T-D) AT SUPP.(IN)= 1.5(FIRST LAYER) (T-D) AT MIDSPAN(IN)= 1.0(FIRST LAYER)
DESIGN BY ULTIMATE STRENGTH LOADING CONDITION = 2

WIND LOAD MOMENTS(FT-KIP)
NOTE---PROVIDED FROM FRAME ANALYSIS.

COLUMN NUMBER	LEFT SIDE SLAB MOMENT	RIGHT SIDE SLAB MOMENT	UPPER COL. MOMENT	LOWER COL. MOMENT
1	0.000	-48.700	-23.000	-22.400
2	48.600	-48.600	-48.000	-47.300
3	48.600	-48.600	-56.900	-49.200
4	48.600	-48.600	-56.900	-49.200
5	48.600	-48.600	-56.900	-49.200
6	48.600	-48.600	-56.900	-49.200
7	48.700	-48.700	-48.000	-47.300
8	-0.000	0.000	-23.000	-22.400

DESIGN PART

SHEAR STRESSES

ALLOWABLE SHEAR STRESS FOR NORMAL WEIGHT CONCRETE--- TWO WAY SLAB SHEAR STRESS= 219.1(PSI)
BEAM OR JOIST SHEAR STRESS= 109.5(PSI)

COL.NO.	WITHOUT TRANSFER OF MOMENT & PUNCH STRESS (PSI)	GOV. PATT.	VERT. REACT. (KIPS)	AROUND DROP (PSI)	WITH TRANSFER OF MOMENT & VERT. REACT. (KIPS)	UNBAL. MOMENT (FT-K)	GOV. PATT	SHEAR STRESS (PSI)	MAX.UNBAL. MOMENT (FT-K)	GOV. PATT.	BENDG. MOMEN. (FT-K)	CRIT.SECT. SIZE (SQ.IN)	CRIT.SEC. WIDTH FT.	FLEX. CAP. (FT-K)
1	169.8	4	110.3	72.6	110.3	-262.0	4	213.2	-262.0	4	157.2	3.0	2.67	266.40
2	176.4	4	220.7	82.2	220.7	-63.0	4	197.2	167.2	2	112.3	2.1	3.00	232.20
3	166.1	4	205.6	75.6	154.2	-187.5	5	171.9	-155.5	2	93.3	2.3	3.00	232.20
4	165.9	4	207.8	76.6	155.8	-139.2	5	170.5	-150.6	2	90.5	2.2	3.00	232.20
5	165.9	4	207.8	76.6	155.8	-141.6	5	171.3	-150.8	2	90.5	2.2	3.00	232.20
6	166.1	4	205.6	75.6	205.6	9.5	4	167.2	155.5	2	93.3	2.3	3.00	232.20
7	176.4	4	220.7	82.2	220.7	-63.0	4	197.2	-167.2	2	112.3	2.1	3.00	232.20
8	169.8	4	110.3	72.6	110.3	262.0	4	213.2	262.0	4	157.2	3.0	2.67	266.40

PRINT-OUT OF STATICS

SLAB MOMENTS (FT-KIP)

COL.NO.	PATTERN NO.1 LEFT	PATTERN NO.1 RIGHT	PATT. NO.2 LEFT	PATT. NO.2 RIGHT	PATT. NO.3 LEFT	PATT. NO.3 RIGHT	PATT. NO.4 LEFT	PATT. NO.4 RIGHT	PATT. NO.5 LEFT	PATT. NO.5 RIGHT	PATT. NO.6 LEFT	PATT. NO.6 RIGHT
1	-15.490	-256.802	-7.880	-256.700	-15.490	-98.627	-16.040	-286.073	-13.530	-272.786	-5.640	-138.575
2	-440.698	-442.962	-419.805	-232.591	-275.919	-384.298	-555.208	-492.227	-380.244	-437.051	-74.152	-196.610
3	[illegible]	-420.075	-208.156	-363.648	-357.136	-213.499	-451.007	[illegible]	-274.896	-413.520	[illegible]	-188.798
4	-427.187	-426.528	-367.230	-216.388	-217.481	-366.287	-466.521	-464.898	-281.729	-418.832	-51.267	-189.883
5	-426.528	-427.187	-216.388	-367.230	-366.287	-217.481	-464.898	-466.521	-280.509	-418.852	-50.867	-190.283
6	-424.075	-421.354	-363.648	-208.156	-213.499	-357.136	-468.478	-451.007	-277.877	-404.817	-49.494	-196.280
7	-442.962	-480.688	-232.591	-419.805	-384.298	-275.919	-492.227	-555.208	-380.878	-479.098	-63.877	-207.571
8	-256.802	-15.490	-256.700	-7.880	-98.627	-15.490	-286.073	-16.040	-218.855	-13.530	-72.858	-5.640

COLUMN MOMENTS (FT-KIP)

COL.NO.	PATTERN NO.1 ABOVE	PATTERN NO.1 BELOW	PATT. NO.2 ABOVE	PATT. NO.2 BELOW	PATT. NO.3 ABOVE	PATT. NO.3 BELOW	PATT. NO.4 ABOVE	PATT. NO.4 BELOW	PATT. NO.5 ABOVE	PATT. NO.5 BELOW	PATT. NO.6 ABOVE	PATT. NO.6 BELOW
1	-120.556	-120.556	-124.430	-124.430	-39.568	-39.568	-131.016	-131.016	-130.520	-129.678	-66.497	-65.839
2	18.063	18.063	93.607	93.607	-58.189	-58.189	31.890	31.890	-88.828	-87.720	-61.650	-59.513
3	-1.761	-1.761	-77.786	-77.786	71.819	71.819	-8.736	-8.736	-74.839	-72.555	-74.069	-71.570
4	.330	.330	75.421	75.421	-74.403	-74.403	.813	.813	[illegible]	[illegible]	[illegible]	[illegible]
5	-.330	-.330	-75.421	-75.421	74.403	74.403	-.813	-.813	-71.947	-69.613	-72.497	-70.560
6	1.761	1.761	77.786	77.786	-71.819	-71.819	8.736	8.736	-67.836	-65.451	-71.565	-69.130
7	-18.063	-18.063	-93.607	-93.607	58.189	58.189	-31.890	-31.890	-92.864	-89.456	-77.910	-75.765
8	120.556	120.556	124.430	124.430	39.568	39.568	131.016	131.016	66.805	66.896	.917	1.775

SHEAR FORCES (KIPS)

COL.NO.	PATTERN NO.1 LEFT	PATTERN NO.1 RIGHT	PATT. NO.2 LEFT	PATT. NO.2 RIGHT	PATT. NO.3 LEFT	PATT. NO.3 RIGHT	PATT. NO.4 LEFT	PATT. NO.4 RIGHT	PATT. NO.5 LEFT	PATT. NO.5 RIGHT	PATT. NO.6 LEFT	PATT. NO.6 RIGHT
1	-15.490	81.387	-7.880	81.668	-15.490	35.066	-18.980	92.296	-10.040	78.074	-5.640	29.961
2	-98.804	92.966	-95.256	63.578	-50.114	89.592	-115.224	105.878	-80.986	86.777	-24.759	33.583
3	-91.298	91.803	-41.542	88.311	-87.328	42.394	-102.042	103.548	-78.863	85.311	-21.137	33.967
4	-92.039	91.917	-88.089	42.500	-42.726	88.860	-104.017	103.700	-72.329	83.598	-21.833	33.151
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	-91.803	91.298	-88.311	41.542	-42.394	87.328	-103.548	102.042	-71.963	81.988	-21.515	32.876
7	-92.966	98.804	-63.578	95.256	-89.592	50.114	-105.878	115.224	-73.650	69.034	-22.288	32.982
8	-81.387	15.490	-81.668	7.880	-35.066	15.490	-92.296	18.980	-88.818	18.080	-21.756	5.644

DESIGN FOR FLEXURE (FOR THE DIRECTION IN WHICH REINFORCEMENT
------------------ IS ON THE FIRST LAYER FROM TOP AND FIRST LAYER FROM BOTTOM.)

NEGATIVE REINFORCEMENT

COL. NO.	NEG. DES. MOMENT (FT-K)	GOV. PATT.	DESIGN M. AT HALF (FT-K)	GOV. PATT.	BAL.REG. MOMENT (FT-K)	STEEL AR. AT TOP COL.STR. (SQ.IN)	MIDDLE (SQ.IN)	STEEL AR. AT BOT. COL.STR. (SQ.IN)	MIDDLE (SQ.IN)	INFLEX.PT. LEFT (FT)	GOV. PATT.	INFLEX.PT. RIGHT (FT)	GOV. PATT.
1	-275.88	5	-107.85	6	975.19	4.90	.22	0.00	0.00	2.00	3	4.00	2
2	-444.49	4	-56.21	6	975.19	7.79	4.02	0.00	0.00	8.64	3	8.64	2
3	-361.48	4	-35.17	6	975.19	6.22	3.23	0.00	0.00	8.64	2	7.00	3
4	-367.02	4	-34.69	6	975.19	6.32	3.29	0.00	0.00	8.64	3	8.64	2
5	[illegible]	4	[illegible]	6	975.19	[illegible]	[illegible]	0.00	0.00	8.64	2	8.64	3
6	-361.48	4	-35.52	6	975.19	6.22	3.23	0.00	0.00	7.00	3	8.64	2
7	-444.49	4	-88.05	6	975.19	7.79	4.02	0.00	0.00	8.64	2	8.64	3
8	-206.29	4	-57.45	6	975.19	4.49	.21	0.00	0.00	4.00	2	2.00	3

POSITIVE REINFORCEMENT

SPAN NO.	MAX. POS.M. (FT-K)	AT POINT (FT)	GOV. PATT.	BAL.REG. MOMENT (FT-K)	STEEL AREA COLUMN (SQ.IN)	MIDDLE (SQ.IN)	INFLEX.PT. LEFT (FT)	GOV. PATT	INFLEX.PT. RIGHT (FT)	GOV. PATT	MOMENT EQ.13.2 (FT-K)	MINIMUM SEC.7.15 (SQ.IN)
1	203.7	10.7	4	825.6	4.06	2.70	3.0	4	5.0	2	532.01	4.15
LEFT DROP PANEL EXTENDS INTO POSITIVE MOMENT AREA												
2	151.2	12.2	3	825.6	2.98	1.98	5.0	3	5.0	3	524.15	4.15
3	156.4	12.0	2	825.6	3.08	2.05	5.0	2	5.0	2	524.15	4.15
4	155.5	12.0	3	825.6	3.06	2.04	5.0	3	5.0	3	524.15	4.15
5	156.0	12.1	2	825.6	3.08	2.05	5.0	2	5.0	2	524.15	4.15
6	151.2	11.9	3	825.6	2.97	1.98	5.0	3	5.0	3	524.15	4.15
7	203.7	13.4	4	825.6	4.06	2.70	5.0	2	3.0	4	532.01	4.15
RIGHT DROP PANEL EXTENDS INTO POSITIVE MOMENT AREA												

TYPE OUT OF REINFORCING DETAILS

NOTE--LENGTH OF TOP BARS BASED ON MOMENT ENVELOPE

NEGATIVE REINFORCEMENT

NOTE--BARS ARE DISTRIBUTED UNIFORMLY ACROSS THE COLUMN AND MIDDLE STRIPS.

COL NO.	COLUMN STRIP (OVER COLUMNS) BAR SIZE	LONG BARS NO.	LEFT	RIGHT *	SHORT BARS NO.	LEFT	RIGHT **	MIDDLE STRIP BAR SIZE	LONG BARS NO.	LEFT	RIGHT *	SHORT BARS NO.	LEFT	RIGHT
(1)	N 5	8	2.0	7.9	8	2.0	4.0	N 4	11	2.0	5.3	0	0.0	0.0
ADD 9 NO 5 BARS IN 2.7 FT. WIDTH OVER COLUMN 1 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(2)	N 6	9	9.9	9.9	9	7.0	6.5	N 4	20	5.3	5.3	0	0.0	0.0
ADD 2 NO 6 BARS IN 3.0 FT. WIDTH OVER COLUMN 2 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(3)	N 5	10	[illegible]	[illegible]	11	[illegible]	[illegible]	N 4	[illegible]	5.3	5.3	0	0.0	0.0
ADD 3 NO 5 BARS IN 3.0 FT. WIDTH OVER COLUMN 3 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(4)	N 5	10	9.6	9.6	11	6.8	6.8	N 4	17	5.3	5.3	0	0.0	0.0
ADD 2 NO 5 BARS IN 3.0 FT. WIDTH OVER COLUMN 4 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(5)	N 5	10	9.6	9.6	11	6.8	6.8	N 4	17	5.3	5.3	0	0.0	0.0
ADD 2 NO 5 BARS IN 3.0 FT. WIDTH OVER COLUMN 5 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(6)	N 5	10	[illegible]	[illegible]	11	[illegible]	[illegible]	N 4	[illegible]	5.3	5.3	0	0.0	0.0
ADD 3 NO 5 BARS IN 3.0 FT. WIDTH OVER COLUMN 6 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(7)	N 6	9	9.9	9.9	9	6.5	7.0	N 4	20	5.3	5.3	0	0.0	0.0
ADD 2 NO 6 BARS IN 3.0 FT. WIDTH OVER COLUMN 7 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(8)	N 4	11	7.9	2.0	12	4.0	2.0	N 4	11	5.3	2.0	0	0.0	0.0
ADD 15 NO 4 BARS IN 2.7 FT. WIDTH OVER COLUMN 8 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														

REINFORCING IN SPANS

COLUMN STRIP ** MIDDLE STRIP

SPAN NO.	BAR SIZE	LONG BARS * NO. LENGTH	SHORT BARS NO. LENGTH	TOP BAR SIZE	NO. LENGTH	BAR SIZE	LONG BARS NO. LENGTH	* SHORT BARS NO. LENGTH	TOP BAR SIZE	NO. LENGTH
(1)	N 5	7 X 18.5	7 X 18.5	N 0	0 X 0.0	N 5	5 X 28.0	4 X 20.0	N 0	0 X 0.0
(2)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	8 X 23.5	3 X 16.0	N 0	0 X 0.0
(3)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	8 X 23.5	3 X 16.0	N 0	0 X 0.0
(4)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	8 X 23.5	3 X 16.0	N 0	0 X 0.0
(5)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	4 X 23.5	3 X 16.0	N 0	0 X 0.0
(6)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	[illegible]	[illegible]	[illegible]	[illegible]
(7)	N 5	7 X 18.5	7 X 18.5	N 0	0 X 0.0	N 5	5 X 24.0	4 X 20.0	N 0	0 X 0.0

MATERIAL QUANTITIES

TOTAL SLAB REINFORCEMENT IN ONE DIRECTION
NEGATIVE STEEL 3410.4 POUNDS POSITIVE STEEL 2601.0 POUNDS

OTHER QUANTITIES
SURFACE AREA 4128.0 SQ.FT. YARDAGE OF CONCRETE 107.85 CU.YD.
REINFORCEMENT PER AREA 1.470 POUNDS PER SQUARE FOOT, IN ONE DIRECTION

APPROXIMATE DEFLECTIONS

APPROXIMATE MIDSPAN DEFLECTIONS

NOTE 1) SEE PAGE OF USERS MANUAL FOR THE FLATE PLATE PANEL CENTER DEFLECTION
---- 2) REFER TO TABLE 9.5(B) OF CODE FOR ALLOWABLE COMPUTED DEFLECTIONS

SPAN NO.	DEAD LOAD DEFL.(IN.)	MAX. LIVE LOAD DEFL.(IN.)	9.5.2.5 LONG TIME DEFL.(IN.)
1	.190	.247	.628
2	.136	.179	.452
3	.144	.190	.479
4	.163	.188	.476
5	.144	.190	.479
6	.136	.179	.452
7	.190	.247	.628

APPROXIMATE CANTILEVER DEFLECTIONS (ALTERNATE LOADING FOR ALL DESIGN CONDITIONS , CONDITION 1 INCLUDED)

CANTILEVER	DEAD LOAD DEFL.(IN.)	MAX. LIVE LOAD DEFL.(IN.)
LEFT	-.065	.045
RIGHT	-.065	.045

INPUT DATA ARE AS FOLLOWS

MARK NUMBER D+L

NO. OF SPANS= 7 REINF. YIELD(PSI)= 60000.0 CONC. STRESS(PSI)= 3000.0
TENS.SPL.HT.= -0.0 CONC.RATIO= 1.00

SPAN NO.	LENGTH (FT)	LIVE LD. (PSF)	SUPERIMP. DL (PSF)	PARTIAL LL. (LB/LIN.FT)	C1 (FT)	C2 (FT)	PARTIAL DL. (LB/LIN.FT)	C1 (FT)	C2 (FT)
1	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
2	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
3	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
4	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
5	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
6	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
7	24.0	125.0	0.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

CANTILEVERS, IF ANY — SPANDREL BEAMS, IF ANY

END	LENGTH (FT)	WIDTH AT END (FT)	LIVELOAD (PSF)	SUPIMP. DL (PSF)	LINE LL (PLF)	LINE DL (PLF)	DEPTH (IN)	WIDTH (IN)	ECCENTRICITY (IN)
LEFT	2.0	24.0	125.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0
RIGHT	2.0	24.0	125.0	-0.0	-0.0	-0.0	-0.0	-0.0	-0.0

COLUMN NUMBER	COLUMN ABOVE SLAB IN DIRECTION OF SPAN (IN)	COLUMN ABOVE SLAB PERPENDICULAR TO SPAN (IN)	COLUMN BELOW SLAB IN DIRECTION OF SPAN (IN)	COLUMN BELOW SLAB PERPENDICULAR TO SPAN (IN)	SLAB WIDTH AT COL.LINE (FT)	DROP PANEL LEFT (FT)	DROP PANEL RIGHT (FT)	DROP PANEL WIDTH (FT)	DROP PANEL DEPTH (IN)	COL. CAP. DIA. (IN)	COL. CAP. DEPTH (IN)
1	24.0	24.0	24.0	24.0	24.0	2.0	4.0	8.0	4.0	-0.0	-0.0
2	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
3	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
4	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
5	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
6	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
7	24.0	24.0	24.0	24.0	24.0	4.0	4.0	8.0	4.0	-0.0	-0.0
8	24.0	24.0	24.0	24.0	24.0	4.0	2.0	8.0	4.0	-0.0	-0.0

STORY HEIGHT ABOVE(FT)= 12.5 STORY HEIGHT BELOW(FT)= 12.5
CONCR.WEIGHT(PCF)= 150.0 SLAB THICKNESS(IN)= 8.0
(T-D) AT SUPP.(IN)= 1.5(FIRST LAYER) (T-D) AT MIDSPAN(IN)= 1.0(FIRST LAYER)
DESIGN BY ULTIMATE STRENGTH LOADING CONDITION = [illegible]

DESIGN PART

SHEAR STRESSES

ALLOWABLE SHEAR STRESS FOR NORMAL WEIGHT CONCRETE--- TWO WAY SLAB SHEAR STRESS= 219.1(PSI)
BEAM OR JOIST SHEAR STRESS= 149.5(PSI)

COL.NO.	WITHOUT TRANSFER OF MOMENT PUNCH STRESS (PSI)	GOV. PATT.	VERT. REACT. (KIPS)	AROUND UNOP (PSI)	VERT. REACT. (KIPS)	UNBAL. MOMENT (FT-K)	GOV. PATT	WITH TRANSFER OF MOMENT SHEAR STRESS (PSI)	MAX.UNBAL MOMENT (FT-K)	GOV. PATT.	BENDG. PUNCH. (FT-K)	CRIT.BELT STEEL (SQ.IN)	CRIT.SEC-WIDTH FT.	FLEX. CAP. (FT-K)
1	134.8	4	114.5	72.6	114.3	-262.8	4	213.2	-262.8	4	157.2	[illegible]	2.67	[illegible]
2	170.8	4	220.7	82.2	220.7	63.0	4	197.2	147.2	2	112.3	2.7	3.00	232.20
3	164.1	4	205.6	75.6	205.6	-9.5	4	167.2	-155.5	2	93.3	2.3	3.00	232.20
4	165.9	4	207.8	76.6	207.8	1.0	4	166.4	154.8	2	90.5	2.2	3.00	232.20
5	165.9	4	207.8	76.6	207.8	-1.0	4	166.4	-153.4	2	90.5	2.2	3.00	232.20
6	164.1	4	205.6	75.6	205.6	9.5	4	167.2	155.5	2	93.3	2.3	3.00	232.20
7	170.8	4	220.7	82.2	220.7	-63.0	4	197.2	-147.2	2	112.3	2.7	3.00	232.20
8	149.8	4	114.5	72.6	114.3	262.8	4	213.2	262.8	4	157.2	3.6	2.67	[illegible]

PRINT-OUT OF STATICS

SLAB MOMENTS (FT-KIP)

COL.NO.	PATTERN NO.1 LEFT	RIGHT	PATT. NO.2 LEFT	RIGHT	PATT. NO.3 LEFT	RIGHT	PATT. NO.4 LEFT	RIGHT
1	-15.4900	-256.6021	-7.8400	-256.7002	-15.4900	-94.6270	-10.0400	-280.0720
2	-480.6880	-482.9619	-419.8052	-232.5918	-275.9193	-384.2975	-555.2077	-492.2264
3	-421.3541	-428.8754	-204.1556	-363.6443	-357.1364	-213.4992	-451.4048	-460.4780
4	-427.1869	-426.5277	-367.2304	-216.3879	-217.8808	-366.2869	-466.5206	-460.6937
5	-426.5277	-427.1869	-216.3879	-367.2304	-366.2869	-217.8808	-460.6937	-466.5206
6	-428.8754	-421.3541	-363.6443	-204.1556	-213.4992	-357.1364	-460.4780	-451.4048
7	-482.9619	-480.6880	-232.5918	-419.8052	-384.2975	-275.9193	-492.2264	-555.2077
8	-256.6021	-15.4900	-256.7002	-7.8400	-94.6270	-15.4900	-280.0720	-10.0400

COLUMN MOMENTS (FT-KIP)

COL.NO.	ABOVE	BELOW	ABOVE	BELOW	ABOVE	BELOW	ABOVE	BELOW
1	-120.5560	-120.5560	-124.4301	-124.4301	-39.5685	-39.5685	-131.0164	-131.0164
2	18.8651	18.8651	93.6869	93.6869	-54.1891	-54.1891	31.4904	31.4904
3	-1.7607	-1.7607	-77.7463	-77.7463	71.8186	71.8186	-4.7356	-4.7356
4	.3296	.3296	75.4213	75.4213	-78.4030	-78.4030	.0135	.0135
5	-.3296	-.3296	-75.4213	-75.4213	78.4030	78.4030	-.0135	-.0135
6	1.7607	1.7607	77.7463	77.7463	-71.8186	-71.8186	4.7356	4.7356
7	-18.8651	-18.8651	-93.6869	-93.6869	54.1891	54.1891	-31.4904	-31.4904
8	120.5560	120.5560	124.4301	124.4301	39.5685	39.5685	131.0164	131.0164

SHEAR FORCES (KIPS)

COL.NO.	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
1	-15.4900	81.3866	-7.8400	81.6608	-15.4900	35.0062	-10.0400	92.2960
2	-98.8037	92.9656	-95.2560	43.5782	-58.1138	89.5917	-115.2240	105.4775
3	-91.2982	91.8832	-81.5418	88.3107	-87.3283	42.3941	-102.8825	103.5082
4	-92.0388	91.9388	-88.6093	42.5688	-42.7254	88.4080	-104.0110	103.7600
5	-91.9388	92.0388	-42.5688	88.6093	-88.4080	42.7254	-103.7600	104.0110
6	-91.8832	91.2982	-88.3107	81.5418	-42.3941	87.3283	-103.5082	102.8825
7	-92.9656	98.8037	-43.5782	95.2560	-89.5917	58.1138	-105.4775	115.2240
8	-81.3866	15.4900	-81.6608	7.8400	-35.0062	15.4900	-92.2960	10.0400

DESIGN FOR FLEXURE (FOR THE DIRECTION IN WHICH REINFORCEMENT
------------------ IS ON THE FIRST LAYER FROM TOP AND FIRST LAYER FROM BOTTOM.)

NEGATIVE REINFORCEMENT

COL. NO.	DESIGN MOMENT (FT-K)	GOV. PATT.	BAL.RFS. MOMENT (FT-K)	STEEL AREA COLUMN (SQ.IN)	STEEL AREA MIDDLE (SQ.IN)	INFLEX.PT. LEFT (FT)	GOV. PATT	INFLEX.PT. RIGHT (FT)	GOV. PATT
1	-206.29	4	975.19	4.49	.21	2.00	3	4.80	2
2	-444.49	4	975.19	7.79	4.02	8.64	3	8.54	2
3	-361.48	4	975.19	6.22	3.23	8.84	2	7.68	3
4	-367.02	4	975.19	6.32	3.29	8.64	3	8.69	2
5	-367.02	4	975.19	6.32	3.29	8.64	2	8.48	3
6	-361.48	4	975.19	6.22	3.23	7.68	3	8.48	2
7	-444.49	4	975.19	7.79	4.02	8.64	2	8.44	3
8	-206.29	4	975.19	4.49	.21	4.80	2	2.00	3

POSITIVE REINFORCEMENT

SPAN NO.	MAX. POS.M. (FT-K)	AT POINT (FT)	GOV. PATT.	BAL.RES. MOMENT (FT-K)	STEEL AREA COLUMN (SQ.IN)	STEEL AREA MIDDLE (SQ.IN)	INFLEX.PT. LEFT (FT)	GOV. PATT	INFLEX.PT. RIGHT (FT)	GOV. PATT	MIN.MT. EQ.13.2 (FT-K)	A.MIN. SEC.7.13 (SQ.IN)
1	203.7	10.7	4	825.6	4.06	2.70	5.8	4	5.8	2	532.03	4.15
LEFT DROP PANEL EXTENDS INTO POSITIVE MOMENT AREA												
2	151.2	12.2	3	825.6	2.98	1.98	5.8	3	5.8	3	524.15	4.15
3	156.4	12.0	2	825.6	3.08	2.05	5.8	2	5.8	2	524.15	4.15
4	155.5	12.0	3	825.6	3.06	2.04	5.8	3	5.8	3	524.15	4.15
5	156.4	12.1	2	825.6	3.08	2.05	5.8	2	5.8	2	524.15	4.15
6	151.2	11.9	3	825.6	2.97	1.98	5.8	3	5.8	3	524.15	4.15
7	203.7	13.8	4	825.6	4.06	2.70	5.8	2	3.8	4	532.03	4.15

RIGHT DROP PANEL EXTENDS INTO POSITIVE MOMENT AREA

TYPEOUT OF REINFORCING DETAILS

NOTE--LENGTH OF TOP BARS BASED ON MOMENT ENVELOPE

NEGATIVE REINFORCEMENT

NOTE--BARS ARE DISTRIBUTED UNIFORMLY ACROSS THE COLUMN AND MIDDLE STRIPS.

COLUMN STRIP(OVER COLUMNS) ** MIDDLE STRIP

COL NO.	BAR SIZE	LONG BARS NO.	LEFT	RIGHT *	SHORT BARS NO.	LEFT	RIGHT **	BAR SIZE	LONG BARS NO.	LEFT	RIGHT *	SHORT BARS NO.	LEFT	RIGHT
(1)	N 4	11	2.0	7.9	12	2.0	4.0	N 4	11	2.0	5.3	0	0.0	0.0
ADD 15 NO. 4 BARS IN 2.7 FT. WIDTH OVER COLUMN 1 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(2)	N 6	9	9.9	9.9	9	7.0	6.5	N 4	20	5.3	5.3	0	0.0	0.0
ADD 2 NO 6 BARS IN 3.0 FT. WIDTH OVER COLUMN 2 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(3)	N 5	10	9.6	9.7	11	6.5	6.6	N 4	16	5.3	5.3	0	0.0	0.0
ADD 3 NO.5 BARS IN 3.0 FT. WIDTH OVER COLUMN 3 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(4)	N 5	10	9.6	9.6	11	6.8	6.8	N 4	17	5.3	5.3	0	0.0	0.0
ADD 2 NO 5 BARS IN 3.0 FT. WIDTH OVER COLUMN 4 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(5)	[illegible]	10	9.6	9.6	11	6.8	6.8	N 4	17	5.3	5.3	0	0.0	0.0
ADD [illegible] 5 BARS IN 3.0 FT. WIDTH OVER COLUMN 5 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(6)	[illegible]	10	9.7	9.6	11	6.6	6.5	N 4	16	5.3	5.3	0	0.0	0.0
ADD 3 NO 5 BARS IN 3.0 FT. WIDTH OVER COLUMN 6 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(7)	N 6	9	9.9	9.9	9	6.5	7.0	N 4	20	5.3	5.3	0	0.0	0.0
ADD 2 NO 6 BARS IN 3.0 FT. WIDTH OVER COLUMN 7 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														
(8)	N 4	11	7.9	2.0	12	4.0	2.0	N 4	11	5.3	2.0	0	0.0	0.0
ADD 15 NO 4 BARS IN 2.7 FT. WIDTH OVER COLUMN 8 TO MEET CRITERIA FOR TRANSFER OF MOMENT FROM SLAB TO COLUMN														

REINFORCING IN SPANS

COLUMN STRIP ** MIDDLE STRIP

SPAN NO.	BAR SIZE	BOTTOM BARS: LONG BARS & NO. LENGTH	SHORT BARS NO. LENGTH	TOP BAR SIZE	UNBROKEN SPANS NO. LENGTH	BAR SIZE	BOTTOM BARS: LONG BARS NO. LENGTH	SHORT BARS NO. LENGTH	TOP BAR SIZE	UNBROKEN SPANS NO. LENGTH
(1)	N 5	7 X 18.5	7 X 18.5	N 0	0 X 0.0	N 5	5 X 24.0	4 X 20.0	N 0	0 X 0.0
(2)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	4 X 23.5	3 X 16.0	N 0	0 X 0.0
(3)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	4 X 23.5	3 X 16.0	N 0	0 X 0.0
(4)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	4 X 23.5	3 X 16.0	N 0	0 X 0.0
(5)	N 5	5 X 18.5	5 X 18.5	N 0	0 X 0.0	N 5	4 X 23.5	3 X 16.0	N 0	0 X 0.0
~~(6)~~	~~N 5~~	~~5 X 18.5~~	~~5 X 18.5~~	~~N 0~~	~~0 X 0.0~~	~~N 5~~	~~4 X 23.5~~	~~3 X 16.0~~	~~N 0~~	~~0 X 0.0~~
(7)	N 5	7 X 18.5	7 X 18.5	N 0	0 X 0.0	N 5	5 X 24.0	4 X 20.0	N 0	0 X 0.0

MATERIAL QUANTITIES

TOTAL SLAB REINFORCEMENT IN ONE DIRECTION

NEGATIVE STEEL 3406.2 POUNDS POSITIVE STEEL 2681.0 POUNDS

OTHER QUANTITIES

SURFACE AREA 6128.0 SQ.FT. YARDAGE OF CONCRETE 107.85 CU.YD.

REINFORCEMENT PER AREA 1.975 POUNDS PER SQUARE FOOT, IN ONE DIRECTION

APPROXIMATE DEFLECTIONS

APPROXIMATE MIDSPAN DEFLECTIONS

NOTE 1) SEE PAGE OF USERS MANUAL FOR THE FLATE PLATE PANEL CENTER DEFLECTION

---- 2) REFER TO TABLE V.5(B) OF CODE FOR ALLOWABLE COMPUTED DEFLECTIONS

SPAN NO.	DEAD LOAD DEFL.(IN.)	MAX. LIVE LOAD DEFL.(IN.)	V.5.2.3 LONG TIME DEFL.(IN.)
1	.190	.247	.626
2	.136	.179	.452
3	.144	.190	.479
4	.145	.188	.474
5	.144	.190	.479
6	.136	.179	.452
7	.190	.247	.626

APPROXIMATE CANTILEVER DEFLECTIONS (ALTERNATE LOADING FOR ALL DESIGN CONDITIONS - CONDITION-1 INCLUDED)

CANTILEVER	DEAD LOAD DEFL.(IN.)	MAX. LIVE LOAD DEFL.(IN.)
LEFT	-.063	.045
RIGHT	-.063	.045