Research Report

ECONOMIC CONSIDERATIONS IN THE DESIGN OF MULTI-STORY FRAMES

By

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CHAPTER I
INTRODUCTION

1.1 General.

Typical framing in multi-story buildings consists of columns and beams which support both gravity and lateral loads. The use of different types of construction and different types of steel permits many possibilities for alternate choices of members. Sizes of beams used in multi-story buildings depend to a large extent on the type of floor system used. Columns generally have a low slenderness ratio because the floor to floor height is usually relatively small and axial loads are high. The nominal column depth selected for use in a particular design can significantly affect the overall economy of the structure.

When a structure is designed to resist lateral forces as well as gravity loads by flexural action, it is necessary to consider bending moments in the columns. When lateral loads are resisted by shear walls or braced bents the columns are usually designed assuming that bending moments are negligible. The structural behavior of multi-story buildings under the action of lateral force is quite complex and highly indeterminant because of the dynamic nature of the loads. Common practice in design is to replace the dynamic loading conditions by equivalent static loads.

The purpose of this study is to compare the economies of using W12 or W14 column sections in both braced and unbraced multi-story frames. To develop design data from which costs can be determined, a preliminary design methodology was first developed, then a computer program written implementing this methodology, and finally case studies developed.

1.2 Limitations of the Study.

This study was limited to a single floor plan with both braced and unbraced bents for lateral load resistance. (The computer program is capable of handling almost unlimited framing schemes.) The building was analyzed for wind loads found in five areas of the southeastern portion of the United States. In addition, a design was completed for earthquake loading for the Los Angeles area. Designs using both A36 and A572 Gr 50 steels were made for building heights up to the maximum number of stories that W12 sections can support. Total frame weight for each design was calculated but basic steel and fabrication costs are not part of this study.

The maximum drift for each design was calculated but no modifications were made because of excessive drift. The selection of a drift control criterion may be depend on the area in which the building is located or on the purpose of the building. For high rise buildings, a deflection criterion may become the controlling factor rather than the strength of the structural members and certain modifications are then required to keep the drift index under the desired limitation. The computer program described herein can easily be modified to accomplish this purpose.

1.3 Description of Methods Used.

The design methodology presented here consists of gravity load analysis, lateral load analysis, selection of structural members, and an estimate of lateral deflections for the frame. The method employed for gravity load analysis is two-cycle moment distribution and that for lateral load analysis is the portal method for unbraced frames. Since the braced frame configuration used in this study is determinate, axial forces can be computed directly from equilibrium considerations and no specific analysis is required.

Two-cycle moment distribution is performed for a single story assuming the far ends of the columns are fixed. Assumptions are made regarding the distribution factors at each joint; the distribution factor for the columns above and below the story level are assumed to be equal. Unbalanced and patterned live loadings are considered in the analysis.

The portal method of analysis is based on two geometric approximations; first, the inflection points are assumed to occur exactly at the center of all beams and columns and second, it is assumed that each column in a story resists a percentage of the total horizontal shear on that story in proportion to the width of the respective bays. With horizontal shears in each column, column moments and girder moments can be determined from simple statics. Columns axial loads due to lateral load effects can then be directly determined.

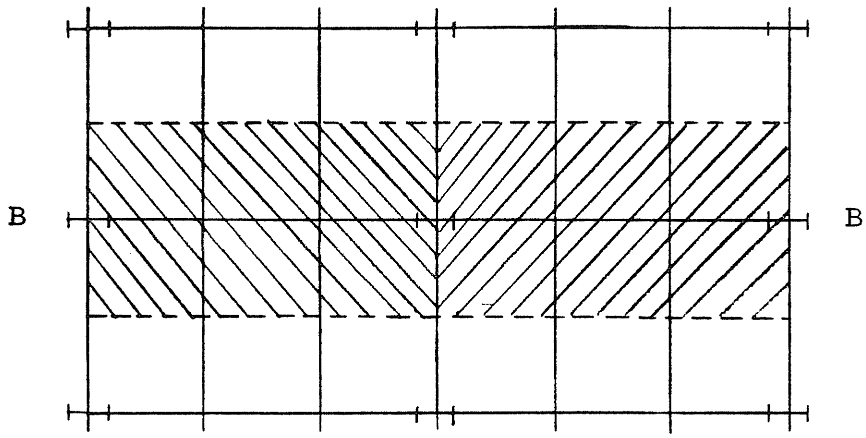
The design methodology is explained in detail in Chapter II and an extensive set of design examples is presented in Chapter IV.

CHAPTER II
DESIGN METHODOLOGY

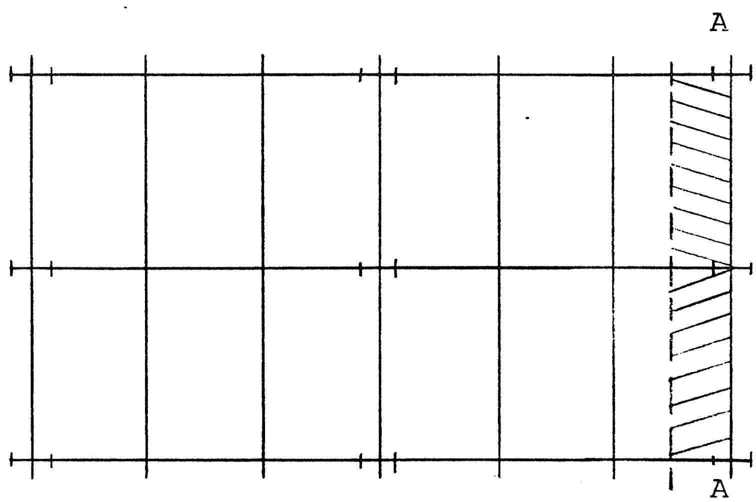
2.1 Gravity Load Analysis.

Figure 2.1 shows the assumed distribution of gravity loads to frames used in this report. For frame A-A of Figure 2.1a the filler beams are transverse to the girders. The loading is taken as a uniform load along the entire length of the girders and is equal to the distributed load over one half of each bay on each side of the girder. For frame B-B of Figure 2.1b, the beams are parallel to the girders and the girder load is taken as a uniform load equal to the distributed load over one half the distance from the girder to the first interior beam. Weight of the exterior wall is included on girders in frames around the perimeter of the building. The computer program described later, automatically includes self weight of the members in the design.

Two-cycle moment distribution is used to determine column and girder gravity moments. A reasonable approximation is assumed for the distribution factors for end moments at column-girder joints. Since a preliminary selection of members sizes must be made before relative stiffnesses are known, the distribution factors shown in Figure 2.2 are assumed. The distribution factors shown in Figure 2.2a are for the uppermost story and the factors in 2.2b are for intermediate stories. After initial selection of members,

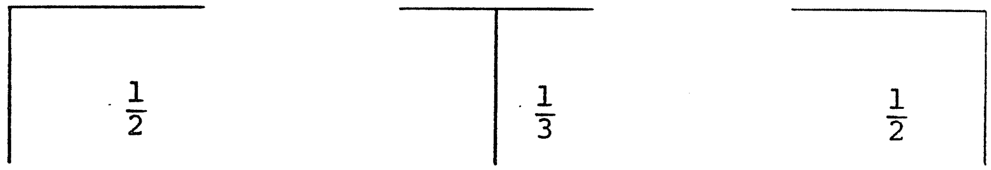


a) Beams Perpendicular to Girders

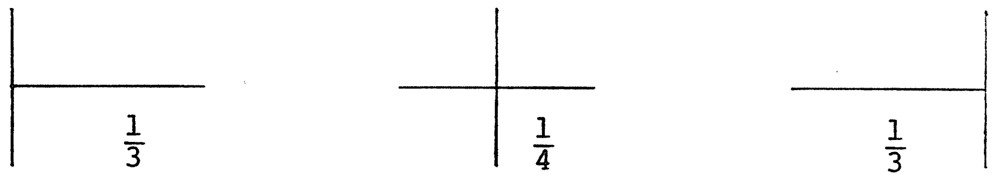


b) Beams Parallel to Girders

Figure 2.1 Distribution of Gravity Loads to the Frame



a) Uppermost Story



b) Intermediate Story

Figure 2.2 Assumed Moment Distribution Factors

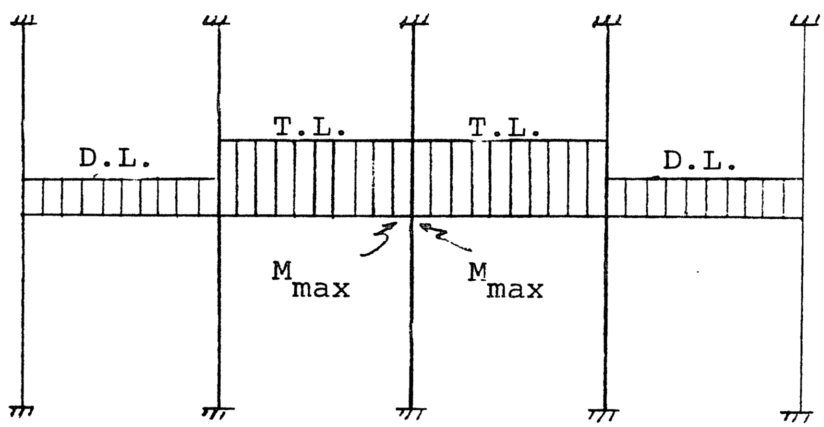


Figure 2.3 Loading Conditions for Critical Girder Negative Moments

an exact calculation of the distribution factor is made in the automatic redesign procedure.

To find maximum end moments for the girders and columns consideration is given to various live load patterns. Maximum negative girder moments and maximum column end moments for gravity loading are found from the load distribution shown in Figure 2.3. Using two-cycle moment distribution, the maximum moments are found at each location at each level of the unbraced frames. Maximum positive moments in the spans of the girders are not critical in typical unbraced frames and are not calculated in the analysis.

A numerical example follows for the geometry and loading condition shown in Figure 2.4.

Step 1.

Moment distribution factors using the approximate assumption are shown in Figure 2.5.

Step 2.

The fixed end moments are computed using $wL^2/12$. For the sign convention used here, the moment at the left end of the span is negative and that at the right end is positive. The fixed end moments for an intermediate level are shown in Figure 2.5. Total load is applied to the center span and dead load to the two exterior loads.

Step 3.

Unbalanced moments at the joint are distributed using the distribution factors.

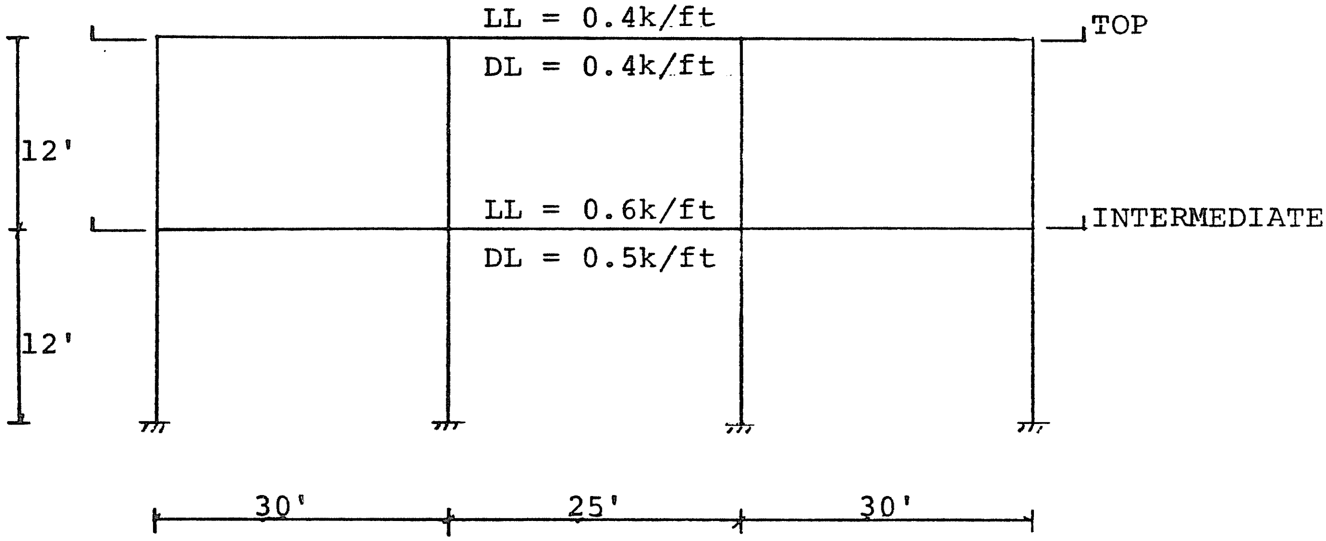


Figure 2.4 Frame Dimensions and Loading for Example Calculations

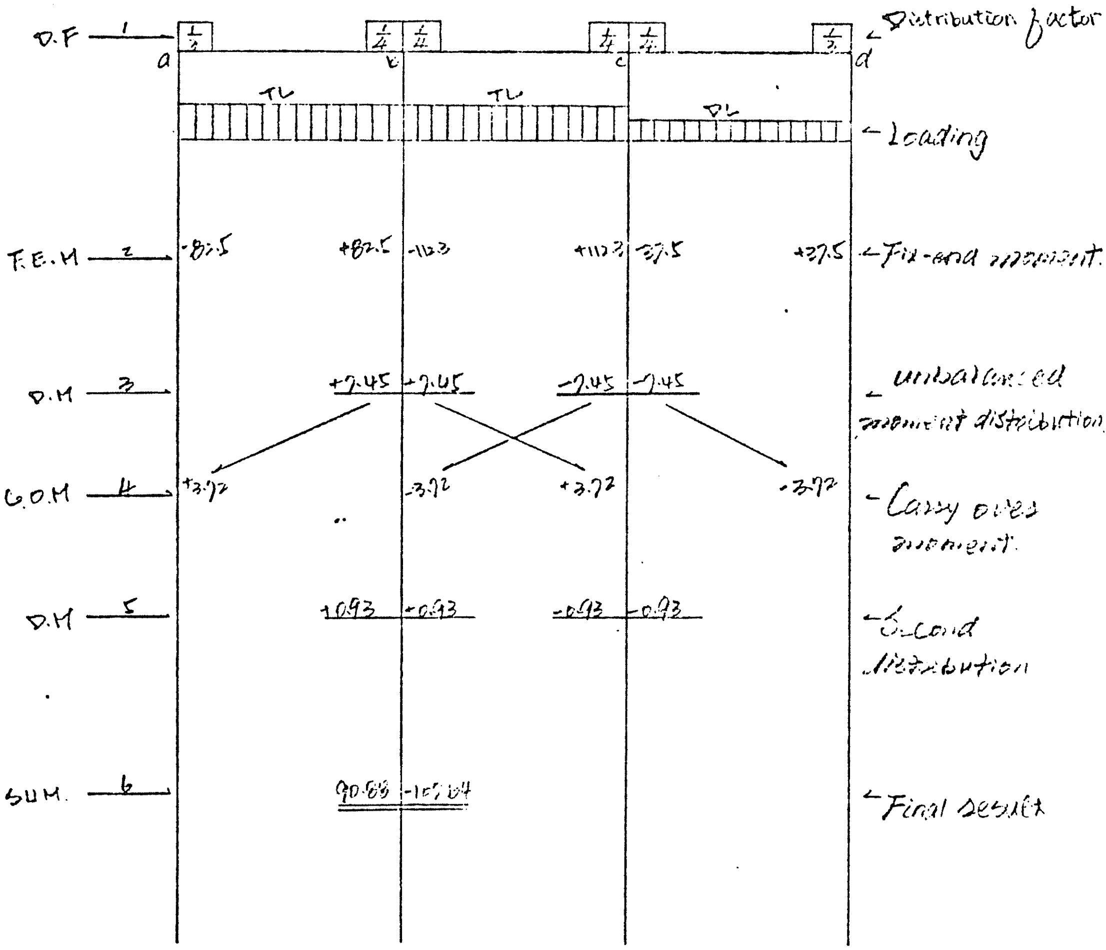


Figure 2.5 Example of Two-Cycle Moment Distribution

Step 4.

The distributed moments from Step 3 are then carried over to the far ends of the members. It is noted that the carry-over moments constitute half of the new set of fixed end moments for the far ends.

Step 5.

The new unbalanced moment at each joint is distributed using the same process as in Step 3. Steps 3 and 4 can be continued alternately until the carry over moment is negligible.

Step 6.

Sum up the moments from all fixed end, distributed and carry-over moments to obtain the final result.

For typical frames, the unbalanced end moments after the second distribution are small enough to be neglected. Thus, only two cycles of distribution are used in the preliminary design procedure.

2.2 Lateral Load Analysis.

For the purposes of this study, both wind and earthquake lateral loads are represented with static concentrated loads at floor levels. Applicable building codes are used to determine wind loading distributions. In general, these distributions are a function of the location and height above ground level.

Earthquake loads are represented with an equivalent static load computed from the formula:

$$V = ZIKCSW \tag{2.1}$$

where Z = a numerical coefficient depending upon the area of the country, I = occupancy importance factor, K = a numerical coefficient dependent on the type or arrangement of the building, $C = 1/\sqrt{15T}$, a coefficient dependent on the fundamental elastic period of vibration T, and W = the total building dead load. The total lateral force V is distributed over the height of the building in accordance with the following formula:

$$F_x = (V-F_t) \frac{w_x h_x}{\Sigma w_i h_i} \tag{2.2}$$

where w_i and h_i are dead load and story height for a general level, and w_x and h_x are for a designated level. F_t is the equivalent load at the uppermost level.

Once the lateral loads are known the postal method is used in the following way:

Step 1.

The total story shears due to the lateral loads above each story are distributed among the columns in direct proportion to the width of the bays that the columns support. Thus, in the case of equal bays, the exterior columns of the bent are assumed to take one half as much shear as the interior columns. An example is shown in Figure 2.6a.

Step 2.

The moments in all columns of the bent are then computed. Since the point of contraflexure is assumed to be at mid-story height, the moments at the top and bottom of a column are equal and each is the product of the column shear and half of the story height.

Step 3.

Beginning at the upper left corner of the frame and working toward the right and downward, the wind moments in the girders can then be found from joint equilibrium. The sum of the girder moments adjacent to a given joint is numerically equal to the sum of the column moments at the same joint but of opposite signs.

Step 4.

The girder shears are then determined. The shear in a girder is equal to the sum of its end moments divided by the span.

Step 5.

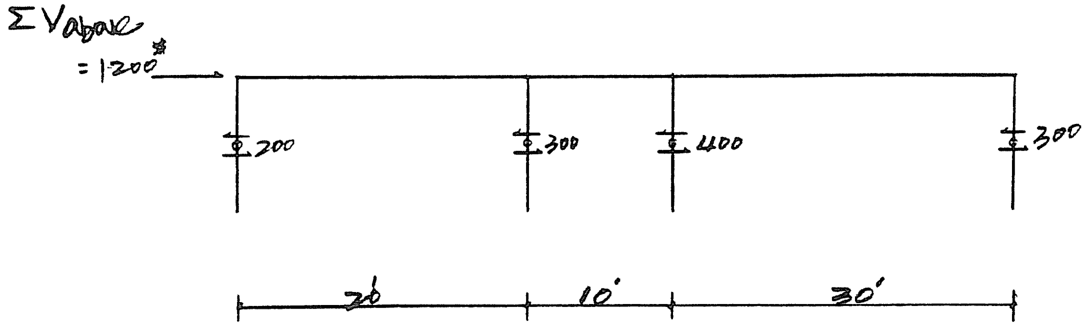
Axial forces in the columns due to the lateral loads are then found by imposing equilibrium at a joint with the girder shears known.

End moments, shears and axial forces for a typical intermediate story are shown in Figure 2.6b.

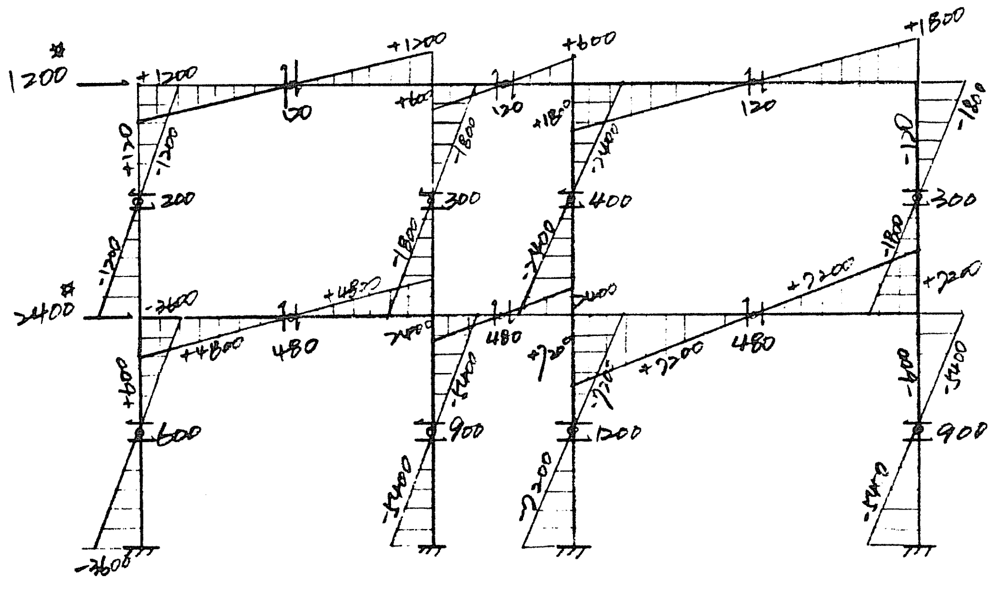
2.3 Preliminary Selection of Member Sizes.

For the purposes of this study, only two load combinations were considered: dead plus live, or full gravity load, and dead plus live plus wind. Since most specifications and codes permit a 33 1/3 per cent increase in allowable stresses if wind or earthquake load is present, only three-fourths of dead plus live plus lateral load was used.

Preliminary girder sections are determined using the maximum moment from the two loading cases and assuming



a) Distribution of Lateral Loads



b) Moment Diagram

Figure 2.6 Numerical Example of the Portal Method continuous lateral support. That is, the required section modulus is found from

$$S_R = \frac{M}{F_b} \tag{2.3}$$

where M = the maximum girder moment, F_b = the allowable bending stress taken as .66 F_y, where F_y is the specified yield stress for the material, and S_R = the required section modulus. Only the maximum negative moment is considered, since in most frames it is always greater than the maximum positive moment. Typically, the gravity loading condition governs only for the uppermost three or four stories of the frame.

Preliminary column sections are determined using the maximum combination of end moment and axial load considering the two loading cases. The initial column sections are determined from a list of available sections, e.g., W12 or W14 sections. Adequacy of the sections is determined using AISC formulas 1.6-1a and 1.6-1b. The equations are repeated here for convenience. Formula 1.6-1a:

$$\frac{f_a}{F_a} + \frac{C_{mx}\, f_{bx}}{(1 - \frac{f_a}{F'_{ex}})\, F_{bx}} + \frac{C_{my}\, f_{by}}{(1 - \frac{f_a}{F'_{ey}})\, F_{by}} \leq 1.0 \tag{2.4}$$

Formula 1.6-1b:

$$\frac{f_a}{0.6F_y} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \leq 1.0 \tag{2.5}$$

Formula 1.6-1a checks stability of the member and 1.6-1b is used to check yielding at the member ends. Parameters used in these formulas have detailed explanations in the AISC specification and are not repeated here.

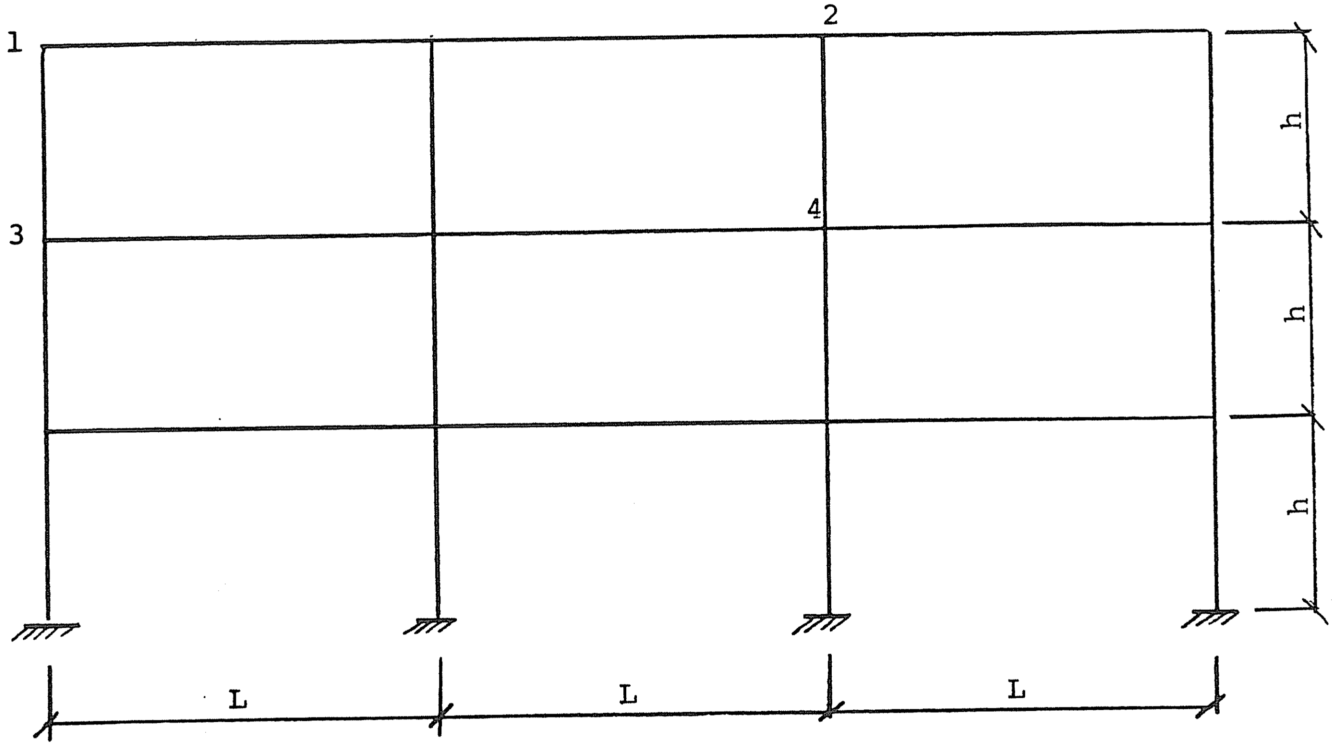
2.4 Estimation of Frame Drift.

The ability of bents to limit lateral deflections is of prime importance when the serviceability of multi-story steel buildings is considered. The parameter most commonly used as a measure of frame stiffness is the drift index which is defined as the lateral deflection at the uppermost level of the frame divided by the height of the building. Common practice is to limit the drift index to 0.002 to 0.0035. Because of the wide range of acceptable drift indices, no attempt was made to iterate the designs to satisfy a particular drift index criterion.

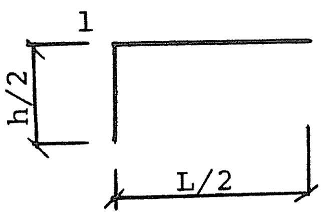
The method developed by Cheong-Siat-Moy as described in References 1-5 was used. The method, referred to herein as the C-S-M method, is simple to use and its accuracy has been confirmed by comparison with conventional elastic methods. The concept upon which the method rests is that the stiffness of the story can be represented by the sum of the stiffnesses of its subassemblages. A subassemblage is a substructure consisting of one column and its restraining girders as shown in Figure 2.7. The lateral displacement, Δ, at any story level for a total story shear, Q, is found from

$$\Delta = Q/S_T \tag{2.6}$$

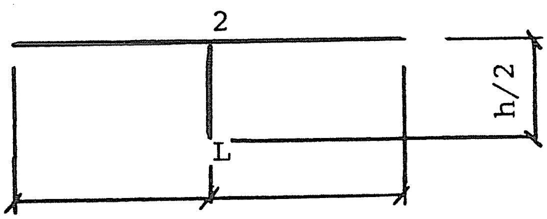
where S_T = story stiffness = $\frac{12E}{h^3} \sum^{m} \left(\frac{I_c}{1+2\psi}\right)$ and m = number of



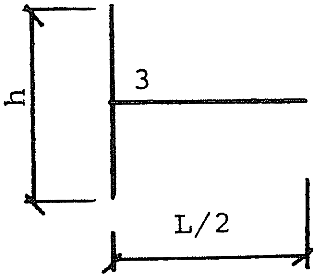
a) Typical Rigid Frame



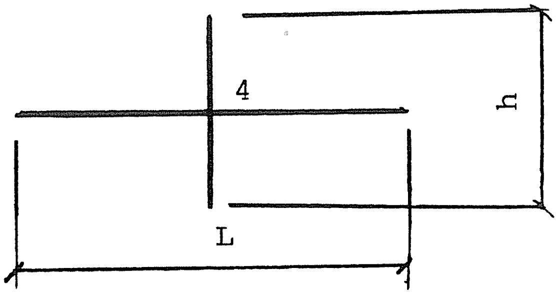
a) Uppermost Exterior



b) Uppermost Interior



c) Intermediate Exterior



d) Intermediate Interior

Figure 2.7 Story Subassemblages for Deflection Calculations columns in a story, h = story height and ψ = ratio of column stiffness to beam stiffness.

Comparisons of lateral deflection predicted by the method described above and standard stiffness analyses are presented in a following section.

2.5 Computer Program.

A computer program, Appendix A, was developed to implement the design methodology described in Sections 2.1-2.4. The rigid frame, unbraced frame, program can theoretically handle any size of frame with the following considerations: First, member sections must be available in the input data. Second, the frame must be "rectangular", that is, all beams and columns intersect at right angles with no missing beams or columns. Third, the accuracy of the preliminary methods used must be considered.

Input for the program consists of frame geometry, uniformly distributed gravity loads for all stories and concentrated lateral loads at story levels. Output consists of critical moments and axial loads, selected section sizes, total frame weight, and the drift index. So that economic comparisons can be made, two designs are made for each run: 1) using only W12 column sections and 2) using only W14 column sections. Automatic redesign occurs in the program so that correct distribution factors are used in the gravity load analysis.

In Chapter 4, results of a preliminary design using the computer program are compared to an "exact" analysis using a commercially available stiffness analysis program and manual checking of all members sizes selected.

CHAPTER III
DESIGN METHODOLOGY FOR BRACED FRAME

3.1 General.

Basically, a braced frame is defined as one in which sidesway buckling is prevented by bracing elements of the structure other than the structural frame itself. It is assumed in an elastic stability analysis that a braced frame has negligible moment resistance from columns and girders, and negligible shear restraint from diagonals or other bracing. In other words, all joints are assumed to be simple connections and horizontal forces are carried by the bracing elements.

3.2 Thrust and Moments Due to Gravity Loads.

Since braced frames are considered to be constructed using simple connections, the axial forces and moments due to gravity loads can be calculated as for truss structures. Beams are designed to carry the maximum midspan moment only and columns to carry the gravity loads as

$$M = wL2/8 \tag{3.1}$$

and

$$P = w \times \text{area} + \text{member weights} \tag{3.2}$$

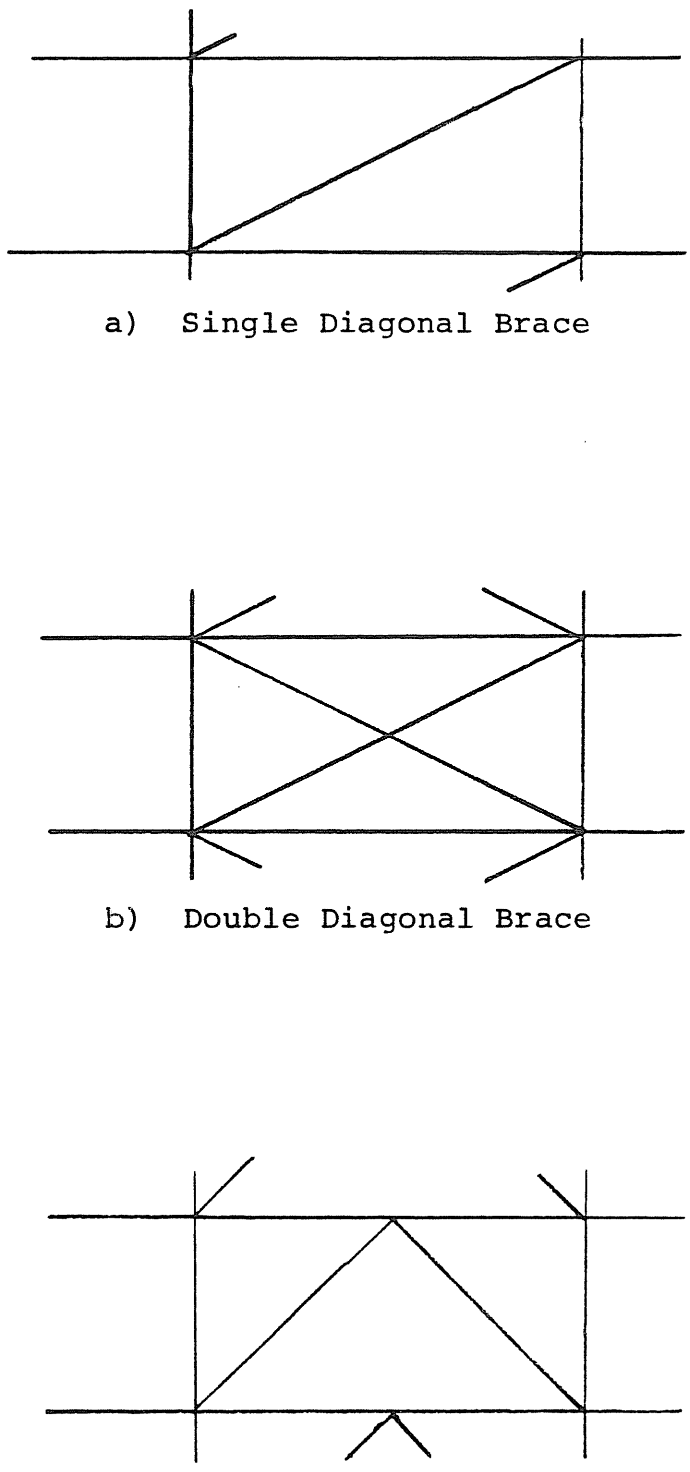
where w = distributed loading and L = span.

Beams and columns are designed for M and P, respectively. The effective length factor for columns is taken as 1.0. For the design program developed in this study, AISC formulas 1.5-1 and 1.5-2 were used to determine column capacity.

3.3 Bracing.

A computer program, Appendix B, was developed to analyze bents with the three types of bracing schemes shown in Figure 3.1. For each scheme, the story shear was divided equally between the bracing members in a story and the resulting axial forces and column thrusts computed. Because of the wide variety of sections that can be used for bracing members and because of the relative ease of design, no attempt was made to provide final member selection.

Input for the program consists of frame geometry and gravity and lateral loadings. Output consists of an echo of input data, column axial forces and bracing forces. A sample output is shown in Appendix J.



a) Single Diagonal Brace

b) Double Diagonal Brace

c) K - Brace

Figure 3.1 Bracing Schemes

CHAPTER IV
DESIGN EXAMPLES

4.1 Limitations.

To study the economics of W12 column sections a series of design examples was generated. The framing plan shown in Figure 4.1 was used. Lateral resistance in the long direction of the building is provided by unbraced frames A-A. Lateral resistance in the short direction comes from braced frames B-B. All interior beam to column sections are considered to be ASCE Type 2, that is, simple connections. Designs were prepared for wind loadings found in Atlanta, Georgia; Dallas, Texas; Jacksonville, Florida; Houston, Texas; Los Angeles, California and New Orleans, Louisiana. Three designs were prepared for each location: a 7-story building, a building with a maximum height that can be supported by W12 columns, and a building with an intermediate number of stories. Designs were made for both A36 and A572 Grade 50 steels. The following loadings were assumed:

Roof Dead Load = 20 psf
Roof Live Load = 20 psf
Floor Dead Load = 3.25 in. of 100 pcf concrete + beam weight + 2.0 psf deck weight
= 30.6 psf
Floor Live Load = 80 psf
Exterior Wall Weight = 20 psf

A reduction in live load as permitted by the Code was used.

Wind Loads were determined using the Uniform Building Code requirements for the various cities as shown in Table 4.1.

Table 4.1 Wind Pressure for Various Cities and Height Zones

Height Zone (FEET)	WIND PRESSURE, psf					
	ATLANTA	DALLAS	HOUSTON	JACKSONVILLE	LOS ANGELES	NEW ORLEANS
Less than 30	20	20	25	29	15	24
31∿50	28	25	35	40	20	34
51∿100	33	30	45	48	25	40
101∿200	40	40	55	58	30	49
201∿300	42	40	55	67	30	52
301∿400	52	40	55	74	30	62

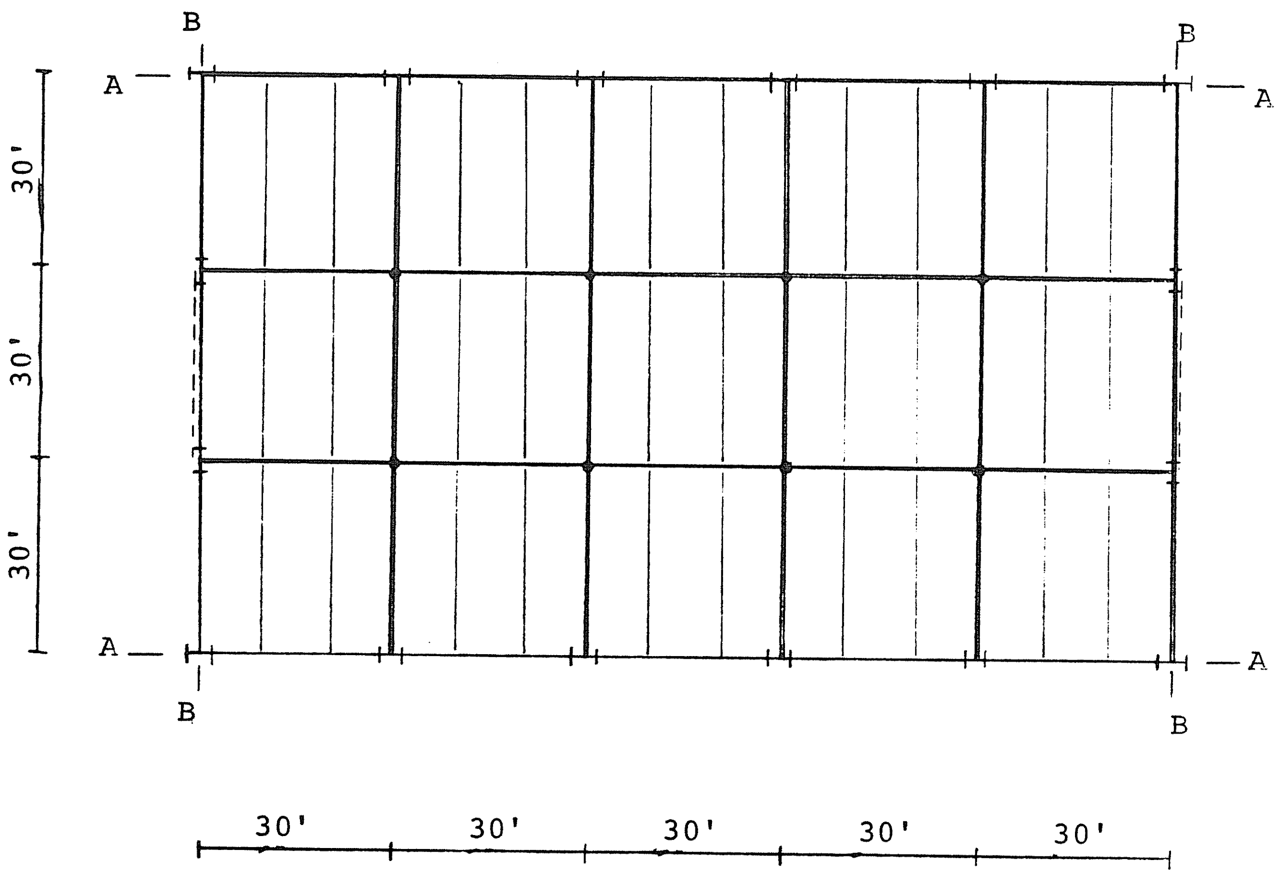


Figure 4.1 Framing Plan for Example Designs

The example building was also analyzed for earthquake loading in the Los Angeles area. For the analysis, horizontal shear forces were computed as described previously with Z, I, K taken as 1.0.

In the following sections, results of the designs and comparisons with more rigorous design and analysis methods are discussed.

4.2 Frame A Design (Unbraced Frame).

4.2.1 Input Data

In the design examples, Frame A is an unbraced frame five bays in width. The bays are equal, 30 ft. each, and story heights are 14 ft. for the first level and 12 ft. for all other levels.

The uniformly distributed gravity loading for each of the girders based on the design data given is as follows:

Roof Dead Load - 0.3 kips/ft.
Roof Live Load - 0.3 kips/ft.
Floor Dead Load - 0.46 kips/ft.
Floor Live Load - 0.82 kips/ft.

Lateral loads computed from wind pressure data given in Table 4.1 are shown in Table 4.2 for the five design cities and to the 24th level.

Earthquake loads for the Los Angeles area 7-story example building, together with calculations are shown in Figure 4.2.

4.2.2 Verification of Proposed Methodology

To verify the methodology for unbraced frames described in Chapter 2, the 7-story frame designed for the Houston, Texas area shown in Figure E.1 was analyzed using the

Table 4.2 Wind Lateral Loads for Various Levels

	Lateral Load, Kips				
City / Story	ATLANTA	DALLAS	HOUSTON	JACKSONVILLE	NEW ORLEANS
24	11.74	10.80	14.85	16.87	13.78
23	23.48	21.60	29.70	33.74	27.56
22	do	do	do	do	do
21	do	do	do	do	do
20	do	do	do	do	do
19	do	do	do	do	do
18	do	do	do	do	do
17	do	do	do	do	do
16	21.60	do	do	31.32	26.45
15	do	do	do	do	do
14	do	do	do	do	do
13	do	do	do	do	do
12	do	do	do	do	do
11	do	do	do	do	do
10	do	do	do	do	do
9	do	do	do	do	do
8	19.70	18.90	27.0	28.62	24.02
7	17.82	16.20	24.30	28.92	do
6	do	do	do	do	do
5	do	do	do	do	do
4	16.47	14.85	21.60	23.76	20.0
3	14.88	13.35	18.52	21.28	18.06
2	11.76	11.40	14.70	16.97	14.16
1	11.70	11.70	14.63	16.96	14.04

EARTHQUAKE LATERAL FORCES

$V = Z\ I\ K\ C\ S\ W$

Z = area factor = 1.0

I = occupancy factor = 1.0

K = building factor = 1.0

CS = coefficient depending on vibration period

$= 1/10\sqrt{T}$

W = total building dead load

$= 290 + 549\ (NS-1)$

$V = [290 + 549\ (NS-1)]/10\sqrt{T}$

for 7-story frame $NS = 7$, $T = 0.7$

$V = 426.5$ kips

DISTRIBUTION OF EARTHQUAKE FORCES

Top Level: $F_t = 0.07 \times T \times V = 0.049V$

Other Levels: $F_x = (V-F_t) \times \dfrac{W_x h_x}{\Sigma W_i h_i}$

Equivalent lateral load at each level:

7th	10.45 kips
6th	56.24 kips
5th	47.12 kips
4th	37.50 kips
3rd	28.88 kips
2nd	19.76 kips
1st	10.46 kips

Figure 4.2 Earthquake Load for 7-Story Frame, Los Angeles

computer program STRUDL. Comparison of results is shown in Tables 4.3 to 4.5. Table 4.3 compares column axial loads obtained from the proposed methodology and those obtained from the STRUDL analysis. The maximum difference is 11.4%. Beam moments from the two procedures are shown in Table 4.4; the maximum difference is 7.3%. Comparison of column moments is found in Table 4.5 with a maximum difference of 4.5%.

Figure 4.3 shows a comparison of frame drift for the two procedures. The C-S-M method described in Chapter II predicts slightly less deflections than those given by the elastic stiffness analysis technique used in the STRUDL program. However, the differences are very small and the C-S-M method is deemed adequate for preliminary design.

From the above results, it is apparent that the proposed design methodology is accurate for preliminary design.

4.2.3 Results for Example Designs

The example building was designed for three heights and lateral load conditions in six cities. Designs were prepared using both W12 and W14 columns in order to determine the feasibility of using W12 columns in multi-story frames. Designs reported in this report were based on A36 steel. A second set of designs was prepared for A572 Gr 50 steels and the same conclusions were reached. Results for the six cities - Atlanta, Dallas, Houston, Jacksonville, Florida, Los Angeles, New Orleans, are shown in Appendices C to H, respectively. The building heights were seven stories, the maximum height for which W12 columns could be used, and

Table 4.3 Comparison of Preliminary Design and STRUDL Analysis Axial Loads

	COLUMN AXIAL LOAD, KIPS					
	BAY 1		BAY 2		BAY 3	
STORY	PRELIM.	STRUDL	PRELIM.	STRUDL	PRELIM.	STRUDL
7	9.30	9.04	18.00	18.87	18.00	18.70
6	33.94	31.56	65.28	66.68	65.28	65.56
5	58.64	53.91	112.68	114.68	112.68	112.36
4	83.49	76.14	160.39	162.78	160.30	159.15
3	108.40	98.47	208.35	211.30	208.26	206.27
2	133.48	120.63	256.64	259.96	256.55	253.40
1	158.78	142.52	305.57	308.99	305.48	300.44

Table 4.4 Comparison of Preliminary Design and STRUDL Girder Moments

	GIRDER BENDING MOMENT K-FT					
	BAY 1		BAY 2		BAY 3	
STORY	PRELIM.	STRUDL	PRELIM.	STRUDL	PRELIM.	STRUDL
R	50.61	48.66	47.46	47.15	46.65	46.61
7	131.40	124.21	125.94	117.54	123.78	117.06
6	146.20	137.77	138.74	129.39	139.18	129.12
5	168.36	163.93	158.11	147.30	159.79	148.38
4	186.59	177.54	175.10	168.48	178.39	167.02
3	203.57	197.51	190.54	187.05	194.39	186.20
2	212.78	205.97	198.59	194.95	203.39	192.61

Table 4.5 Comparison of Preliminary Design and STRUDL Column Moments

	COLUMN BENDING MOMENT K-FT					
	BAY 1		BAY 2		BAY 3	
STORY	PRELIM.	STRUDL	PRELIM.	STRUDL	PRELIM.	STRUDL
7	44.33	44.73	13.30	13.77	10.93	10.32
6	50.19	50.71	35.08	35.95	32.80	33.39
5	58.66	59.80	57.03	56.62	54.73	52.58
4	69.61	71.58	77.72	81.20	74.19	73.32
3	79.17	82.18	94.12	95.48	90.78	90.97
2	85.34	87.16	107.63	110.0	104.01	104.76
1	98.37	94.96	105.69	170.71	164.05	166.51

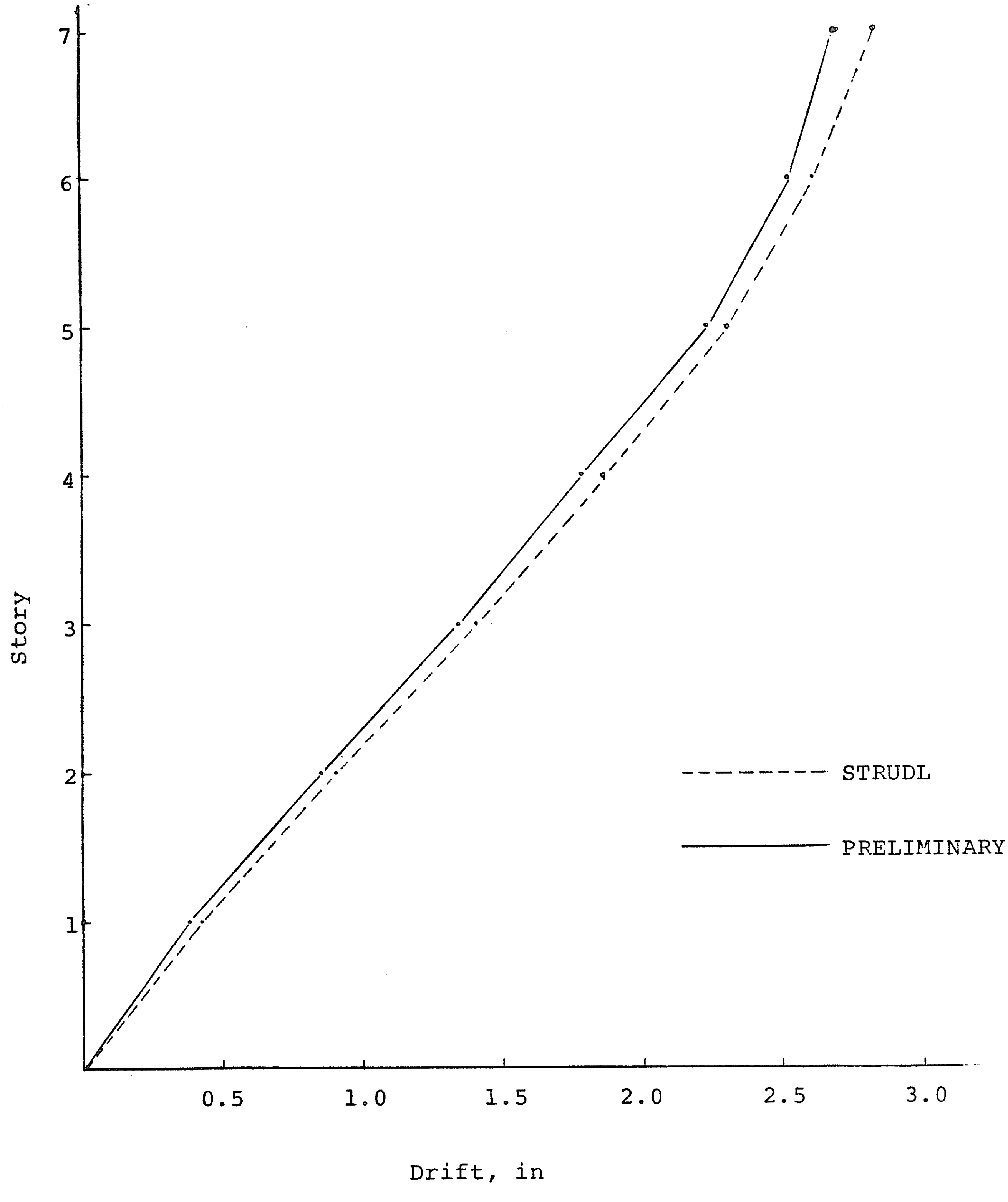


Figure 4.3 Drift Comparisons for 7-Story Frame, Houston, Texas

approximately halfway between the minimum and maximum heights.

Results for the Atlanta, Georgia location are found in Appendix C. Figure C.1 and C.2 are results for a 7-story structure using W12 and W14 columns, respectively. Figures C.3 and C.4 are for a 14-story structure and Figures C.5 and C.6 are for a 21-story structure using W12 and W14 columns, respectively. Comparison of drift and story height using W12 and W14 columns is shown in Figure C.7. The use of W12 columns results in a slightly larger lateral drift. Comparison of total frame weight using W12 and W14 columns for the three building heights is shown in Figure C.8. The use of W12 columns results in a slightly increased frame weight.

Results for 7-, 14-, and 21-story designs for the Dallas, Texas area are shown in Appendix D. Example designs for 7-, 12-, and 17-story structures in the Houston, Texas area are shown in Appendix E. Designs for 7-, 12-, and 16-story frames for Jacksonville, Florida are shown in Appendix F. Example designs for 7-, 13-, and 19-story structures for the Los Angeles, California area are shown in Appendix G and designs for 7-, 13-, and 18-story buildings for the New Orleans, Louisiana area are shown in Appendix H.

Comparison of the maximum number of stories that can be supported by W12 columns in the six subject cities is shown in Figure 4.4. The maximum height is 21 stories for the Atlanta, Georgia and Dallas, Texas area and the minimum is 16 stories for the Jacksonville, Florida area. Figure 4.5 shows a similar comparison using A572 Gr 50 steel. For this

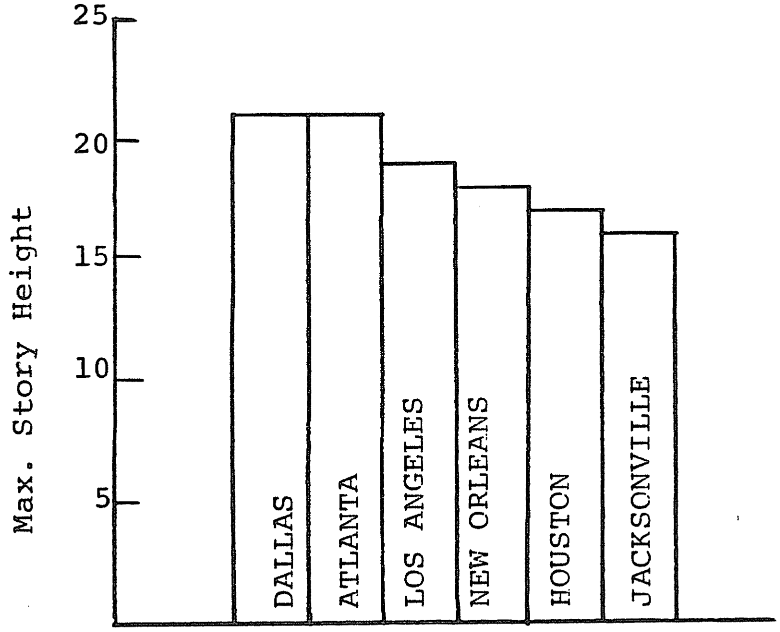


Figure 4.4 Maximum Height W12 Columns Can Support Using A36 Steel

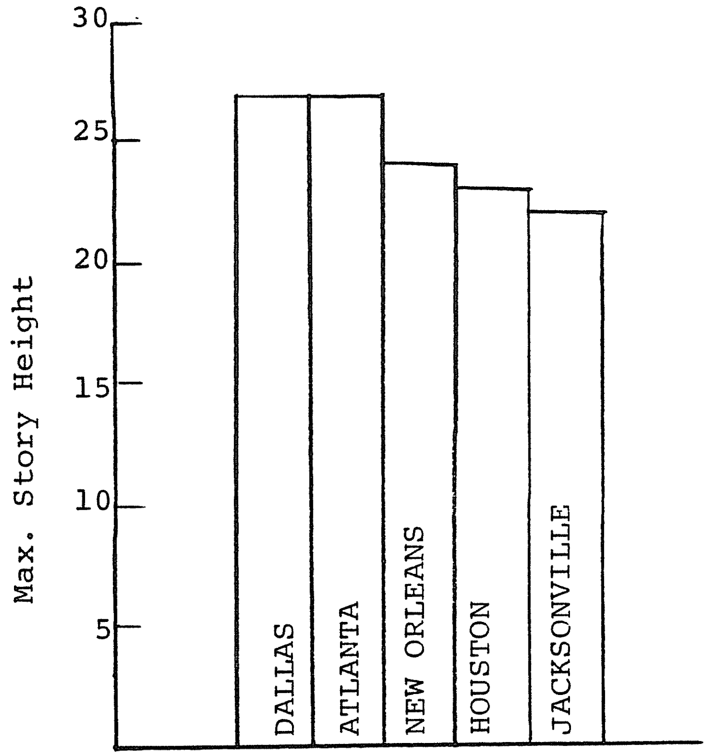


Figure 4.5 Maximum Height W12 Columns Can Support Using A572 Gr.50 Steel

steel grade, the maximum story height is 26 stories for both Atlanta, Georgia and Dallas, Texas and the minimum is 22 stories for Jacksonville, Florida. Obviously, the required design wind load governs the maximum story height that can be supported by W12 columns for a specific building plan.

Table 4.6 is a comparison of the weights of the eighteen designs using both W12 and W14 columns. The maximum percent increase in weight if W12 columns are used for the example structure is 3.98%.

4.3 Design for Frame B (Braced Frame).

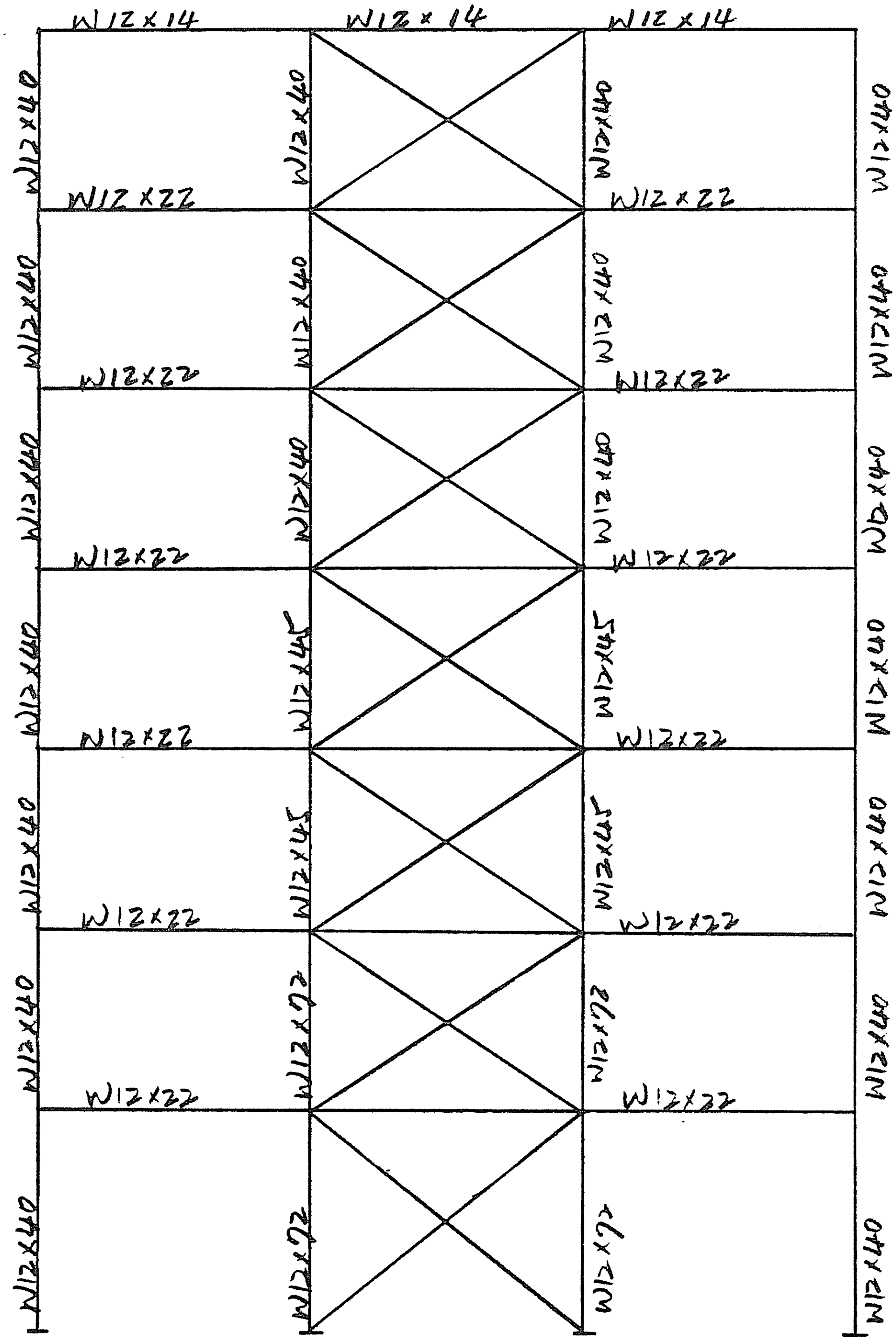
Because of the relative simplicity of the braced frame design procedure, only Frame B-B for the 7-story, Houston, Texas location is reported here. Sample output for the A36 steel design is shown in Appendix J and member sizes are shown for W12 and W14 column designs in Figures 3.53 and 3.54, respectively. The W12 design weighs 8.2% less than the W14 design.

TABLE 4.6

Comparison of Frame Weights Using

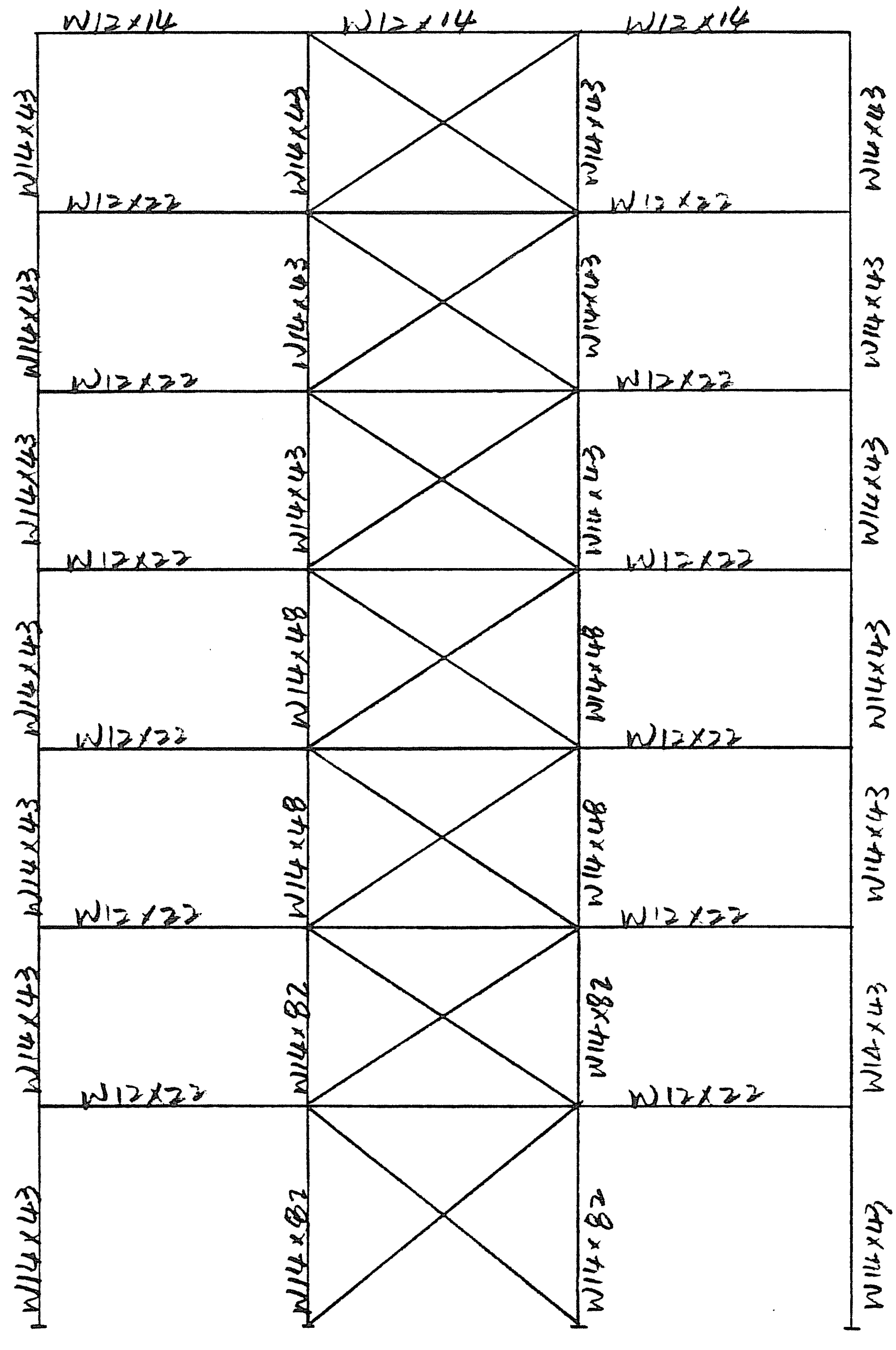
W12 and W14 Columns

City	No. of Stories	Frame Wt., kips		% Increase for W12 columns
		W12 column	W14 column	
ATLANTA	7	72.05	72.09	-0.05
	14	218.78	213.08	2.60
	21	450.07	436.65	2.98
DALLAS	7	70.79	71.01	-0.31
	14	216.91	211.32	2.57
	21	438.37	425.67	2.89
HOUSTON	7	78.38	77.80	0.74
	12	191.77	185.11	3.47
	17	357.43	344.98	3.48
JACKSONVILLE	7	79.38	78.89	0.61
	12	197.62	191.23	3.23
	16	329.13	318.56	3.21
LOS ANGELES	7	94.46	92.97	1.52
	13	234.04	225.75	3.54
	19	413.71	400.03	3.31
NEW ORLEANS	7	75.21	75.45	-0.32
	13	208.82	204.22	2.20
	18	374.46	359.54	3.98



Total Column Wt. - 15,664 lbs.

Figure 4.6 Seven Story Braced Frame Using W12 Columns, Houston, Texas



Total Column Wt. - 17,060 lbs.

Figure 4.7 Seven Story Braced Frame Using W14 Columns, Houston, Texas

CHAPTER V
SUMMARY AND CONCLUSIONS

5.1 Summary.

The purpose of this study was to determine the economics of using W12 columns in multi-story frames. A computer program was developed to provide preliminary designs of typical frames in office buildings. The design methodology used in the computer program is based on two cycle moment distribution for gravity loadings, the portal method for lateral loadings, and an approximate technique to estimate drift. The accuracy of the computer program and design methodology was verified using a commercially available direct stiffness program. The proposed design procedure was found to be extremely accurate and well suited for office design.

The proposed procedure is limited to "rectangular" frames, that is, frames where all beams and columns intersect at right angles and there are no missing members. The developed program assumes fixed base columns and no provision is available for pinned based columns. It is generally assumed that the portal method is valid to approximately 35 stories and the program should not be used for frames above this height without careful study.

To study the feasibility of using W12 columns in typical office structures, designs were completed for an office building 90 ft. by 150 ft. in plan. The building consisted of 30' x 30' square bays, 5 bays in one direction and 3 bays in the other direction. Lateral load resistance was provided in the long direction by two unbraced frames along the outside of the building. Lateral load resistance in the short direction was provided by two braced frames on the exterior faces of the building.

Designs were developed for five locations in the southeastern United States and for Los Angeles, California. For each location three building heights were investigated, seven stories, the maximum height that can be supported by W12 columns and a height intermediate between the maximum and minimum heights. Designs were completed using both W12 and W14 columns of A36 and A572 Gr 50 steels.

5.2 Conclusions.

From the results reported here, it is known that the proposed design methodology is adequate for preliminary design of multi-story frames within the limitations stated. From the case studies presented it was found that A36 W12 columns can be used to a maximum of 21 stories. Additional designs not reported showed that W12 columns could be used to a maximum of 26 stories if the material is A572 Gr 50 steel. It was found that the use of W12 columns results in slightly greater drift and slightly greater total frame weight. However, it is believed that W12 columns can be economical depending on freight and fabrication costs for a specific project.

5.3 Future Work.

Future improvements to the proposed design methodology are possible. A procedure to redesign a frame for a stated drift index limitation can be easily implemented. Usually the most economical way to control drift is to increase the stiffness of the girders. If this is necessary in a design, there is no need for the use of high strength steel girders. An economical design, then, may be A572 Gr 50 columns and A36 steel girders. The present design program can not handle different steels in columns and girders but the implementation of this feature would be relatively easy.

A design procedure for non-standard frames may also be investigated.

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2. Cheong-Siat-Moy, F., "Stiffness Design of Unbraced Steel Frames," Engineering Journal, American Institute of Steel Construction, Vol. 13 No. 1, First Quarter, 1976, pp. 8-10.

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5. Cheong-Siat-Moy, F., "Frame Design Without Using Effective Column Length," Journal of the Structural Division, ASCE, Vol. 104, No. ST1, January, 1978, pp. 23-33.

APPENDIX A

COMPUTER PROGRAM LISTING FOR UNBRACED FRAME DESIGN

```
C***********************************************************************
C***********************************************************************
C**                       DESIGN OF STRUCTURES                        **
C**                                                                   **
C**                       A PROGRAM FOR RIGID FRAME DESIGN            **
C**                                                                   **
C**                                                                   **
C**                                                                   **
C**       SUBMITTED BY JIUNN-SHIUNG.LIN IN PARTIAL FULFILLMENT OF THE REQUIRE- **
C**                                                                   **
C**       MENTS FOR THE MASTER DEGREE IN CIVIL/STRUCTURAL ENGINEERING **
C**                                                                   **
C**       JULY 1980                                                   **
C**                                                                   **
C**       MAJOR PROFESSOR: DR.THOMAS M. MURRAY                        **
C**                                                                   **
C***********************************************************************
C**                            INPUT INSTRUCTIONS                     **
C**     CARD ONE                                                      **
C**                                                                   **
C**       IN 2I5.6F10.3 FORMAT: ENTER THE DIMENSION.STEEL STRENGTH AND LOADINGS**
C**                                                                   **
C**       NB: NUMBER OF BAYS                                          **
C**                                                                   **
C**       NS: NUMBER OF STORIES                                       **
C**                                                                   **
C**       FY: STEEL YIELDING STRESS   KSI                             **
C**                                                                   **
C**       OW: OUTSIDE WALL WEIGHT   PSF                               **
C**                                                                   **
C**       RDL: ROOF DEAD LOAD   KLF                                   **
C**                                                                   **
C**       RLL: ROOF LIVE LOAD   KLF                                   **
C**                                                                   **
C**       FDD: FLOOR DEAD LOAD    KLF                                 **
C**                                                                   **
C**       FLL: FLOOR LIVE LOAD    KLF                                 **
C**                                                                   **
C**     CARD TWO                                                      **
C**                                                                   **
C**       IN 8F10.2 FORMAT: ENTER THE LENGTHS OF BAYS                 **
C**                                                                   **
C**       L(I): LENGTH OF I'TH BAY   FT                               **
C**                                                                   **
C**     CARD THREE                                                    **
C**                                                                   **
C**       IN 8F10.2 FORMAT: ENTER THE HEIGTHS OF STORIES              **
C**                                                                   **
C**       H(I): HEIGTH OF I'TH STORY   FT                             **
C**                                                                   **
C**     CARD FOUR                                                     **
C**                                                                   **
C**       IN 8F10.2 FORMAT: ENTER THE CONCENTRATED LATERAL LOADS      **
C**                                                                   **
C**       HL(I): LATERAL LOAD AT I'HTH LEVEL   KIPS                   **
C**                                                                   **
C***********************************************************************
C***********************************************************************
```

```
                  C     COMPUTER PROGRAM ELEFEET FOR FRAME ANALYSIS AND DESIGN
                  C     MOMENT DISTRIBUTION FOR GRAVITY ANALYSIS
                  C     PORTAL METHOD FOR LATERAL ANALYSIS
                  C     C-S-M METHOD FOR DEFLECTION COMPUTATION
                  C     BEAM DESIGN BASED ON SECTION MODULUS
                  C     COLUMN DESIGN BASED ON AISC SPECIFICATION 1.6-1A,1.6-1B
                  C     MAIN PROGRAM
                  C     INPUT
0001                    REAL L(10),LDF(29,7 ),LM2(29,7 ),LM4(29,7 ),LM5(29,7 ),LM6
                       1,MAM,LBX1,LBX2,LEY1,LBY2
0002                    DIMENSION BXI(111),C1IX(31),C2IX(22),CRX1(31),CRX2(22),CRY1(31),
                       1BW(111),CSX1(31),CSX2(22),A1(31),A2(22),CS1(62),CS2(44),BSX(111),
                       1DLCF2(30),DLCS1(30),DLOS2(30),BIX(29,7 ),CIX1(29,7 ),CIX2(29,7 )
                       1,A(111),BMS(230),DLDF1(30),CFY2(22),CW1(31),CW2(22),CLWT1(29,7),
                       1CLWT2(29,7)
0003                    COMMON L,LDF,LM2,LM4,LM5,NE,NB00,NB0,NB1,NB2,NS,NS0,NS1,NS2,
                       1SP,FY,RDL,RLL,FDL,FLL,H(30),HL(30),FRM(29,7 ),FLM(29,7 ),
                       1RCF(29,7 ),RM2(29,7 ),RM4(29,7 ),RM5(29,7 ),TM4(29,7 ),TM5(29,7 )
                       1,BM4(29,7 ),BM5(29,7 ),P1(29,7 ),P2(29,7 ),RTL,FTT,OW,BMWT(29,7),
                       1FDD,ND
0004                    READ(5,10)NB,NS,FY,OW,RDL,RLL,FDC,FLL
0005                    NE0=NB-1
0006                    NB00=NB-2
0007                    NS0=NS-1
0008                    NB1=NB+1
0009                    NS1=NS+1
0010                    NB2=NB+2
0011                    NS2=NS+2
0012                    L(1)=0.0
0013                    H(1)=0.0
0014                    HL(NS1)=0.0
0015                    IF(NB.GT.NS) GO TO 510
0016                    DO 500 J=NB2,NS1
0017                    L(J)=0.0
0018                500 CONTINUE
0019                    GO TO 530
0020                510 DO 520 J=NS1,NB2
0021                    H(J)=0.0
0022                520 CONTINUE
                  C    ..........I/O BUILDING DIMENSION AND LATERAL LOAD
0023                530 READ (5,20) (L(I),I=2,NB1)
0024                    READ(5,20)(H(I),I=2,NS1)
0025                    READ (5,20)(HL(I),I=1,NS)
0026                    WRITE(6,30)
0027                    WRITE(6,40)NB,NS,FY,CW,RDL,FLL,FDC,FLL
0028                    WRITE(6,50)
0029                    WRITE(6,60)(I,L(I),I,H(I),I,HL(I),I=1,NS1)
0030                    TBL=0.0
0031                    DO 540  I=2,NS1
0032                540 TBL=TBL+H(I)
0033                    DO 550 I=1,111
0034                    I0=2*I-1
0035                    I1=2*I
                  C    ..........I/O  PROPERTIES OF AVAILABLE SECTIONS
0036                550 READ(5,70)  BMS(I0),BMS(I1),BXI(I),BSX(I),BW(I),A(I)
0037                    DO 560 J=1,31
0038                    J0=2*J-1
0039                    J1=2*J
```

```
      560 READ(5,70)  CS1(J0),CS1(J1),A1(J),C1IX(J),CRX1(J),CRY1(J),CW1(J),
         1CSX1(J)
          DO 570 K=1,22
          K0=2*K-1
          K1=2*K
      570 READ(5,70)  CS2(K0),CS2(K1),A2(K),C2IX(K),CRX2(K),CRY2(K),CW2(K),
         1CSX2(K)
C    ..........COMPUTATION FOR MOMENT DISTRIBUYION FACTOR
          LDF(1,NB1)=0.5
          RDF(1,1)=0.5
          RDF(1,NB1)=0.0
          LDF(1,1)=0.0
          DO 580 K=2,NB
          LDF(1,K)=1./3.
          RDF(1,K)=1./3.
          DO 580 I=2,NS
          LDF(I,NB1)=1./3.
          RDF(I,1)=1./3.
          RDF(I,NB1)=0.0
          LDF(I,1)=0.0
          DO 580 M=2,NS
          DO 580 J=2,NB
          RDF(M,J)=0.25
          LDF(M,J)=RDF(M,J)
      580 CONTINUE
C    ..........COMPUTATION FOR GRAVITY LOAD
          NO=1
          RTL=RDL+RLL
          FTT=FDD+FLL
C    ..........CALL SUBROUTINE MD FOR MOMENT DISTRIBUTION CALCULATION
      590 CALL MD
          DO 600 I=2,NS
          DO 600 J=1,NB1
          FTL=FTT+DW*H(I)/1000.
          I0=I-1
          I1=I+1
          IF(NO.EQ.2) BM4(I,J)=-(RM4(I,J)+LM4(I,J))*CIX1(I,J)/H(I1)/(CIX1(
         1I0,J)/H(I)+CIX1(I,J)/H(I1))
          IF(NO.EQ.2) TM4(I,J)=-(RM4(I,J)+LM4(I,J))*CIX1(I0,J)/H(I)/(CIX1(I0
         1,J)/H(I)+CIX1(I,J)/H(I1))
          IF(NO.EQ.2) P1(I,J)=P1(I-1,J)+0.5*(L(J)+L(J+1))*FTL+0.5*(BMWT(I,J)
         1*L(J)+BMWT(I,J+1)*L(J+1))/1000.+CLWT1(I,J)*H(I1)/1000.
          IF(NO.EQ.3) BM4(I,J)=-(RM4(I,J)+LM4(I,J))*CIX2(I,J)/H(I1)/(CIX2(
         1I0,J)/H(I)+CIX2(I,J)/H(I1))
          IF(NO.EQ.3) TM4(I,J)=-(RM4(I,J)+LM4(I,J))*CIX2(I0,J)/H(I)/(CIX2(I0
         1,J)/H(I)+CIX2(I,J)/H(I1))
          IF(NO.EQ.3) P1(I,J)=P1(I-1,J)+0.5*(L(J)+L(J+1))*FTL+0.5*(BMWT(I,J)
         1*L(J)+BMWT(I,J+1)*L(J+1))/1000.+CLWT2(I,J)*H(I1)/1000.
      600 CONTINUE
          IF(NO.EQ.1) WRITE(6,350)
          IF(NO.EQ.2) WRITE(6,360)
          IF(NO.EQ.3) WRITE(6,370)
          WRITE(6,80)
          WRITE(6,90)
          WRITE(6,100)((I,J,RM4(I,J),LM4(I,J),BM4(I,J),TM4(I,J),P1(I,J),J=1
         1,NB1),I=1,NS1)
C    ..........CALL SUBROUTINE PPCRTAL FOR LATERAL LOAD CALCULATION
          CALL PORTAL
```

```
0085               WRITE(6,110)
0086               WRITE(6,120)
0087               WRITE(6,100)((I,J,RM5(I,J),LM5(I,J),BM5(I,J),TM5(I,J),P2(I,J),J=1
                  1,NB1),I=1,NS1)
              C    ..........DESIGN PART
              C    ..........BEAM DESIGN
              C     .........FIND MAX MOMENT MAM
0088               TBW=0.0
0089               DO 690  I=1,NS
0090               DC 690  J=2,NB1
0091               N=J-1
0092               LM6     =(LM4(I,J)+LM5(I,J))*0.75
0093               RM6     =(RM4(I,N)-RM5(I,N))*0.75
0094               MAM     =ABS(RM4(I,J-1))
0095               IF(ABS(RM4(I,J-1)).LT.ABS(RM6)) MAM=ABS(RM6)
0096               IF (MAM.LT.  ABS(LM4(I,J))) MAM=ABS(LM4(I,J))
0097               IF(MAM .LT. ABS(LM6))       MAM=ABS(LM6)
              C    ..........REQUIRED SECTION MODULUS AND THE MOST ECONOMIC SECTIONS
0098               SR      =MAM     /(0.66*FY)*12.
0099               K=1
0100           610 IF(SR     -BSX(K))620,620,640
0101           620 BMWT(I,J)=BW(K)
0102               BA=A(K)
0103               BIX(I,J)=BXI(K)
0104               BXS=BSX(K)
0105               K0=2*K-1
0106               K3=2*K
0107               K1=K+1
0108               K2=K+8
0109               IF(K2.GT.111)K2=111
0110               DC 630  M=K1,K2
0111               IF(BMWT(I,J).LT.BW(M)) GO TC 630
0112               BA=A(M)
0113               BIX(I,J)=BXI(M)
0114               BMWT(I,J)=BW(M)
0115               K0=2*M-1
0116               K3=2*M
0117               BXS=BSX(M)
0118           630 CONTINUE
0119               TBW=TBW+BMWT(I,J)*L(J)
0120               GC TO 660
0121           640 K=K+1
0122               IF(K-111) 610,610,650
0123           650 WRITE(6,140)I,J,MAM,SR
0124               GO TO 690
0125           660 IF(I.EQ.1.AND.J.EQ.2) GO TC 670
0126               GC TO 680
0127           670 WRITE(6,150)
0128               WRITE(6,160)
0129               WRITE(6,170)I,J,MAM,SR, BXS,  BMS(K0),BMS(K3),BA,     BIX(I,J)
0130               GC TO 690
0131           680 WRITE(6,170)I,J,MAM,SR, BXS,  BMS(K0),BMS(K3),BA,     BIX(I,J)
0132           690 CONTINUE
              C    ..........COLUMN DESIGN
              C    ..........FIND MAX AXIAL LOAD AND END MOMENT
0133               TCW1=0.0
0134               TCW2=0.0
0135               DC 770  I=1,NS
```

```
      DO 770  I=1,N3
      DO 770  J=1,NB1
      N=I+1
      P3=0.75*(P1(I,J)+P2(I,J))
      BM6=0.75*(ABS(BM4(I,J))+BM5(I,J))
      TM6=0.75*(ABS(TM4(N,J))+TM5(N,J))
      PMAX=P3
      IF(P1(I,J).GT.P3) PMAX=P1(I,J)
      BMMA=ABS(BM6)
      IF(ABS(BM4(I,J)).GT.ABS(BM6))BMMA=ABS(BM4(I,J))
      TMMA=ABS(TM6)
      IF(ABS(TM4(N,J)).GT.ABS(TM6)) TMMA=ABS(TM4(N,J))
      CM2=TMMA
      CM1=BMMA
      IF(BMMA.GT.TMMA)CM2=BMMA
      IF(BMMA.GT.TMMA)CM1=TMMA
C    ..........DESIGN FOR W14 SECTION AS COLUMN MEMBERS
      K=1
  700 FA1   =PMAX     /A1(K)
      SLRY1=H(N)*12./CRY1(K)
      SLRX1=H(N)*12./CRX1(K)
      CC=SQRT(2*3.1416*3.1416*29000/FY)
      RX=1.7*SLRX1
      FA=(1-(RX*RX*0.5/CC/CC))*FY/(5/3+3*RX/8/CC-RX**3/8/CC**3)
      FE1   =CM2      /CSX1(K)*12.
      FB=0.66*FY
      SLR1   =SLRX1
      IF(SLRX1    .LT.SLRY1    )SLR1=SLRY1
      FE1   =154480./(RX**2)
      CM=0.85
      EQA1   =FA1   /FA+CM     *FE1   /((1-FA1    /FE1    )*FB)
      EQB1   =FA1/(0.6*FY)+FB1/FE
      IF(EQA1    .GT.1.0.OR.EQB1    .GT.1.0) GO TO 710
      CLWT1(I,J)=CW1(K)
      TCW1=TCW1+CLWT1(I,J)*H(N)
      C1A=A1(K)
      C1X1(I,J)=C1IX(K)
      GO TO 720
  710 K=K+1
      IF(K-31) 700,700,740
C    ..........DESIGN FOR W12 SECTION AS COLUMN MEMBERS
  720 M=1
  730 FA2=PMAX/A2(M)
      FB2   =CM2      /CSX2(M)*12.
      SLRX2=H(N)*12./CRX2(M)
      SLRY2=H(N)*12./CRY2(M)
      SLR2   =SLRX2
      IF(SLRX2    .LT.SLRY2)SLR2=SLRY2
      RX=1.7*SLRX2
      FE2   =154480./RX**2
      FA=(1-(RX*RX*0.5/CC/CC))*FY/(5/3+3*RX/8/CC-RX**3/8/CC**3)
      EQA2   =FA2   /FA+CM     *FE2   /((1-FA2    /FE2    )*FB)
      EQB2   =FA2/(0.6*FY)+FB2/FE
      IF(EQA2    .GT.1.0.OR.EQB2    .GT.1.0) GO TO 760
      CLWT2(I,J)=CW2(M)
      TCW2=TCW2+CLWT2(I,J)*H(N)
      C2A=A2(M)
      C1X2(I,J)=C2IX(M)
```

```
0192           IF(NO.EQ.1) WRITE(6,180) I,J,PMAX,CM1,CM2,CS1(K0),CS1(K1),C1A,
              1CIX1(I,J),CS2(M0),CS2(M1),C2A,CIX2(I,J)
0193           IF(NO.EQ.2) WRITE(6,380) I,J,PMAX,CM1,CM2,CS1(K0),CS1(K1),C1A,
              1CIX1(I,J)
0194           IF(NO.EQ.3) WRITE(6,380) I,J,PMAX,CM1,CM2,CS2(M0),CS2(M1),C2A,
              1CIX2(I,J)
0195           GO TO 770
0196       740 WRITE(6,200)I,J,PMAX,CM1,CM2,EQA1,EQB1
0197           GO TO 770
0198       750 K0=2*K-1
0199           K1=2*K
0200           M0=2*M-1
0201           M1=2*M
0202           WRITE(6,190)
0203           IF(NO.EQ.1) WRITE(6,210)
0204           IF(NO.EQ.2) WRITE(6,400)
0205           IF(NO.EQ.3) WRITE(6,410)
0206           M0=2*M-1
0207           M1=2*M
0208           IF(NO.EQ.2) WRITE(6,380) I,J,PMAX,CM1,CM2,CS1(K0),CS1(K1),C1A,
              1CIX1(I,J)
0209           IF(NO.EQ.3) WRITE(6,380) I,J,PMAX,CM1,CM2,CS2(M0),CS2(M1),C2A,
              1CIX2(I,J)
0210           IF(NO.EQ.1) WRITE(6,180) I,J,PMAX,CM1,CM2,CS1(K0),CS1(K1),C1A,
              1CIX1(I,J),CS2(M0),CS2(M1),C2A,CIX2(I,J)
0211           GO TO 770
0212       760 M=M+1
0213           IF(M.LE.22) GO TO 730
0214           CLWT2(I,J)=CLWT1(I,J)
0215           CIX2(I,J)=CIX1(I,J)
0216           K0=2*K-1
0217           K1=2*K
0218           IF(NO.EQ.1) WRITE(6,220) I,J,PMAX,CM1,CM2,EQA1,EQB1,CS1(K0),
              1CS1(K1),EQA2,EQB2,CS1(K0),CS1(K1)
0219           IF(NO.EQ.2) WRITE(6,380) I,J,PMAX,CM1,CM2,CS1(K0),CS1(K1),C1A,
              1CIX1(I,J)
0220           IF(NO.EQ.3) WRITE(6,385) I,J,PMAX,CM1,CM2,CS1(K0),CS1(K1),C1A,
              1CIX1(I,J)
0221       770 CONTINUE
         C    ..........WEIGHT ESTIMATING
0222           TBW=TBW/1000.
0223           TCW1=TCW1/1000.
0224           TCW2=TCW2/1000.
0225           FRMWT1=TBW+TCW1
0226           FRMWT2=TBW+TCW2
0227           WRITE(6,230)
0228           IF(NO.EQ.1) WRITE(6,240)
0229           IF(NO.EQ.2) WRITE(6,420)
0230           IF(NO.EQ.3) WRITE(6,430)
0231           IF(NO.EQ.1) WRITE(6,250) TBW,TCW1,TCW2,FRMWT1,FRMWT2
0232           IF(NO.EQ.2) WRITE(6,440)  TBW,TCW1,FRMWT1
0233           IF(NO.EQ.3) WRITE(6,440)  TBW,TCW2,FRMWT2
         C    ..........COMPUTATION FOR FRAME DEFLECTION
         C    ..........THE METHOD IS BASED ON C.S.W APPROACH
         C    ..........TOP LEVEL
0234           TOL=0.0
0235           DO 780 J=2,NB1
0236       780 TOL=TOL+L(J)
```

```
      SG=(RDL+RLL)*TCL*0.75
      SRIF1   =0.0
      SRIF2   =0.0
      BIX(1,1)=0.0
      BIX(1,NB2)=0.0
      L(1)=1.0
      L(NB2)=1.0
      DO 790  J=1,NB1
      FI1 =0.5*CIX1(1,J)/H(2)/(BIX(1,J)/L(J)+BIX(1,J+1)/L(J+1))
      FI2 =0.5*CIX2(1,J)/H(2)/(BIX(1,J)/L(J)+BIX(1,J+1)/L(J+1))
      RIF1     =CIX1(1,J)/(1+2*FI1)
      RIF2     =CIX2(1,J)/(1+2*FI2)
      SRIF1   =SRIF1   +RIF1
      SRIF2   =SRIF2   +RIF2
  790 CONTINUE
      SSF1   =12*29000/1728/H(2)/H(2)/H(2)*SRIF1
      SSF2   =12*29000/1728/H(2)/H(2)/H(2)*SRIF2
C     DEF DLOF AS FRAME DEFLECTICN IN 1ST ORDER
C     DEF DLOS AS FRAME DEFLECTICN IN 2ST CRDER
      DLOF1(1)=HL(1)/SSF1*0.75
      DLOF2(1)=HL(1)/SSF2*0.75
      SSS1   =SSF1   -SG   /H(2)/12.
      DLOS1(1)=HL(1)/SSS1*0.75
      SSS2   =SSF2   -SG   /H(2)/12.
      DLOS2(1)=HL(1)/SSS2*0.75
C     ........INTERMEDIATE LEVELS
      Q=HL(1)*0.75
      DO 830  I=2,NS
      DO 830  J=1,NB1
      I0=I-1
      I1=I+1
      J1=J+1
      BIX(I,1)=0.0
      BIX(I,NB2)=0.0
      IF (J.NE.1) GO TO 800
      SRIF1   =0.0
      SRIF2   =0.0
  800 FI1=CIX1(I0,J)/H(I1)/(BIX(I,J)/L(J)+BIX(I,J1)/L(J1))
      FI2=CIX2(I0,J)/H(I1)/(BIX(I,J)/L(J)+BIX(I,J1)/L(J1))
      FI2=CIX2(I0,J)/H(I1)/(BIX(I,J)/L(J)+BIX(I,J1)/L(J1))
      IF(I.EQ.NS)GO TO 810
      RIF1=CIX1(I,J)/(1+2*FI1)
      RIF2=CIX2(I,J)/(1+2*FI2)
      GO TO 820
  810 RIF1=CIX1(I,J)*(3+FI1)/(3+4*FI1)
      RIF2=CIX2(I,J)*(3+FI2)/(3+4*FI2)
  820 SRIF1   =SRIF1   +RIF1
      SRIF2   =SRIF2   +RIF2
      IF(J.LT.NB1) GO TO 830
      Q=Q+HL(I)*0.75
      FDL=FDC+DW*H(I)/1000.
      SG=SG+(FDL+FLL)*TCL*0.75
      SSF1   =12.*29000./1728./H(I1)/H(I1)/H(I1)*SRIF1
      DLOF1(I)=Q   /SSF1
      SSF2   =12.*29000./1728./H(I1)/H(I1)/H(I1)*SRIF2
      DLOF2(I)=Q   /SSF2
      SSS1   =SSF1   -SG   /H(I1)/12.
      DLOS1(I)=Q   /SSS1
```

```
0292            SSS2   =SSF2   -SG    /H(I1)/12.
0293            DLCS2(I)=Q   /SSS2
0294        830 CONTINUE
0295            WRITE(6,260)
0296            IF(NO.EQ.1) WRITE(6,270)
0297            IF(NO.EQ.2) WRITE(6,450)
0298            IF(NO.EQ.3) WRITE(6,460)
0299            IF(NO.EQ.1) WRITE(6,280) (I,DLOF1(I),DLOF2(I),DLCS1(I),DLOS2(I),
               1I=1,NS)
0300            IF(NO.EQ.2) WRITE(6,470) (I,DLOF1(I),DLCS1(I),I=1,NS)
0301            IF(NO.EQ.3) WRITE(6,470) (I,DLOF2(I),DLOS2(I),I=1,NS)
0302            TDLF1    =0.0
0303            TDLF2    =0.0
0304            TCLS1    =0.0
0305            TDLS2    =0.0
0306            DO 840  I=1,NS
0307            TDLF1    =TCLF1    +CLOF1(I)
0308            TDLF2    =TDLF2    +DLCF2(I)
0309            TDLS1    =TDLS1    +DLOS1(I)
0310            TDLS2    =TDLS2    +DLCS2(I)
0311        840 CONTINUE
0312            CIF1   =TCLF1    /TBL/12.
0313            DIF2   =TDLF2    /TBL/12.
0314            CIS1   =TDLS1    /TBL/12.
0315            DIS2   =TDLS2    /TBL/12.
0316            WRITE(6,290)
0317            IF(NO.EC.1) WRITE(6,300)
0318            IF(NO.EC.2) WRITE(6,450)
0319            IF(NO.EQ.3) WRITE(6,460)
0320            I=1
0321            IF(NO.EQ.1) WRITE(6,280) I,TDLF1,TDLF2,TCLS1,TDLS2
0322            IF(NO.EC.2) WRITE(6,470) I,TDLF1,TDLS1
0323            IF(NO.EQ.3) WRITE(6,470) I,TDLF2,TDLS2
0324            DO 850  I=2,NS
0325            IO=I-1
0326            TDLF1    =TDLF1     -DLCF1(IO)
0327            TCLF2    =TDLF2     -DLOF2(IC)
0328            TDLS1    =TDLS1     -DLCS1(IO)
0329            TDLS2    =TDLS2     -DLOS2(IO)
0330            IF(NO.EC.1) WRITE(6,280) I,TDLF1,TDLF2,TDLS1,TDLS2
0331            IF(NO.EC.2) WRITE(6,470) I,TDLF1,TDLS1
0332            IF(NO.EQ.3) WRITE(6,470) I,TDLF2,TDLS2
0333        850 CCNTINUE
0334            WRITE(6,320)
0335            IF(NO.EC.1) WRITE(6,330)
0336            IF(NO.EC.2) WRITE(6,480)
0337            IF(NO.EQ.3) WRITE(6,490)
0338            IF(NO.EC.1) WRITE(6,340) DIF1,DIF2,DIS1,DIS2
0339            IF(NO.EC.2) WRITE(6,130) DIF1,DIS1
0340            IF(NO.EC.3) WRITE(6,130) DIF2,DIS2
0341            IF(NO.EQ.2) GC TC 880
0342            IF(NO.EQ.3) GO TC 870
0343            RCF(1,1)=BIX(1,2)/L(2)/(BIX(1,2)/L(2)+CIX1(1,1)/H(2))
0344            LDF(1,NB1)=BIX(1,NB1)/L(NB1)/(BIX(1,NE1)/L(NB1)+CIX1(1,NB1)/H(2))
0345            CC 860 K=2,NB
0346            K1=K+1
0347            RDF(1,K)=BIX(1,K1)/L(K1)/(BIX(1,K)/L(K)+BIX(1,K1)/L(K1)+CIX1(1,K)
               1/H(2))
```

```
          LDF(1,K)=BIX(1,K)/L(K)/(BIX(1,K)/L(K)+BIX(1,K1)/L(K1)+CIX1(1,K)/H
         1(2))
          DO 860 I=2,NS
          DO 860 J=2,NB
          I0=I-1
          I1=I+1
          RDF(I,1)=BIX(I,2)/L(2)/(BIX(I,2)/L(2)+CIX1(I0,1)/H(I)+CIX1(I,1)/
         1H(I1))
          LDF(I,NB1)=BIX(I,NB1)/L(NB1)/(BIX(I,NB1)/L(NB1)+CIX1(I0,NB1)/H(I)
         1+CIX1(I,NB1)/H(I1))
          J1=J+1
          RDF(I,J)=BIX(I,J1)/L(J1)/(BIX(I,J)/L(J)+BIX(I,J1)/L(J1)+CIX1(I0,J)
         1/H(I)+CIX1(I,J)/H(I1))
          LDF(I,J)=BIX(I,J )/L(J )/(BIX(I,J)/L(J)+BIX(I,J1)/L(J1)+CIX1(I0,J)
         1/H(I)+CIX1(I,J)/H(I1))
      860 CONTINUE
          NC=NO+1
          GO TO 590
      880 RDF(1,1)=BIX(1,2)/L(2)/(BIX(1,2)/L(2)+CIX2(1,1)/H(2))
          LDF(1,NB1)=BIX(1,NB1)/L(NB1)/(BIX(1,NB1)/L(NB1)+CIX2(1,NB1)/H(2))
          DO 890 K=2,NB
          K1=K+1
          RDF(1,K)=BIX(1,K1)/L(K1)/(BIX(1,K)/L(K)+BIX(1,K1)/L(K1)+CIX2(1,K)
         1/H(2))
          LDF(1,K)=BIX(1,K)/L(K)/(BIX(1,K)/L(K)+BIX(1,K1)/L(K1)+CIX2(1,K)/H
         1(2))
          DO 890 I=2,NS
          DO 890 J=2,NB
          I0=I-1
          I1=I+1
          RDF(I,1)=BIX(I,2)/L(2)/(BIX(I,2)/L(2)+CIX2(I0,1)/H(I)+CIX2(I,1)/
         1H(I1))
          LDF(I,NB1)=BIX(I,NB1)/L(NB1)/(BIX(I,NB1)/L(NB1)+CIX2(I0,NB1)/H(I)
         1+CIX2(I,NB1)/H(I1))
          J1=J+1
          RDF(I,J)=BIX(I,J1)/L(J1)/(BIX(I,J)/L(J)+BIX(I,J1)/L(J1)+CIX2(I0,J)
         1/H(I)+CIX2(I,J)/H(I1))
          LDF(I,J)=BIX(I,J )/L(J )/(BIX(I,J)/L(J)+BIX(I,J1)/L(J1)+CIX2(I0,J)
         1/H(I)+CIX2(I,J)/H(I1))
      890 CONTINUE
          NC=NO+1
          GO TO 590
       10 FORMAT(2I5,6F10.3)
       20 FORMAT(8F10.2)
       30 FORMAT(1H1, 35X,'THE DESCRIPTION OF FRAME DIMENSION AND LOADING')
       40 FORMAT(1H0,/,42X,'THE NO OF BAYS NB',6X,'=',I3,//,42X,'THE NO OF S
         1TORIES NS',3X,'=',I3,//,42X,'STEEL YIELDS STRESS FY =',F5.2,'KSI',
         1//,42X,'OUTSIDE WALL WT',8X,'=',F5.2,'PSF',//,42X,'ROOF DEAD LOAD
         1RDL',5X,'=',F5.3,'KLF',//,42X,'ROOF LIVE LOAD RLL',5X,'=',F5.3,
         1'KLF',//,42X,'FLOOR DEAD LOAD FDL',4X,'=',F5.3,'KLF',//,42X,'FLOOR
         1 LIVE LOAD FLL',4X,'=',F5.3,'KLF')
       50 FORMAT(1H0,//,10X,'BAY NO',5X,'BAY WIDTH(FT)',10X,'STORY NO',
         15X,'STORY HEIGHT(FT)',10X,'LEVEL NO',5X,'LATERAL LOAD(K)')
       60 FORMAT(1H0,12X,I2,10X,F5.2,17X,I2,13X,F5.2,19X,I2,11X,F5.2)
       70 FORMAT ((2A4),6F10.2)
       80 FORMAT(1H0//,52X,'GRAVITY   LOAD   MOMENTS')
       90 FORMAT(1H0,/,26X,'I',4X,'J',13X,'RM4',14X,'LM4',14X,'EM4',14X,'TM4
         1',16X,'P1')
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0388        100 FORMAT(1H0, 17X,'JOINT',2X,I2,2X,I3,5F17.2)
0389        110 FORMAT(1H1, 55X,'LATERAL   LOAD   MOMENTS')
0390        120 FORMAT(1H0,//,26X,'I',4X,'J',13X,'RM5',14X,'LM5',14X,'BM5',14X,
               1'TM5',16X,'P2')
0391        130 FORMAT(1H0,30X,F10.4,36X,F10.4)
0392        140 FORMAT(1H0,'MEMBER',2X,I2,I5,8X,F7.2,15X,F6.2,18X,'NO SEC MEETS')
0393        150 FORMAT(1H1,41X,'MAX  MOMENTS  SEC  MODULUS  AND  SECS  FOR  BEAMS'
               1)
0394        160 FORMAT(1H0,//,17X,'I',4X,'J',7X,'MAX MOMENT',5X,'REQUIRED SEC MODUL
               1US',5X,'SUGGESTED SEC MODULUS',5X,'LIGHTEST SECTION',3X,'AX',8X,'
               1IZ')
0395        170 FORMAT(1H0, 7X,'MEMBER',2X,I2,I5,8X,F7.2,15X,F6.2,18X,F7.2,13X,2A4
               1,7X,F6.2,4X,F7.2)
0396        180 FORMAT(1H0,'MEMBER',5X,I2,I5,3F12.2,4X,2A4,2F12.2,4X,2A4,2F12.2)
0397        190 FORMAT(1H1,35X,'MAX AXIAL LOAD ,END MOMENTS AND COMPUTATION RESULT
               1S FOR COLUMN SECTIONS')
0398        200 FORMAT(1H0,'MEMBER',5X,I2,I5,F12.2,F8.2,F8.2,F9.2,F9.2,4X,'NO SEC
               1MEETS')
0399       -210 FORMAT(1H0,//,13X,'I',4X,'J',7X,'PMAX',9X,'CM1',5X,'CM2',6X,'W14
               1SEC',8X,'AX',9X,'IZ',9X,'W12 SEC',8X,'AX',8X,'IZ')
0400        220 FORMAT(1H0,'MEMBER',5X,I2,I5,5F12.2,4X,2A4,2F12.2,4X,2A4,'***')
0401        230 FORMAT(1H1,38X,'ESTIMATED TOTAL BEAM WEIGHT COLUMN WEIGHT AND FRAM
               1E WEIGHT')
0402        240 FORMAT(1H0,//,20X,'TOTAL BM WEIGHT',5X,'TOTAL W14 COL WT',5X,'TOTA
               1L W12 COL WT',5X,'TOTAL FRM1 WT',5X,'TOTAL FRM2 WT')
0403        250 FORMAT(1H0,20X,F9.2,'KIPS',5X,F12.2,'KIPS',5X,F12.2,'KIPS',5X,F9.2
               1,'KIPS',5X,F9.2,'KIPS')
0404        260 FORMAT(1H1,45X,'FRAME DEFLECTION OF 1ST AND 2ND ORDER')
0405        270 FORMAT(1H0,//,5X,'FLOOR LEVEL',3X,'1ST DEFL WITH W14 COL',3X,'1ST
               1 DEFL WITH W12 COL',3X,'2ND DEFL WITH W14 COL',3X,'2ND DEFL WITH W
               112 COL')
0406        280 FORMAT(1H0,5X,I6,F16.4,3F25.4)
0407        290 FORMAT(2H0,//,58X,'TOTAL DEFLECTION')
0408        300 FORMAT(1H0,/,11X,'FLOOR LEVEL',3X,'1ST DEFL WITH W14 COL',3X,'1ST
               1 DEFL WITH W12 COL',3X,'2ND DEFL WITH W14 COL',3X,'2ND DEFL WITH W
               112 COL')
0409        320 FORMAT(1H0,//,60X,'DRIFT INDEX')
0410        330 FORMAT(1H0,/,40X,'1ST IND W14',5X,'1ST IND W12',5X,'2ND IND W14',
               15X,'2ND IND W12')
0411        340 FORMAT(1H0,44X,F8.4,7X,F8.4,8X,F8.4,7X,F8.4)
0412        350 FORMAT(1H1,50X,'RESULTS OF PRELIMINARY DESIGN')
0413        360 FORMAT(1H1,50X,'RESULTS OF REDESIGN FOR W14 COLUMNS')
0414        370 FORMAT(1H1,50X,'RESULTS OF REDESIGN FOR W12 COLUMNS')
0415        380 FORMAT(1H0,23X,'MEMBER',5X,I2,I5,3F12.2,4X,2A4,2F12.2)
0416        385 FORMAT(1H0,23X,'MEMBER',5X,I2,I5,3F12.2,4X,2A4,2F12.2,'*****')
0417        400 FORMAT(1H0,//,36X,'I',4X,'J',7X,'PMAX',9X,'CM1',5X,'CM2',6X,'W14
               1SEC',8X,'AX',9X,'IZ')
0418        410 FORMAT(1H0,//,36X,'I',4X,'J',7X,'PMAX',9X,'CM1',5X,'CM2',6X,'W12
               1SEC',8X,'AX',9X,'IZ')
0419        420 FORMAT(1H0,//,20X,'TOTAL BM WEIGHT',20X,'TOTAL W14 COL WT',20X,
               1'TOTAL FRM1 WT')
0420        430 FORMAT(1H0,//,20X,'TOTAL BM WEIGHT',20X,'TOTAL W12 COL WT',20X,
               1'TOTAL FRM2 WT')
0421        440 FORMAT(1H0,20X,F9.2,'KIPS',20X,F12.2,'KIPS',20X,F9.2,'KIPS')
0422        450 FORMAT(1H0,/,17X,'FLOOR LEVEL',15X,'1ST DEL WITH W14 COL',18X,
               1'2ND DELF WITH W14 COL')
0423        460 FORMAT(1H0,/,17X,'FLOOR LEVEL',15X,'1ST DEL WITH W12 COL',18X,
               1'2ND DELF WITH W12 COL')
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      470 FORMAT(1H0,22X,I2,25X,F10.4,28X,F10.4)
      480 FORMAT(1H0,/,30X,'1ST DI WITH W14 COL',30X,'2ND CI WITH W14 COL')
      490 FORMAT(1H0,/,30X,'1ST DI WITH W12 CCL',30X,'2ND CI WITH W12 CCL')
      870 STCP
          END
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*OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
*OPTIONS IN EFFECT*  NAME = MAIN    , LINECNT =       60
*STATISTICS*    SOURCE STATEMENTS =       428,PROGRAM SIZE =    27662
*STATISTICS*  NO DIAGNOSTICS GENERATED
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                C      SUB PROGRAM MD FCR MCMENT DISTRIBUTICN COMPUTATICN
0001                   SUBRCUTINE MC
0002                   REAL L(10),LDF(29,7 ),LM2(29,7 ),LM4(29,7 ),LM5(29,7 )
0003                   COMMON L,LDF,LM2,LM4,LM5,NB,NB00,NB0,NB1,NB2,NS,NS0,NS1,NS2,
                      1SP,FY,RDL,RLL,FDL,FLL,H(30),HL(30),FRM(29,7 ),FLM(29,7 ),
                      1RDF(29,7 ),RM2(29,7 ),RM4(29,7 ),RM5(29,7 ),TM4(29,7 ),TM5(29,7 )
                      1,BM4(29,7 ),BM5(29,7 ),P1(29,7 ),P2(29,7 ),RTL,FTT,OW,BMWT(29,7),
                      1FDD,NO
                C      FIX-END MOMENT COMPUTATION
                C      MC METHCD FCR ROOF LEVEL
0004                   I=1
0005                   DO 90  J=1,NB
0006                   FRM(I,J)=-RTL*L(J+1)*L(J+1)/12.
0007                   IF(NO.NE.1) FRM(I,J)=-(RTL+BMWT(I,J+1)/1000.)*L(J+1)*L(J+1)/12.
0008                90 FLM(I,J+1)=-FRM(I,J)
                C      FIRST CARRY CVER CCMPUTATICN
0009                   FRM(I,NB1)=0.0
0010                   FLM(I,1)=0.0
0011                   RM2(I,NB1)=0.0
0012                   LM2(I,1)=0.0
0013                   DC 100 K=2,NB
0014                   RM2(I,K)=-LDF(I,K+1)*(FRM(I,K+1)+FLM(I,K+1))*0.5
0015                   LM2(I,K)=-RDF(I,K-1)*(FRM(I,K-1)+FLM(I,K-1))*0.5
0016               100 CCNTINUE
0017                   RM2(I,1)=-LDF(I,2)*(FRM(I,2)+FLM(I,2))*0.5
0018                   LM2(I,NB1)=-RDF(I,NB)*(FRM(I,NB)+FLM(I,NB))*0.5
                C      SECOND DISTRIBUTION CYCLE
0019                   DC 110 J=1,NB1
0020                   RM4(I,J)=FRM(I,J)+RM2(I,J)-RDF(I,J)*(RM2(I,J)+LM2(I,J)+FRM(I,J)+
                      1FLM(I,J))
0021                   LM4(I,J)=FLM(I,J)+LM2(I,J)-LDF(I,J)*(RM2(I,J)+LM2(I,J)+FRM(I,J)+
                      1FLM(I,J))
0022               110 CCNTINUE
                C      MD METHCD FCR CTHER LEVELS
                C      MAX MOMENT AT OUT-MOST SPANS
                C      APPLY TL TO OUT-MOST SPANS CNLY
                C      FIX-END MCMENT
0023                   DO 120 I=2,NS
0024                   FTL=FTT+OW*H(I)/1000.
0025                   FRM(I,1)=-FTL*L(2)*L(2)/12.
0026                   FRM(I,NB)=-FTL*L(NB1)*L(NB1)/12.
0027                   IF(NO.NE.1)FRM(I,NB)=-(FTL+BMWT(I,NB1)/1000.)*L(NB1)*L(NB1)/12.
0028                   IF(NO.NE.1) FRM(I,1)=-(FTL+BMWT(I,  2)/1000.)*L( 2 )*L( 2 )/12.
0029                   FLM(I,2)=-FRM(I,1)
0030                   FLM(I,NB1)=-FRM(I,NB)
0031                   RM4(I,1)=FRM(I,1)-RDF(I,1)* FRM(I,1)
0032                   LM4(I,1)=-LDF(I,1)*FRM(I,1)
0033                   RM4(I,NB1)=-RDF(I,NB1)*FLM(I,NB1)
0034                   LM4(I,NB1)=FLM(I,NB1)-LDF(I,NB1)* FLM(I,NB1)
0035               120 CONTINUE
0036                   DC 130 M=2,NS
0037                   DC 130 J=2,NB0
0038                   FDL=FDD+OW*H(I)/1000.
0039                   FRM(M,J)=-FDL*L(J+1)*L(J+1)/12.
0040                   IF(NO.NE.1) FRM(M,J)=-(FDL+BMWT(I,J+1)/1000.)*L(J+1)*L(J+1)/12.
0041               130 FLM(M,J+1)=-FRM(M,J)
                C      FIRST CARRY OVER CCMPUTATICN
0042                   DO 150 I=2,NS
```

```
0043          RM2(I,1)=-LDF(I,2)*(FRM(I,2)+FLM(I,2))*0.5
0044          LM2(I,NB1)=-RDF(I,NB)*(FRM(I,NB)+FLM(I,NB))*0.5
0045          RM4(I,1)=RM4(I,1)+RM2(I,1)-RDF(I,1)* RM2(I,1)
0046          LM4(I,1)=LM4(I,1)-LDF(I,1)*RM2(I,1)
0047          RM4(I,NB1)=RM4(I,NB1)-RDF(I,NB1)*LM2(I,NB1)
0048      150 LM4(I,NB1)=LM4(I,NB1)+LM2(I,NB1)-LDF(I,NB1)*LM2(I,NB1)
        C     MAX MOMENT AT INTERIOR JOINTS
        C     FOREACH JOINT, APPLY TL TO ADJCINT SPANS CNLY
0049          DO 180 I=2,NS
0050          FTL=FTT+CW*H(I)/1000.
0051          FDL=FDD+DW*H(I)/1000.
0052          J=2
0053          FRM(I,1)=-FTL*L(2)*L(2)/12.
0054          FRM(I,2)=-FTL*L(3)*L(3)/12.
0055          IF(NO.NE.1) FRM(I,1)=-(FTL+EMWT(I, 2 )/1000.)*L( 2 )*L( 2 )/12.
0056          IF(NO.NE.1) FRM(I,2)=-(FTL+BMWT(I, 3 )/1000.)*L( 3 )*L( 3 )/12.
0057          FLM(I,1)=0.0
0058          FLM(I,2)=-FRM(I,1)
0059          FLM(I,3)=-FRM(I,2)
0060          FRM(I,NB1)=0.0
0061          RM4(I,J)=FRM(I,J)-RDF(I,J)*(FRM(I,J)+FLM(I,J))
0062          LM4(I,J)=FLM(I,J)-LDF(I,J)*(FRM(I,J)+FLM(I,J))
0063          DC 160 K=3,NB
0064          FRM(I,K)=-FDL*L(K+1)*L(K+1)/12.
0065          IF(NO.NE.1) FRM(I,K)=-(FDL+EMWT(I,K+1)/1000.)*L(K+1)*L(K+1)/12.
0066      160 FLM(I,K+1)=-FRM(I,K)
        C     FIRST CARRY OVER COMPUTATION
0067          DC 170 K=2,NB
0068          RM2(I,K)=-LDF(I,K+1)*(FRM(I,K+1)+FLM(I,K+1))*0.5
0069      170 LM2(I,K)=-RDF(I,K-1)*(FRM(I,K-1)+FLM(I,K-1))*0.5
0070          RM2(I,1)=-LDF(I,2)*(FRM(I,2)+FLM(I,2))*0.5
0071          LM2(I,NB1)=-RDF(I,NB)*(FRM(I,NB)+FLM(I,NB))*0.5
0072          RM2(I,NB1)=0.0
0073          LM2(I,1)=0.0
        C     SECCND DISTRIBUTION CYCLE
0074          LM4(I,J)=LM4(I,J)+LM2(I,J)-LDF(I,J)*(RM2(I,J)+LM2(I,J))
0075          RM4(I,J)=RM4(I,J)+RM2(I,J)-RDF(I,J)*(RM2(I,J)+LM2(I,J))
0076      180 CONTINUE
0077          DO 210 I=2,NS
0078          FTL=FTT+DW*H(I)/1000.
0079          FDL=FDD+CW*H(I)/1000.
0080          J=NB
0081          FRM(I,NB)=-FTL*L(NB1)*L(NB1)/12.
0082          FRM(I,NB0)=-FTL*L(NB)*L(NB)/12.
0083          IF(NC.NE.1)FRM(I,NB)=-(FTL+EMWT(I,NB1)/1000.)*L(NB1)*L(NB1)/12.
0084          IF(NO.NE.1) FRM(I,NB0)=-(FTL+BMWT(I,NE )/1000.)*L(NB)*L(NB)/12.
0085          FRM(I,NB1)=0.0
0086          FLM(I,NB)=-FRM(I,NB0)
0087          FLM(I,NB1)=-FRM(I,NB)
0088          FLM(I,1)=0.0
0089          RM4(I,J)=FRM(I,J)-RDF(I,J)*(FRM(I,J)+FLM(I,J))
0090          LM4(I,J)=FLM(I,J)-LDF(I,J)*(FRM(I,J)+FLM(I,J))
0091          DC 190 K=1,NB00
0092          FDL=FDD+CW*H(I)/1000.
0093          FRM(I,K)=-FDL*L(K+1)*L(K+1)/12.
0094          IF(NO.NE.1) FRM(I,K)=-(FDL+EMWT(I,K+1)/1000.)*L(K+1)*L(K+1)/12.
0095      190 FLM(I,K+1)=-FRM(I,K)
        C     FIRST CARRY OVER CCMPUTATICN
```

```
      DC 200 K=2,NB
      RM2(I,K)=-LDF(I,K+1)*(FRM(I,K+1)+FLM(I,K+1))*0.5
      LM2(I,K)=-RDF(I,K-1)*(FRM(I,K-1)+FLM(I,K-1))*0.5
  200 CONTINUE
      RM2(I,1)=-LDF(I,2)*(FRM(I,2)+FLM(I,2))*0.5
      LM2(I,NB1)=-RDF(I,NB)*(FRM(I,NB)+FLM(I,NB))*0.5
      RM2(I,NB1)=0.0
      LM2(I,1)=0.0
      RM4(I,J)=RM4(I,J)+RM2(I,J)-RDF(I,J)*(RM2(I,J)+LM2(I,J))
      LM4(I,J)=LM4(I,J)+LM2(I,J)-LDF(I,J)*(RM2(I,J)+LM2(I,J))
  210 CONTINUE
      IF(NB.EQ.3) GO TO 245
      DO 240 I=2,NS
      DC 240 J=3,NB0
      FTL=FTT+OW*H(I)/1000.
      FDL=FDD+OW*H(I)/1000.
      FRM(I,J-1)=-FTL*L(J)*L(J)/12.
      IF(ND.NE.1) FRM(I,J-1)=-(FTL+BMWT(I,J)/1000.)*L(J)*L(J)/12.
      FLM(I,J)=-FRM(I,J-1)
      FRM(I,J)=-FTL*L(J+1)*L(J+1)/12.
      IF(ND.NE.1) FRM(I,J)=-(FTL+EMWT(I,J+1)/1000.)*L(J+1)*L(J+1)/12.
      FLM(I,J+1)=-FRM(I,J)
      J1=J+1
      DO 220 M=J1,NB
      FRM(I,M)=-FDL*L(M+1)*L(M+1)/12.
      IF(ND.NE.1) FRM(I,M)=-(FDL+EMWT(I,M+1)/1000.)*L(M+1)*L(M+1)/12.
      FLM(I,M+1)=-FRM(I,M)
      J00=J-2
      DO 220 K=1,J00
      FRM(I,K)=-FDL*L(K+1)*L(K+1)/12.
      IF(ND.NE.1) FRM(I,K)=-(FDL+EMWT(I,K+1)/1000.)*L(K+1)*L(K+1)/12.
  220 FLM(I,K+1)=-FRM(I,K)
      FLM(I,1)=0.0
      FRM(I,NB1)=0.0
      RM4(I,J)=FRM(I,J)-RDF(I,J)*(FRM(I,J)+FLM(I,J))
      LM4(I,J)=FLM(I,J)-LDF(I,J)*(FRM(I,J)+FLM(I,J))
C     FIRST CARRY OVER COMPUTATION
      DO 230 K=2,NB
      RM2(I,K)=-LDF(I,K+1)*(FRM(I,K+1)+FLM(I,K+1))*0.5
  230 LM2(I,K)=-RDF(I,K-1)*(FRM(I,K-1)+FLM(I,K-1))*0.5
      RM2(I,1)=-LDF(I,2)*(FRM(I,2)+FLM(I,2))*0.5
      LM2(I,NB1)=-RDF(I,NB)*(FRM(I,NB)+FLM(I,NB))*0.5
      RM2(I,NB1)=0.0
      LM2(I,1)=0.0
      RM4(I,J)=RM4(I,J)+RM2(I,J)-RDF(I,J)*(RM2(I,J)+LM2(I,J))
      LM4(I,J)=LM4(I,J)+LM2(I,J)-LDF(I,J)*(RM2(I,J)+LM2(I,J))
  240 CONTINUE
C     COLUMN END MOMENT COMPUTATION
  245 DO 250 I=2,NS
      DC 250 J=1,NB1
      I1=I+1
      TM4(I,J)=-(RM4(I,J)+LM4(I,J))*H(I1)/(H(I)+H(I1))
      BM4(I,J)=-(RM4(I,J)+LM4(I,J))*H(I)/(H(I)+H(I1))
      TM4(1,J)=0.0
      BM4(1,J)=(RM4(1,J)+LM4(1,J))*(-1.0)
      BM4(NS1,J)=0.0
      EM4(NS1,J)=0.0
      RM4(NS1,J)=0.0
```

```
      LM4(NS1,J)=0.0
      P1(NS1,J)=0.0
  250 CONTINUE
      DO 260 J=1,NB1
  260 TM4(NS1,J)=0.5*BM4(NS,J)
C     COLUMN AXIAL LOAD COMPUTATION
      DO 270 I=2,NS
      DO 270 J=1,NB1
      FTL=FTT+DW*H(I)/1000.
      P1(1,J)=RTL*0.5*(L(J)+L(J+1))
      P1(I,J)=P1(I-1,J)+FTL*0.5*(L(J)+L(J+1))
  270 CONTINUE
      RETURN
      END
```

```
*OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
*OPTIONS IN EFFECT*  NAME = MD      , LINECNT =        60
*STATISTICS*    SOURCE STATEMENTS =       164,PROGRAM SIZE =      8566
*STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
              C      SUBROUTINE PORTAL
0001                 SUBROUTINE PORTAL
0002                 REAL L(10),LDF(29,7 ),LM2(29,7 ),LM4(29,7 ),LM5(29,7 )
0003                 COMMON L,LDF,LM2,LM4,LM5,NB,NB00,NB0,NB1,NB2,NS,NS0,NS1,NS2,
                    1SP,FY,RDL,RLL,FDL,FLL,H(30),HL(30),FRM(29,7 ),FLM(29,7 ),
                    1RDF(29,7 ),RM2(29,7 ),RM4(29,7 ),RM5(29,7 ),TM4(29,7 ),TM5(29,7 )
                    1,BM4(29,7 ),BM5(29,7 ),P1(29,7 ),P2(29,7 ),RTL,FTT,OW,BMWT(29,7),
                    1FCC,NO
              C      COIUMN SHEAR COMPUTATION
0004                 BTL=0.0
0005                 DO 100 I=2,NB1
0006                 BTL=BTL+L(I)
0007             100 CONTINUE
0008                 L(NB2)=0.0
0009                 HL(NS1)=0.0
0010                 Q=0.0
0011                 DO 110 I=1,NS
0012                 DO 110 J=1,NB1
0013                 IF(J.EQ.1) Q=Q+HL(I)
0014                 CRA=(L(J)+L(J+1))*0.5/BTL
0015                 V=Q*CRA
0016                 TM5(1,J)=0.0
0017                 TM5(I+1,J)=V*0.5*H(I+1)
0018                 BM5(I,J)=V*0.5*H(I+1)
0019                 BM5(NS1,J)=0.0
0020                 BM5(NS,J)=V*0.4*H(NS1)
0021                 TM5(NS1,J)=V*0.60*H(NS1)
0022             110 CONTINUE
              C      BEAM END MOMENT
0023                 DO 120 I=1,NS
0024                 DO 120 J=2,NB
0025                 RM5(I,1)=TM5(I,1)+BM5(I,1)
0026                 LM5(I,NB1)=TM5(I,NB1)+BM5(I,NB1)
0027                 LM5(I,J)=RM5(I,J-1)
0028                 RM5(I,J)=TM5(I,J)+BM5(I,J)-LM5(I,J)
0029                 RM5(I,NB1)=0.0
0030                 LM5(I,1)=0.0
0031             120 CONTINUE
0032                 DO 130  J=1,NB1
0033                 BM5(NS1,J)=0.0
0034                 LM5(NS1,J)=0.0
0035                 RM5(NS1,J)=0.0
0036                 P2(NS1,J)=0.0
0037             130 CONTINUE
              C      COLUMN AXIAL FORCE
0038                 P2(1,1)=RM5(1,1)*2.0/L(2)
0039                 P2(1,NB1)=ABS(RM5(1,NB)*2.0/L(NB1))
0040                 DO 140  I=2,NS
0041                 DO 140  J=2,NB
0042                 P2(1,J)=ABS(RM5(1,J-1)*2.0/L(J)-RM5(1,J)*2.0/L(J+1))
0043                 P2(I,1)=P2(I-1,1)+RM5(I,1)*2.0/L(2)
0044                 P2(I,J)=ABS(RM5(I,J-1)*2.0/L(J)-RM5(I,J)*2.0/L(J+1))+P2(I-1,J)
0045                 P2(I,NB1)=ABS(RM5(I,NB)*2.0/L(NB1))+P2(I-1,NB1)
0046             140 CONTINUE
0047                 RETURN
0048                 END
```

```
FORTRAN IV G1   RELEASE 2.0              PORTAL            DATE = 80164         22/22/21              PAGE 0002

  *OPTIONS IN EFFECT*  NOTERM,ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,NOMAP,NOTEST
  *OPTIONS IN EFFECT*  NAME = PORTAL  , LINECNT =       60
  *STATISTICS*    SOURCE STATEMENTS =       48,PROGRAM SIZE =     1842
  *STATISTICS*  NO DIAGNOSTICS GENERATED

  *STATISTICS*  NO DIAGNOSTICS THIS STEP
```

```
F64-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED LIST,MAP,LET
        DEFAULT OPTION(S) USED -   SIZE=(196608,38912)


                                                         MODULE MAP

 CONTROL  SECTION                     ENTRY

   NAME     ORIGIN  LENGTH              NAME    LOCATION      NAME    LOCATION      NAME    LOCATION      NAME    LOCATION
 MAIN           00    6C0E
 MD           6C10    2176
 PORTAL       8D88     732
 IHOECOMH*    94C0     E30
                                       IBCOM#      94F4     FDIOCS#      95B0     INTSWTCH     A238
 FIOAP#  *    A2F0     624
 IHOCOMH2*    A918     9A5
                                       SEQDASD     ACEA
 IHOFCVTH*    B2C0     CEA
                                       ADCON#      B2C0     FCVAOUTP     B32C     FCVLOUTP     B344     FCVZOUTP     B35C
                                       FCVIOUTP    E374     FCVECUTP     B3AC     FCVCOUTP     B3AC     ADCONI#      BAB0
                                       ADCONO#     BACC     INT6SWCH     BFA9
 IHOEFNTH*    BFB0     800
                                       ARITH#      BFB0     ADJSWTCH     C544
 IHCEFICS*    C7B0    118C
                                       FIOCS#      C7B0     FIOCSBEP     C7B6
 IHOFIOS2*    D940     642
 IHOUCPT *    DF88     338
 IHOERRM *    E2C0     624
                                       ERRMON      E2C0     IHCERRE      E2C8
 IHOFCCNI*    E8E8     416
                                       FGCCNI#     E8E8
 IHCFCONO*    EC00     8B8
                                       FGCONC#     ED00
 IHOUATBL*    F5B8     638
 IHOFTEN *    FBF0     220
                                       FTEN#       FBF0
 IHOETRCH*    FE10     2AE
                                       IHOTRCH     FE10     ERRTRA       FE18
$BLANKCOM    100C0    3754


ENTRY ADDRESS        00

 TOTAL LENGTH     13818
****FORTGCLG  DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET
AUTHORIZATION CODE IS          0.
```

APPENDIX B

COMPUTER PROGRAM LISTING FOR BRACED FRAME DESIGN

```
$JCB
C*******************************************************************************
C*******************************************************************************
C**                                                                           **
C**                     DESIGN OF STRUCTURES                                  **
C**                                                                           **
C**                     A PROGRAM FOR BRACED FRAME ANALYSIS                   **
C**                                                                           **
C**                                                                           **
C**                                                                           **
C**      SUBMITTED BY JIUNN-SHIUNG.LIN IN PARTIAL FULFILLMENT OF THE REQUIRE- **
C**                                                                           **
C**      MENTS FOR THE MASTER DEGREE IN CIVIL/STRUCTURAL ENGINEERING          **
C**                                                                           **
C**      JULY 1980                                                            **
C**                                                                           **
C**      MAJOR PROFESSOR: DR.THOMAS M. MURRAY                                 **
C**                                                                           **
C*******************************************************************************
C**                                                                           **
C**                                                                           **
C**                          INPUT INSTRUCTIONS                               **
C**                                                                           **
C**    CARD ONE                                                               **
C**                                                                           **
C**      IN 2I5,6F10.3 FORMAT: ENTER THE DIMENSION,STEEL STRENGTH AND LOADINGS**
C**                                                                           **
C**      NB: NUMBER OF BAYS                                                   **
C**      NS: NUMBER OF STORIES                                                **
C**      NP: NO OF SPAN THAT BRACED                                           **
C**      NO: INDEX FOR TYPE OF BRACINGS                                       **
C**          1=SINGLE DIAGONAL BRACINGS                                       **
C**          2=CROSS DIAGONAL BRACINGS                                        **
C**          3=K BRACINGS                                                     **
C**      FY: STEEL YIELDING STRESS   KSI                                      **
C**      OW: OUTSIDE WALL WEIGHT   PSF                                        **
C**      RDL: ROOF DEAD LOAD   KLF                                            **
C**      RLL: ROOF LIVE LOAD   KLF                                            **
C**      FDL: FLOOR DEAD LOAD    KLF                                          **
C**      FLL: FLOOR LIVE LOAD    KLF                                          **
C**    CARD TWO                                                               **
C**                                                                           **
C**      IN 8F10.2 FORMAT: ENTER THE LENGTHS OF BAYS                          **
C**                                                                           **
C**      L(I): LENGTH OF I'TH BAY   FT                                        **
C**                                                                           **
C**    CARD THREE                                                             **
C**                                                                           **
C**      IN 8F10.2 FORMAT: ENTER THE HEIGTHS OF STORIES                       **
C**                                                                           **
C**      H(I): HEIGTH OF I'TH STORY   FT                                      **
C**                                                                           **
C**    CARD FOUR                                                              **
C**                                                                           **
C**      IN 8F10.2 FORMAT: ENTER THE CONCENTRATED LATERAL LOADS               **
C**                                                                           **
C**      HL(I): LATERAL LOAD AT I'HTH LEVEL   KIPS                            **
C**                                                                           **
C*******************************************************************************
C*******************************************************************************
```

```
      REAL L
      DIMENSION L(20),PCL(30,20),H(30),HL(30),SDM(30),CEM(30),FKM(30)
      READ(5,9) NB,NS,NP,NO,FY,OW,RDL,RLL,FDL,FLL
      NS1=NS+1
      NB2=NB+2
      NF1=NF+1
      NB1=NB+1
      HL(NS1)=0.0
      IF(NB.GT.NS) GO TO 470
      DO 460 J=NB1,NS1
      L(J)=0.0
  460 CONTINUE
      GO TO 400
  470 DO 480 J=NS1,NB2
      H(J)=0.0
  480 CONTINUE
  400 READ(5,10)(L(I),I=1,NB)
      READ(5,10)(H(I),I=1,NS)
      READ(5,10)(HL(I),I=1,NS)
      WRITE(6,150)
      WRITE(6,20)NB,NS,FY,OW,RDL,RLL,FDL,FLL
      WRITE(6,160)
      WRITE(6,30)(I,L(I),I,H(I),I,HL(I),I=1,NS)
C UNBRACING PART IN THE FRAME
C BEAM ANALYSIS
      RTL=RDL+RLL
      FTL=FDL+FLL
      DO 500 J=1,NB
      RBM=RTL*L(J)*L(J)/8
      FBM=FTL*L(J)*L(J)/8
      RSR=RBM*12/(FY*0.65)
      FSR=FBM*12/(FY*0.65)
      IF(J.EQ.1)GO TO 490
      WRITE(6,70) J,RSR,FSR
      GO TO 500
  490 WRITE(6,50)
      WRITE(6,60)
      WRITE(6,70)J,RSR,FSR
  500 CONTINUE
C COL ANALYSIS
C DEFINE PCL AS AXIAL LOAD IN COLUMN
      PCL(1,1)=RTL*0.5*L(1)
      PCL(1,NB1)=RTL*0.5*L(NB)
      DO 510 I=2,NS
      IO=I-1
      PCL(I,1)=PCL(IO,1)+(FTL+CW*H(I)/1000.)*0.5*L(1)*1.02
      PCL(I,NB1)=PCL(IO,NB1)+(FTL+OW*H(I)/1000.)*0.5*L(NB)
  510 CONTINUE
      DO 520 J=2,NB
      JO=J-1
      PCL(1,J)=RTL*0.5*(L(JO)+L(J))
  520 CONTINUE
      DO 530 I=2,NS
      DO 530 J=2,NB
      IO=I-1
      JO=J-1
      PCL(I,J)=(PCL(IO,J)+(FTL+CW*H(I)/1000.)*0.5*(L(JO)+L(J)))*1.02
  530 CONTINUE
      WRITE(6,80)
      DO 535 I=1,NS
```

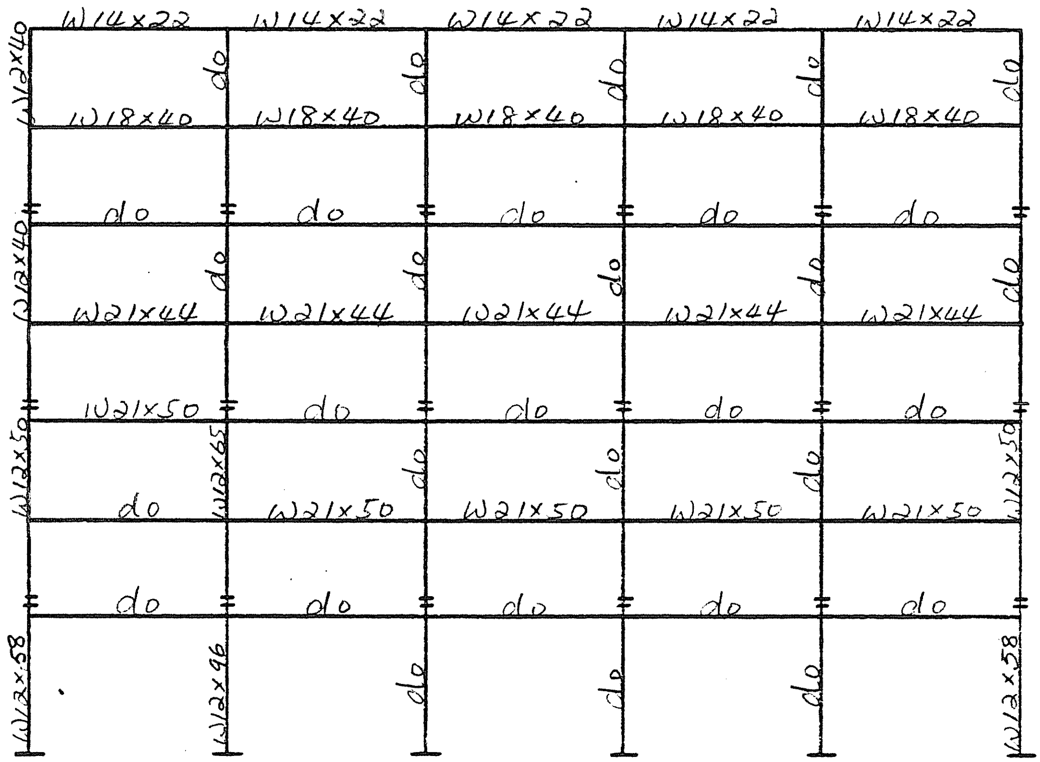
```
      DO 535 J=1,NBI
      IF(J.EQ.NP.OR.J.EQ.NP1) GO TO 535
      WRITE(6,90) I,J,PCL(I,J)
  535 CONTINUE
C BRACING SPAN ANALYSIS
C DEFINE NP AS NO OF BRACING SPAN
C DEFINE SDM AS SINGLE DIAGONAL BRACING MEMBER FORCE
C DEFINE CBM AS CROSS BRACING MEMBER FORCE
C DEFINE HKM AS HORIZONTAL K BRACING MEMBER FORCE
      NP1=NP+1
      IF(NO.EQ.2) GO TO 550
      IF(NO.EQ.3) GO TO 570
      SDM(1)=HL(1)*SQRT(H(1)*H(1)+L(NP)*L(NP))/L(NP)
      PCLO=SDM(1)*H(1)/SQRT(H(1)*H(1)+L(NP)*L(NP))*0.75
      PCL(1,NP)=PCL(1,NP)+PCLO
      PCL(1,NP1)=PCL(1,NP1)+PCLO
      DO 540 I=2,NS
      IO=I-1
      HL(I)=HL(IO)+HL(I)
      SDM(I)=HL(I)*SQRT(H(I)*H(I)+L(NP)*L(NP))/L(NP)
      PCLO=PCLO+SDM(I)*H(I)/SQRT(H(I)*H(I)+L(NP)*L(NP))
      PCL(I,NP)=PCL(I,NP)+PCLO
      PCL(I,NP1)=PCL(I,NP1)+PCLO
  540 CONTINUE
      WRITE(6,100)
      WRITE(6,110)
      WRITE(6,120) (I,PCL(I,NP),PCL(I,NP1),SDM(I),I=1,NS)
      GO TO 590
C CROSS DIAGONAL BRACING ANALYSIS
  550 CBM(1)=HL(1)*0.5*SQRT(H(1)*H(1)+L(NP)*L(NP))/L(NP)
      PCLO=CBM(1)*H(1)/SQRT(H(1)*H(1)+L(NP)*L(NP))*0.75
      PCL(1,NP)=PCL(1,NP)+PCLO
      PCL(1,NP1)=PCL(1,NP1)+PCLO
      DO 560 I=2,NS
      IO=I-1
      HL(I)=HL(IO)+HL(I)
      CBM(I)=HL(I)*0.5*SQRT(H(I)*H(I)+L(NP)*L(NP))/L(NP)
      PCLO=PCLO+CBM(IO)*H(IO)/SQRT(H(IO)*H(IO)+L(NP)*L(NP))*0.75+CBM(I)
     1*H(I)/SQRT(H(I)*H(I)+L(NP)*L(NP))*0.75
      PCL(I,NP)=PCL(I,NP)+PCLO
      PCL(I,NP1)=PCL(I,NP1)+PCLO
  560 CONTINUE
      WRITE(6,130)
      WRITE(6,110)
      WRITE(6,120) (I,PCL(I,NP),PCL(I,NP1),CBM(I),I=1,NS)
      GO TO 590
C     HORIZONTAL K BRACING ANALYSIS
  570 HKM(1)=HL(1)*0.5*SQRT(H(1)*H(1)+L(NP)*L(NP))/L(NP)
      PCLO=0.0
      DO 580 I=2,NS
      IO=I-1
      HL(I)=HL(IO)+HL(I)
      HKM(I)=HL(I)*0.5*SQRT(H(I)*H(I)+L(NP)*L(NP))/L(NP)
      PCLO=PCLO+HKM(IO)*H(IO)/SQRT(H(IO)*H(IO)+L(NP)*L(NP))
      PCL(I,NP)=PCL(I,NP)+PCLO
      PCL(I,NP1)=PCL(I,NP1)+PCLO
  580 CONTINUE
      WRITE(6,140)
      WRITE(6,110)
      WRITE(6,120) (I,PCL(I,NP),PCL(I,NP1),HKM(I),I=1,NS)
```

```
590 STOP
  9 FORMAT(4I5,6F10.3)
 10 FCRMAT(8F10.2)
 20 FORMAT(1H0,/,42X,'THE NO OF BAYS NB',6X,'=',I3,//,42X,'THE NC CF S
   1TORIES NS',3X,'=',I3,//,42X,'STEEL YIELDS STRESS FY =',F5.2,'KSI',
   1//,42X,'OUTSIDE WALL WT',8X,'=',F5.2,'PSF',//,42X,'ROOF DEAC LCAC
   1RDL',5X,'=',F5.3,'KLF',//,42X,'ROOF LIVE LOAD RLL',5X,'=',F5.3,
   1'KLF',//,42X,'FLOCR DEAD LCAD FDL',4X,'=',F5.3,'KLF',//,42X,'FLCOR
   1 LIVE LOAC FLL',4X,'=',F5.3,'KLF')
 30 FCRMAT(1H0,12X,I2,10X,F5.2,17X,I2,13X,F5.2,19X,I2,11X,F5.2)
 50 FCRMAT(1H1,//,24X,'COMPUTATICN RESULTS FOR UNBRACING PART IN FRAME
   1')
 60 FORMAT(1H0,//,28X,'SPAN NO',5X,'ROOF BM SR',5X,'FLCCR BM SR')
 70 FORMAT(1H0,21X,'BEAM',4X,I5,5X,F9.2,5X,F9.2)
 80 FORMAT(1H0,/,32X,'I',3X,'J',10X,'COL AXIAL LCAD')
 90 FCRMAT(1H0,20X,'CCLUMN',4X,I2,2X,I2,10X,F10.2)
100 FORMAT(1H0,/,24X,'CONPUTATICN RESULTS FOR SINGLE CIAGONAL ERACING'
   1)
110 FORMAT(1H0,14X,'STCRY NO',5X,'LEFT CCL',5X,'RIGHT CCL',5X,'BRACING
   1MEMBER')
120 FCRMAT(1H0,17X,I3,3F13.2)
130 FORMAT(1H0,/,24X,'COMPUTATICN RESULTS FCR CROSS  CIAGONAL BRACING'
   1)
140 FCRMAT(1H0,/,40X,'CCMPUTATION RESULTS FOR HORIZONTAL K.   BRACING'
   1)
150 FORMAT(1H1,  35X,'THE DESCRIPTION OF FRAME DIMENSICN AND LCACING')
160 FCRMAT(1H0,//,10X,'BAY NO',5X,'BAY WICTH(FT)',10X,'STORY NC',
   15X,'STORY HEIGHT(FT)',10X,'LEVEL NO',5X,'LATERAL LCAD(K)')
    END

$EXEC
```

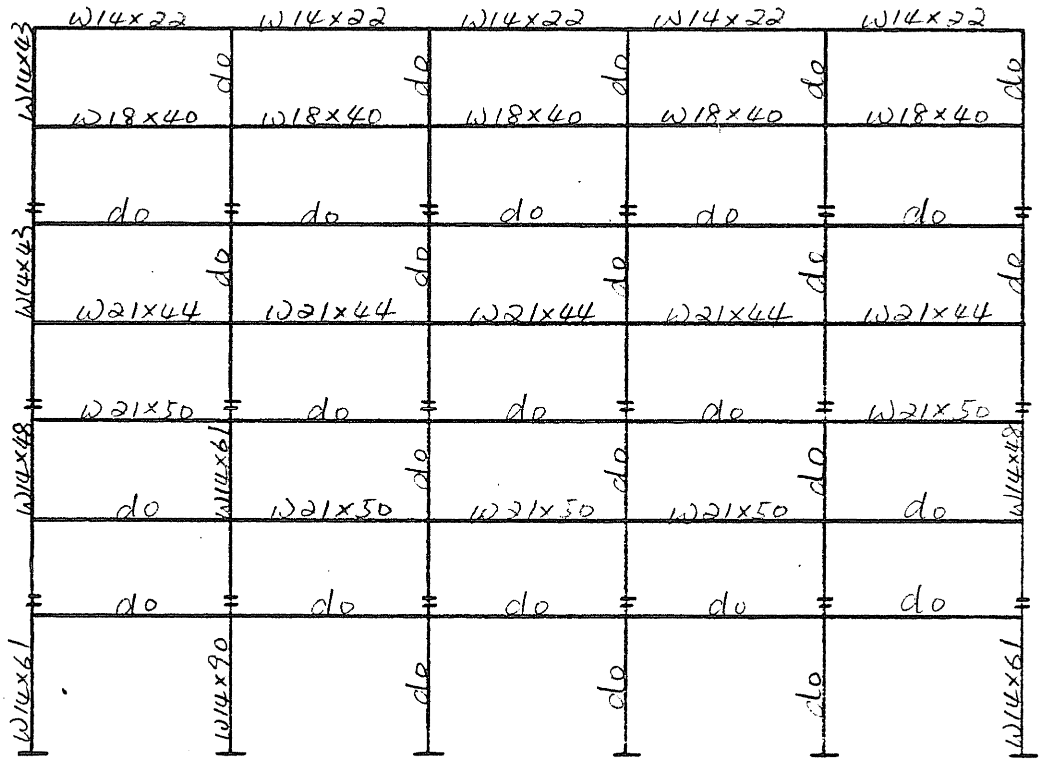
APPENDIX C

DESIGN EXAMPLES FOR ATLANTA, GEORGIA



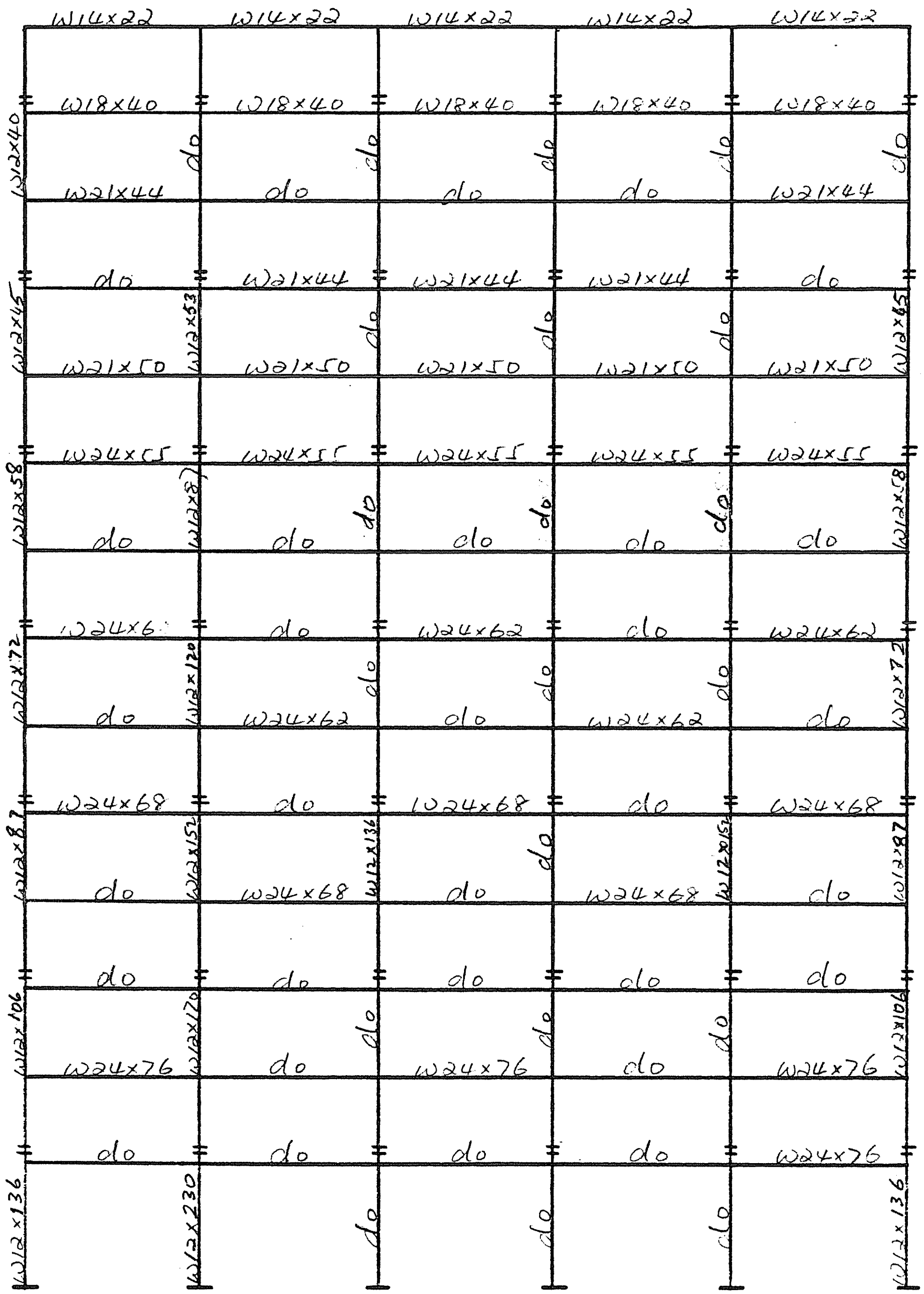
Frame Weight = 72.05 kips

Figure C.1 Design for 7 Stories, W12 Columns



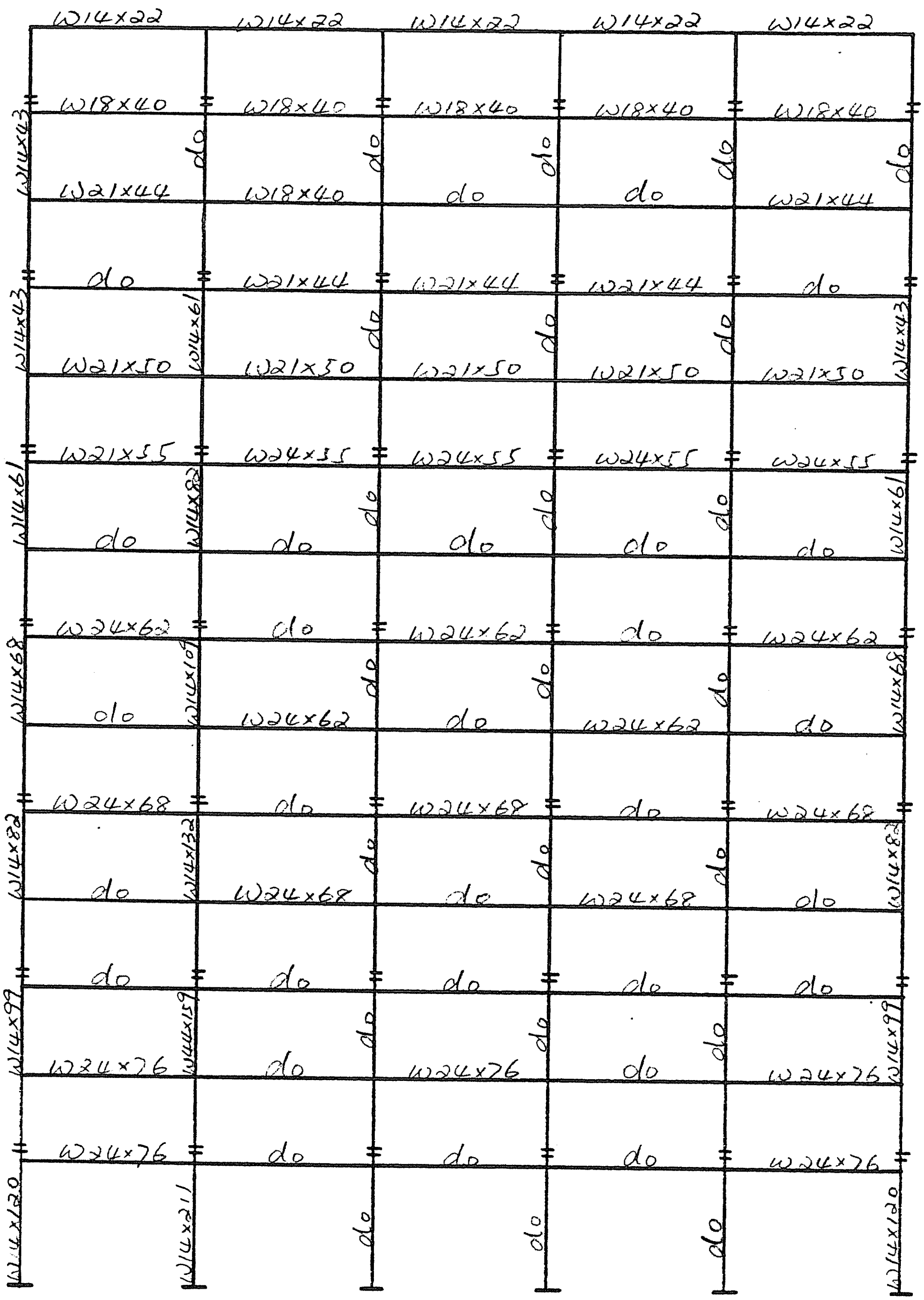
Frame Weight = 72.09 kips

Figure C.2 Design for 7 Stories, W14 Columns



Frame Weight = 218.78 kips

Figure C.3 Design for 14 Stories, W12 Columns



Frame Weight = 213.08 kips

Figure C.4 Design for 14 Stories, W14 Columns

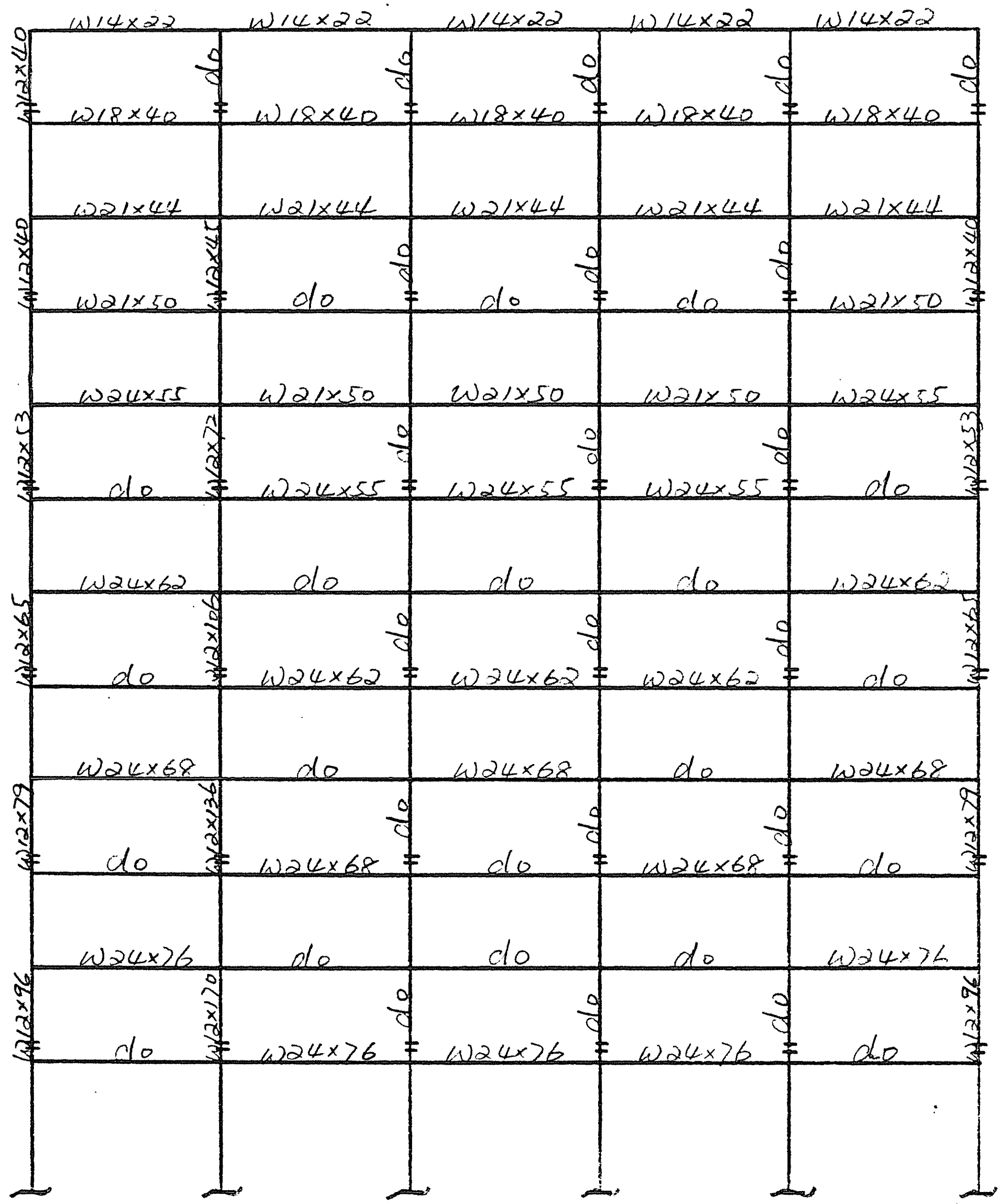
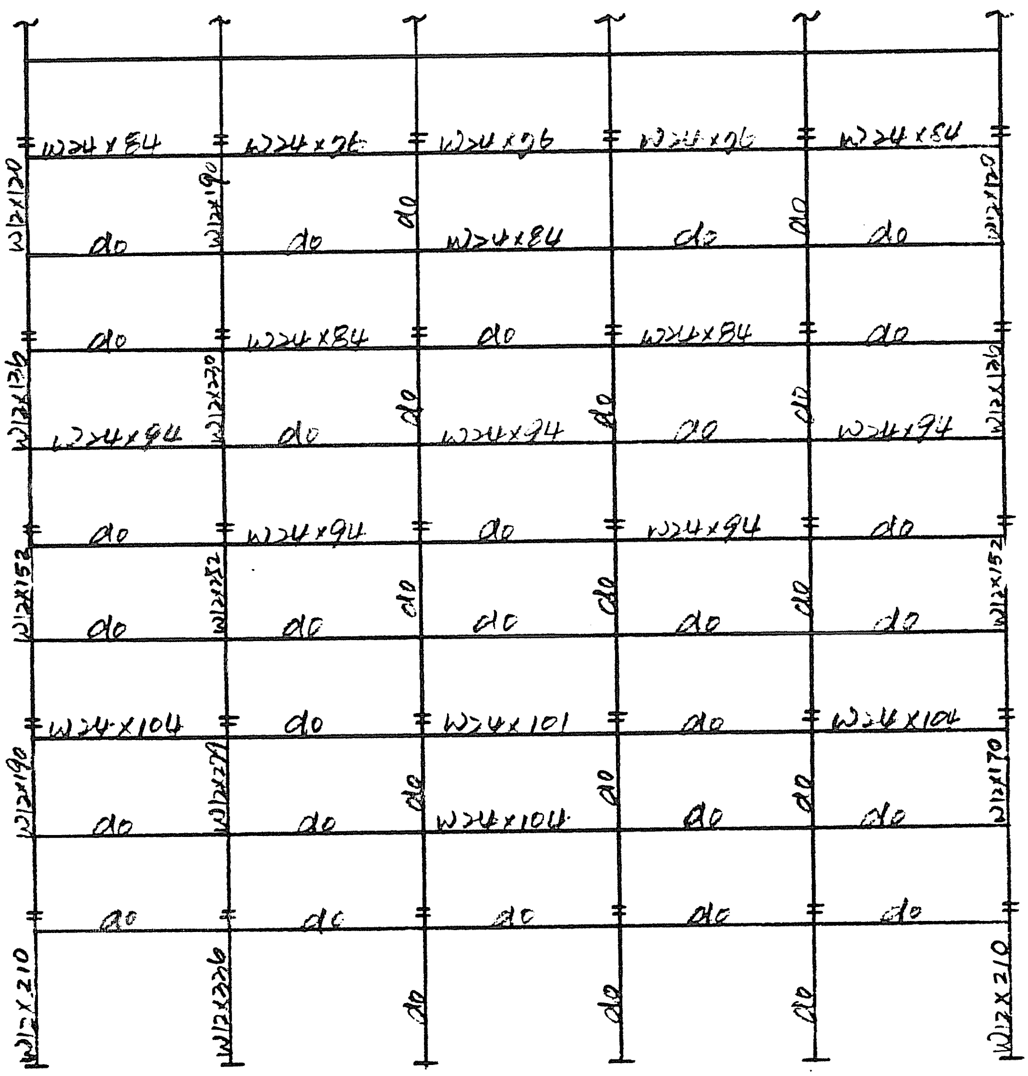


Figure C.5 Design for 21 Stories, W12 Columns



Frame Weight = 430.07 kips

Figure C.5 Design for 21 Stories, W12 Columns Continued

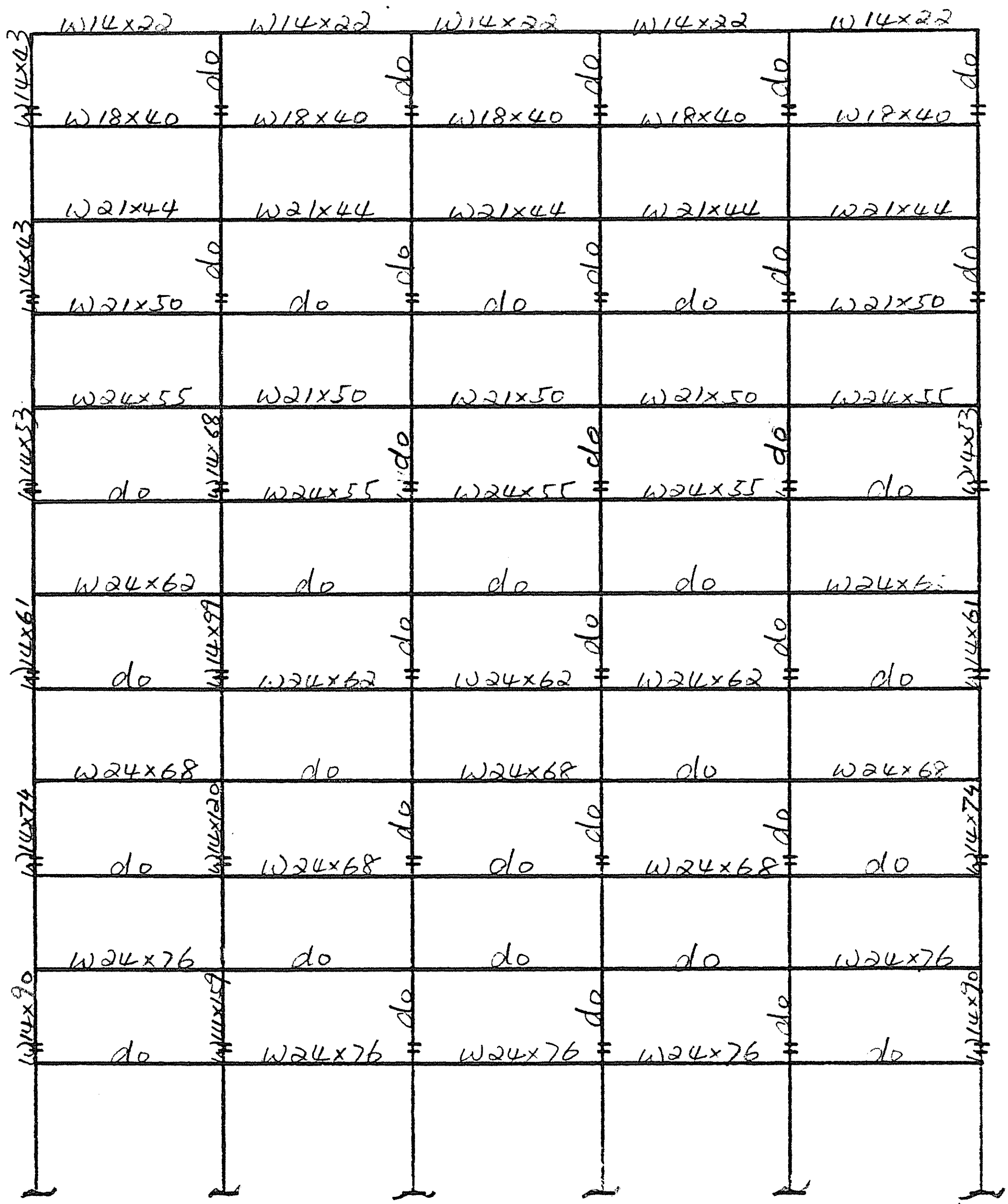
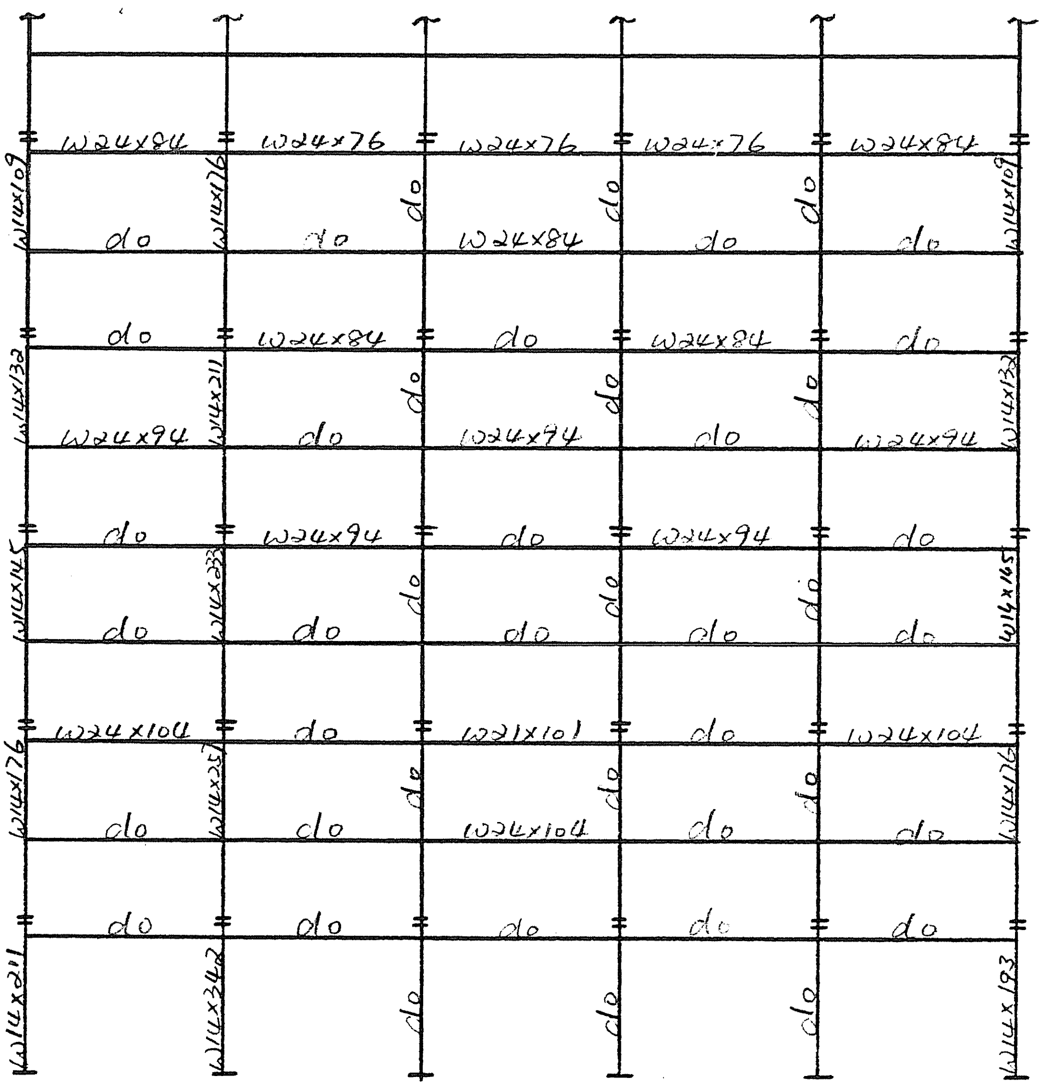


Figure C.6 Design for 21 Stories, W14 Columns



Frame Weight = 436.65 kips

Figure C.6 Design for 21 Stories, W14 Columns Continued

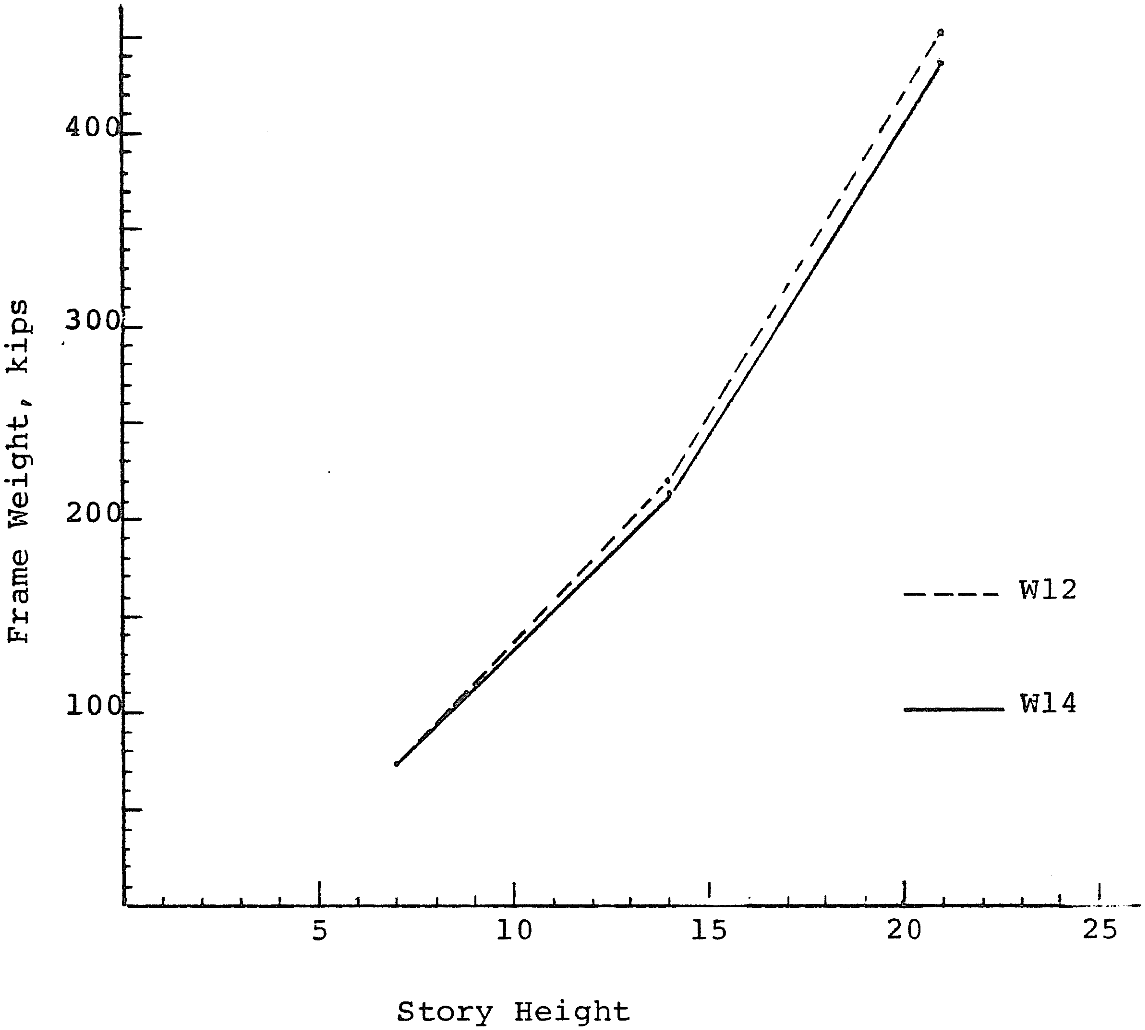


Figure C.7 Weight for Frames of Various Heights

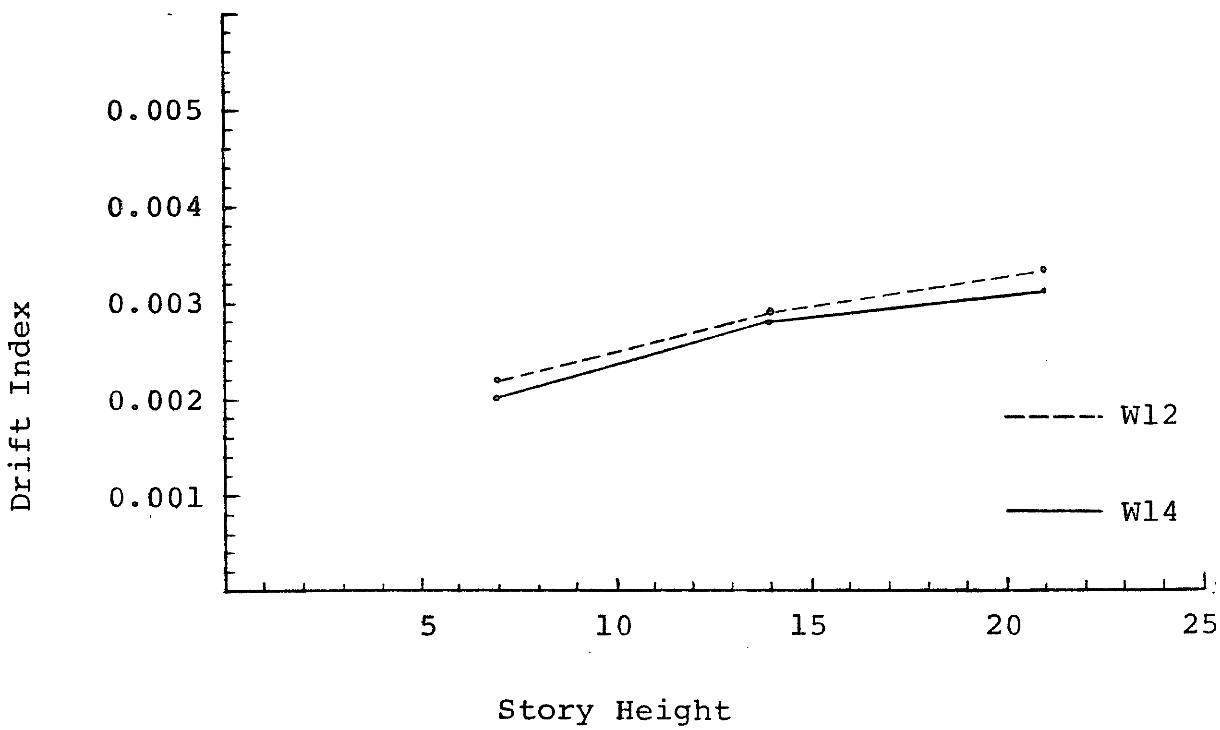
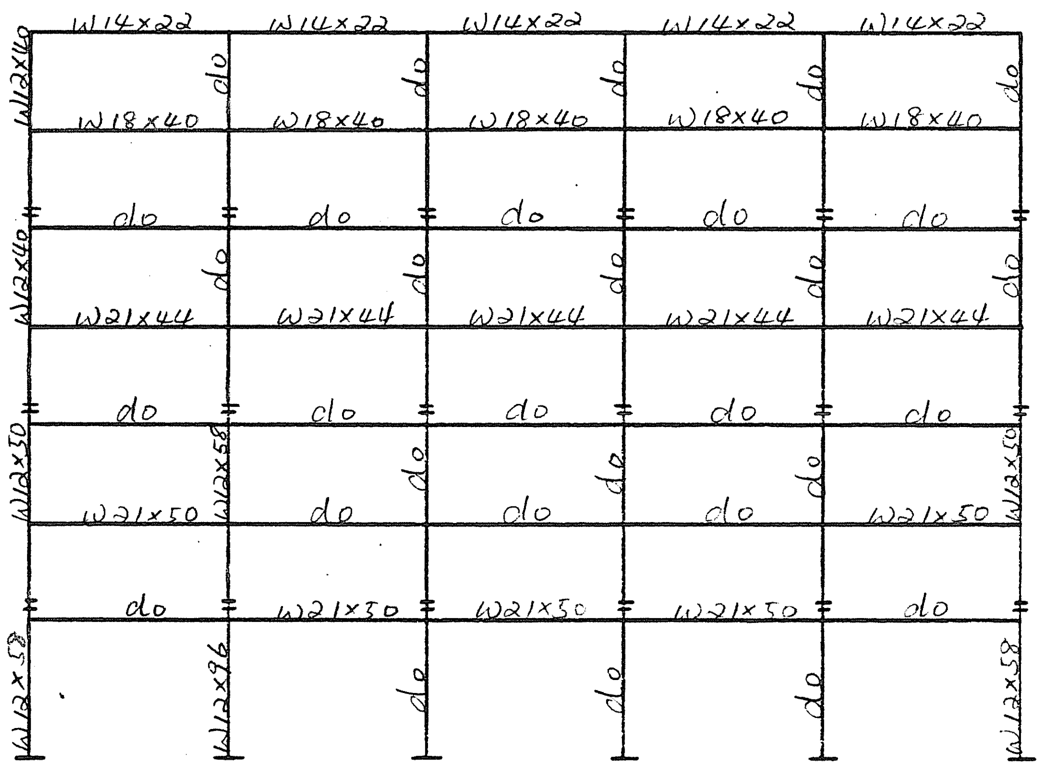


Figure C.8 Drift Index for Frames of Various Heights

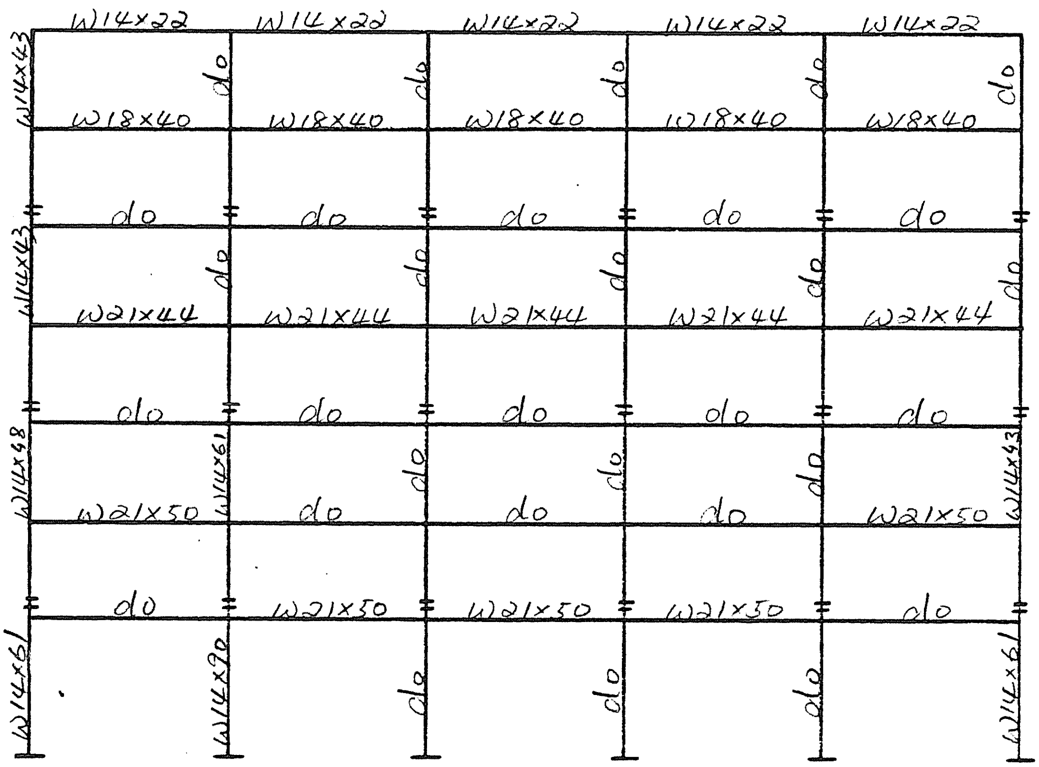
APPENDIX D

DESIGN EXAMPLES FOR DALLAS, TEXAS



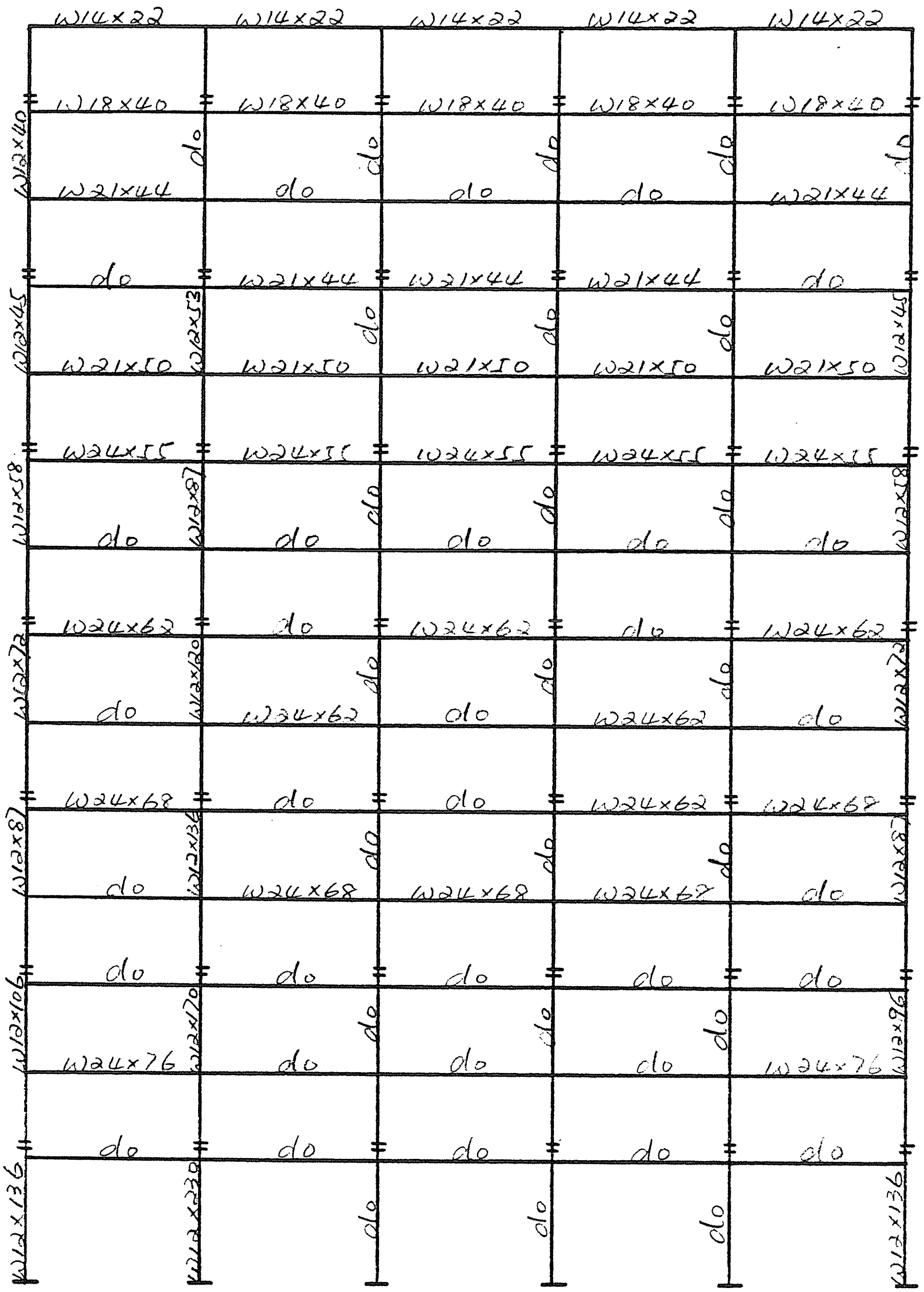
Frame Weight = 70.79 kips

Figure D.1 Design for 7 Stories, W12 Columns



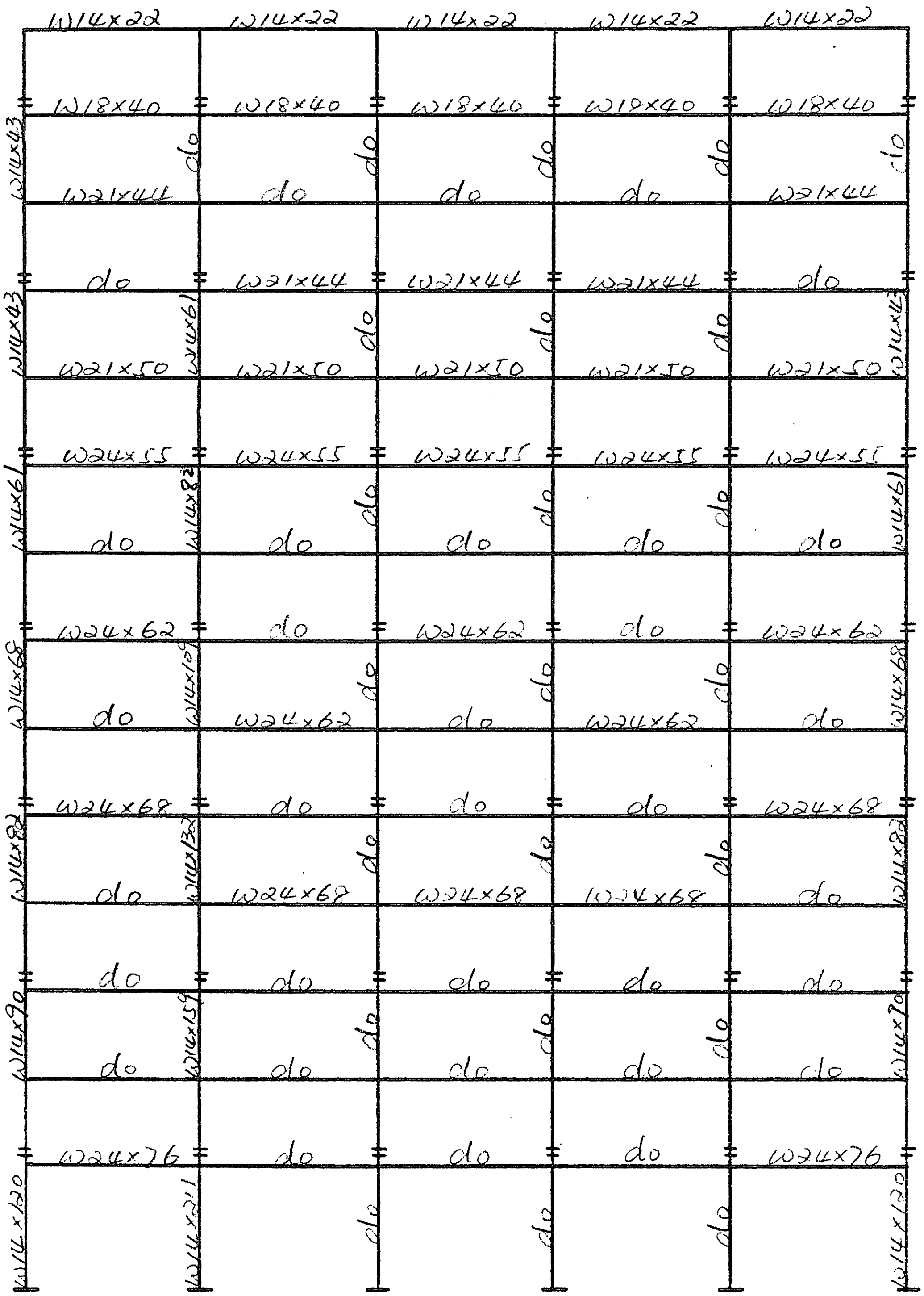
Frame Weight = 71.01 kips

Figure D.2 Design for 7 Stories, W14 Columns



Frame Weight = 216.91 kips

Figure D.3 Design for 14 Stories, W12 Columns



Frame Weight = 211.32 kips

Figure D.4 Design for 14 Stories, W14 Columns

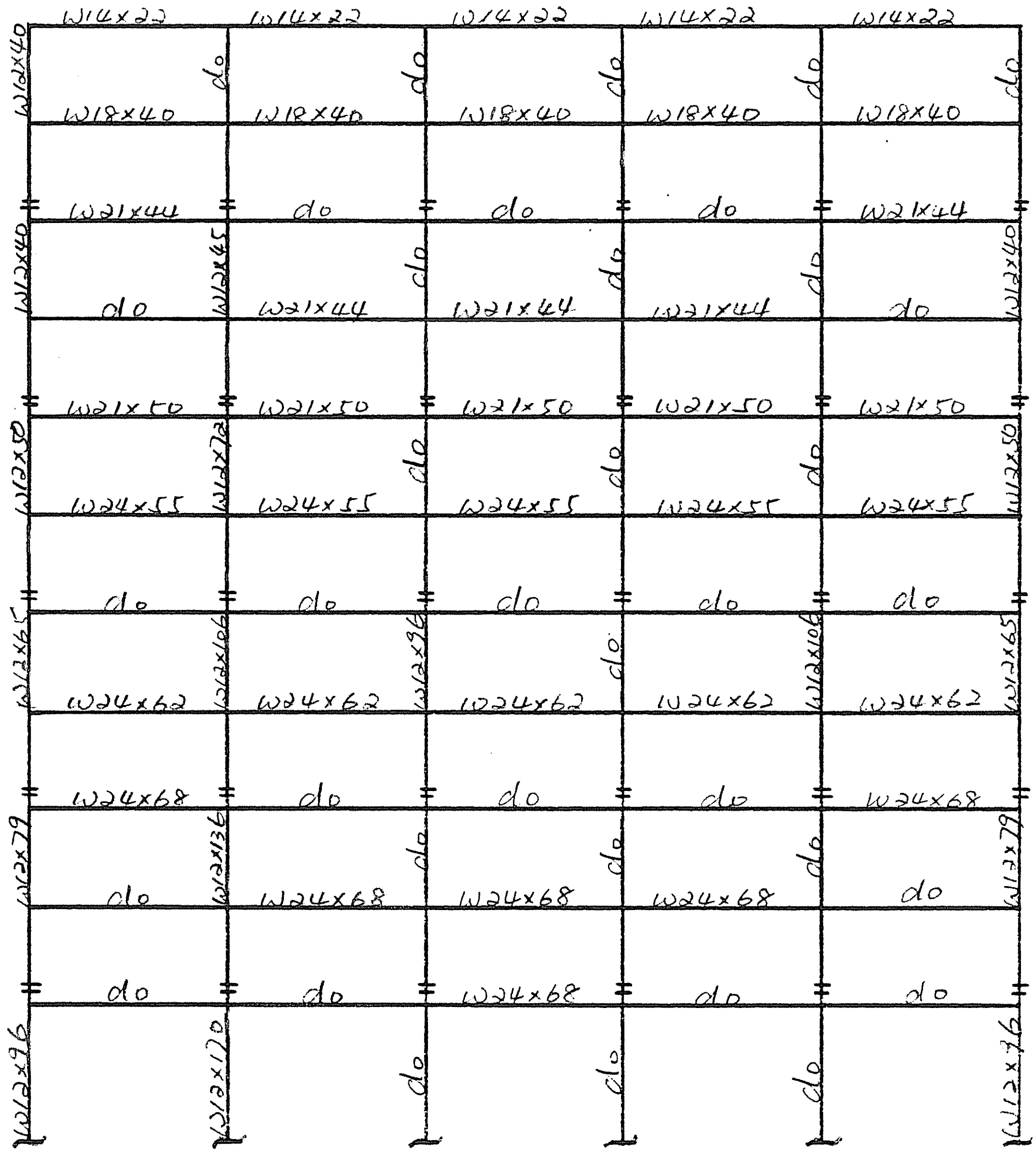
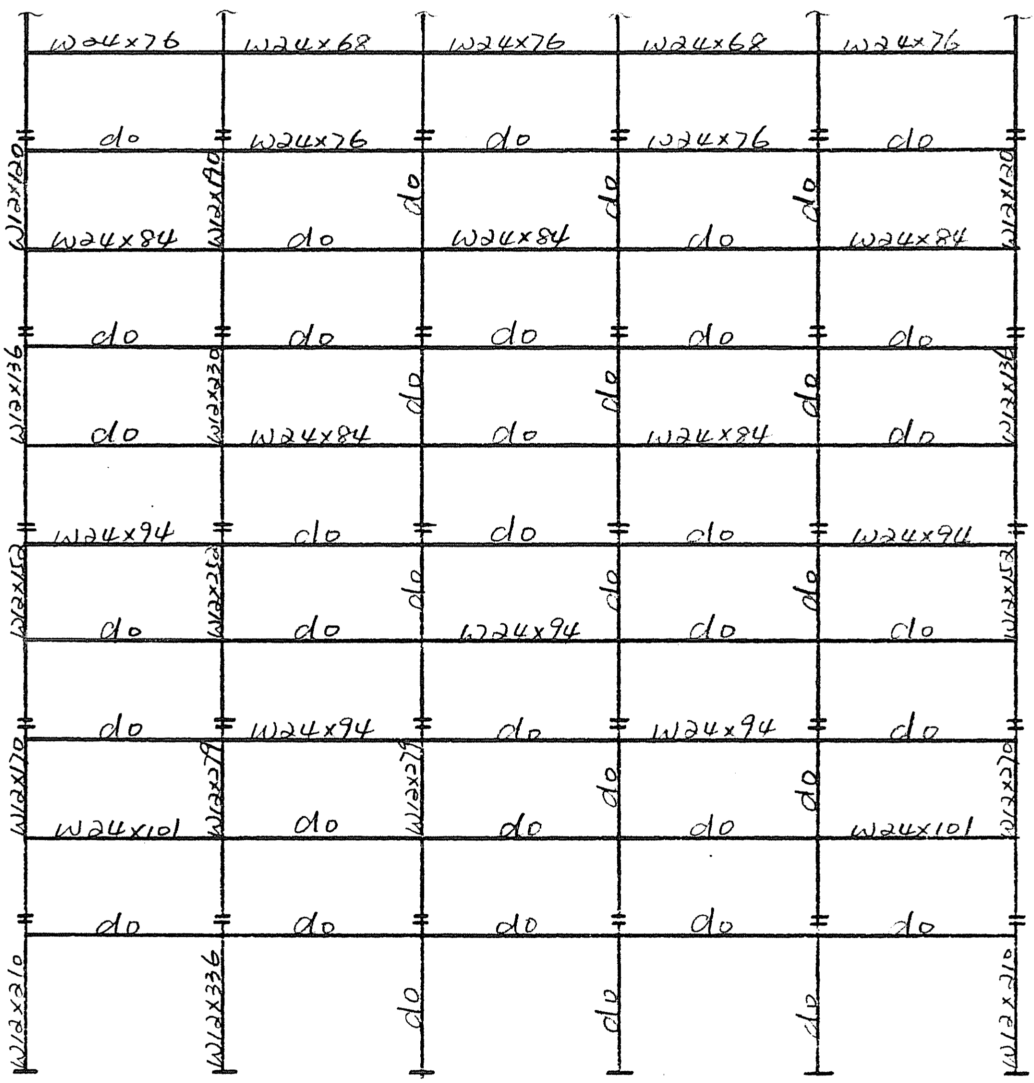


Figure D.5 Design for 21 Stories, W12 Columns



Frame Weight = 438.37 kips

Figure D.5 Design for 21 Stories, W 12 Columns Continued

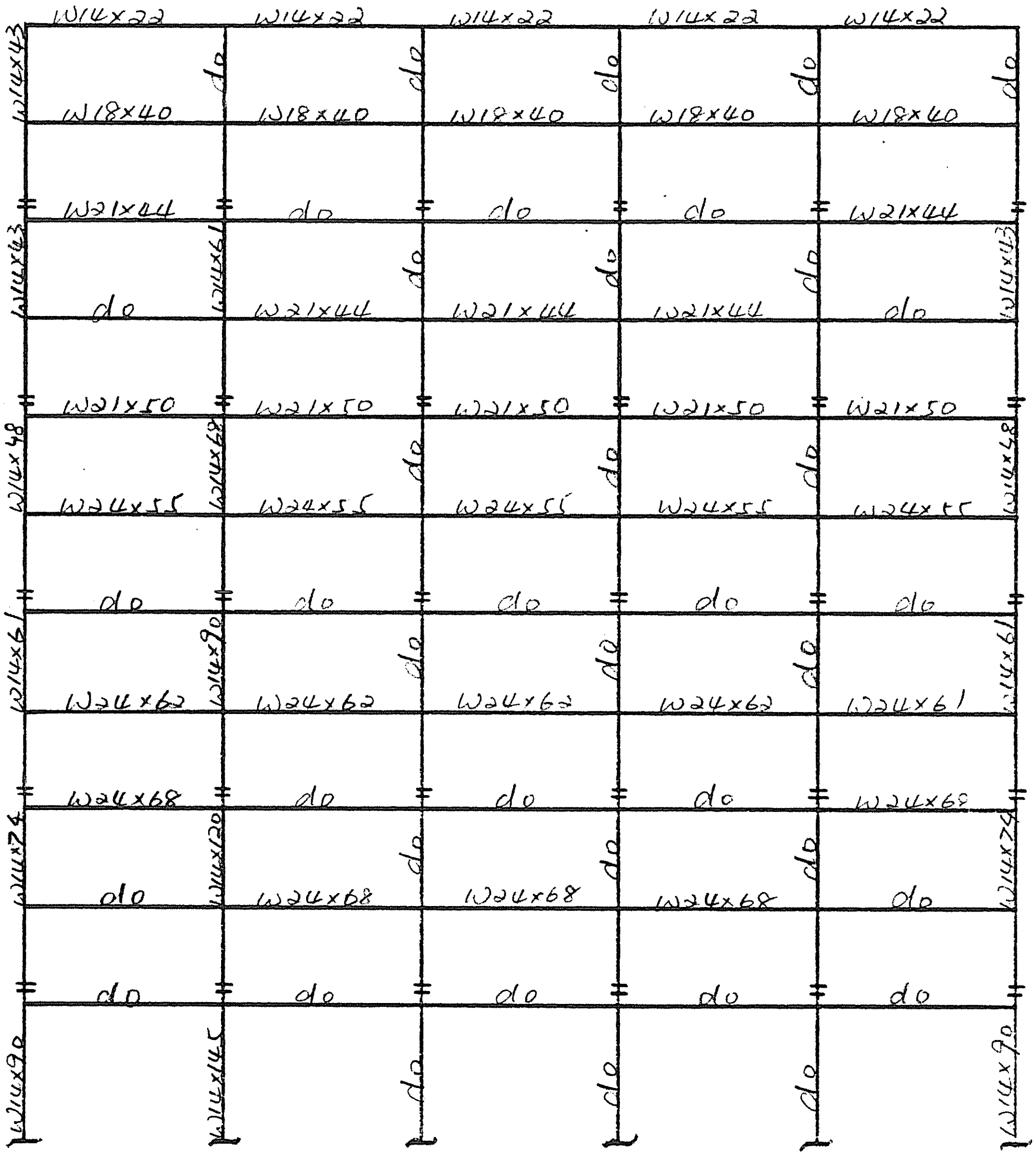
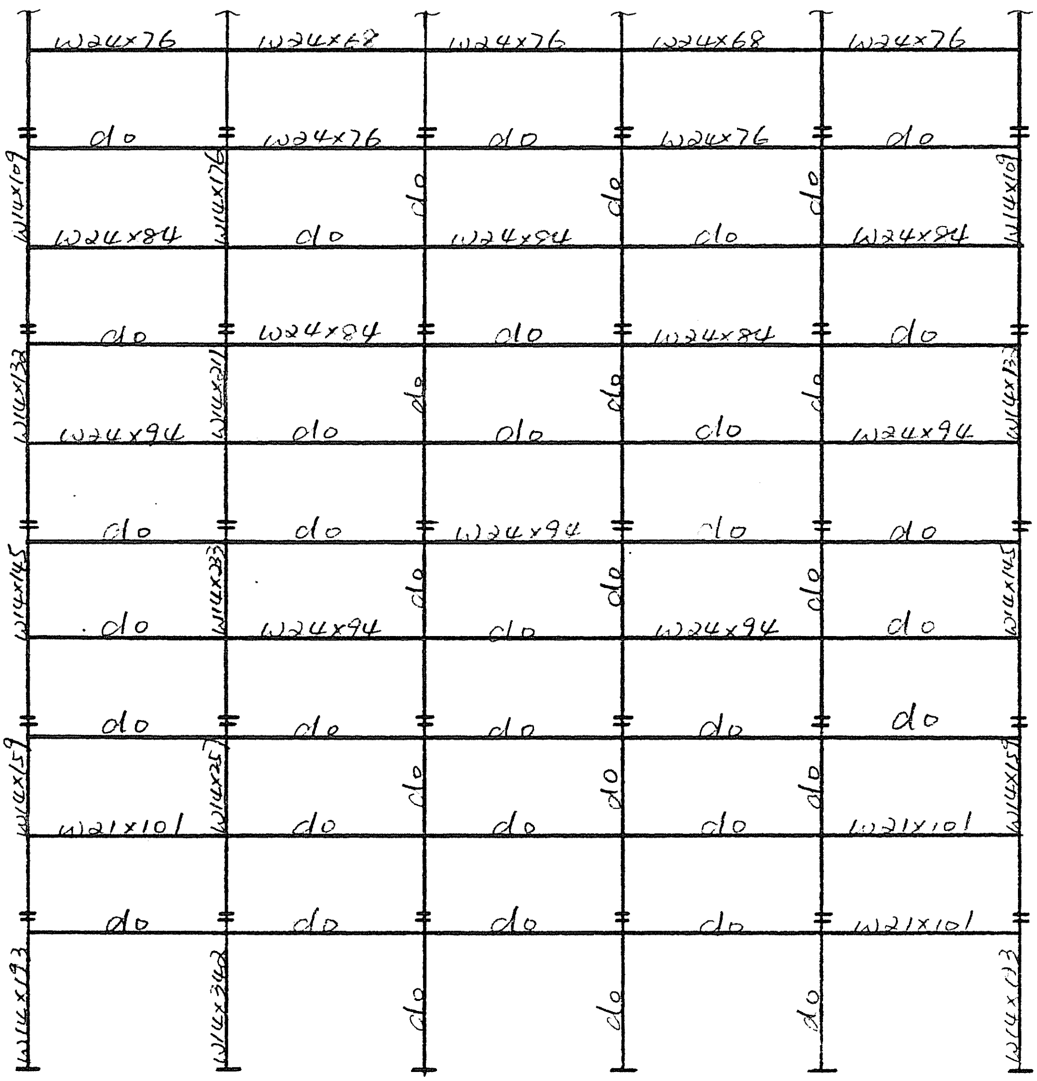


Figure D.6 Design for 21 Stories, W14 Columns



Frame Weight = 425.67 kips

Figure D.6 Design for 21 Stories, W14 Columns Continued

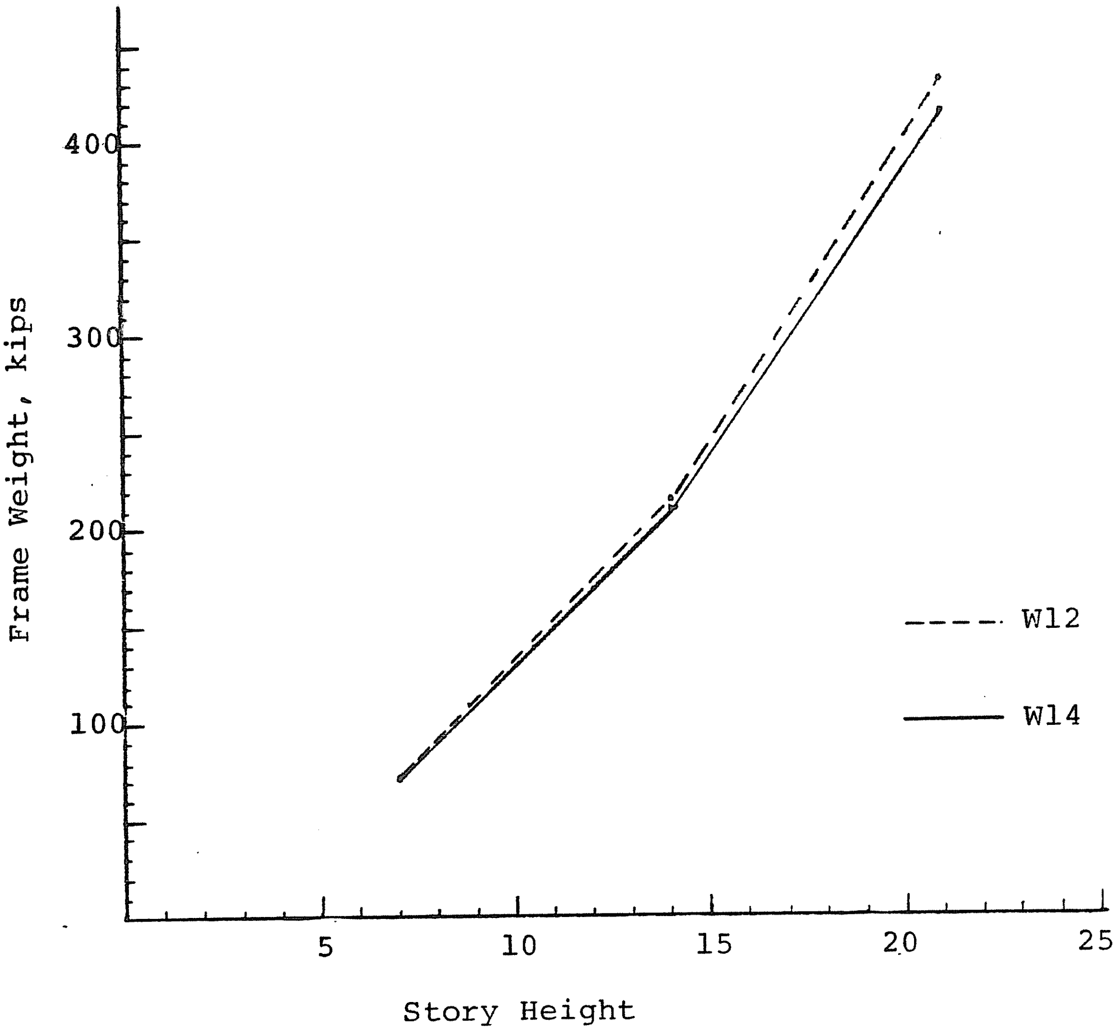


Figure D.7 Weight for Frames of Various Heights

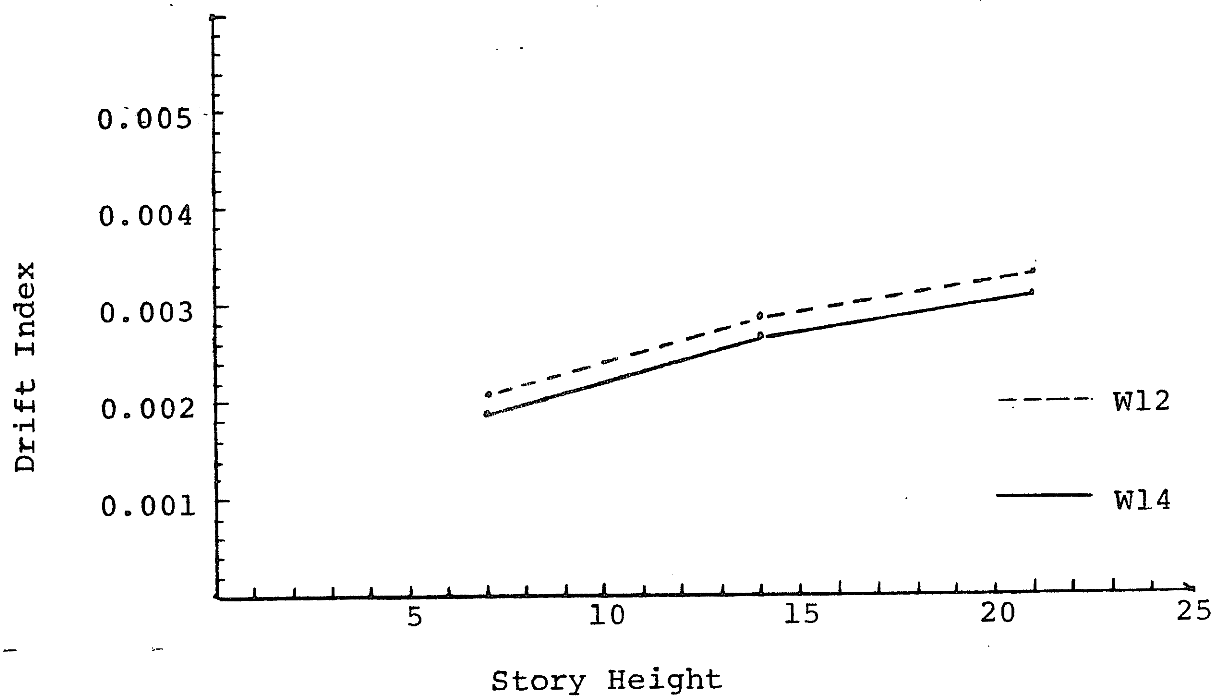
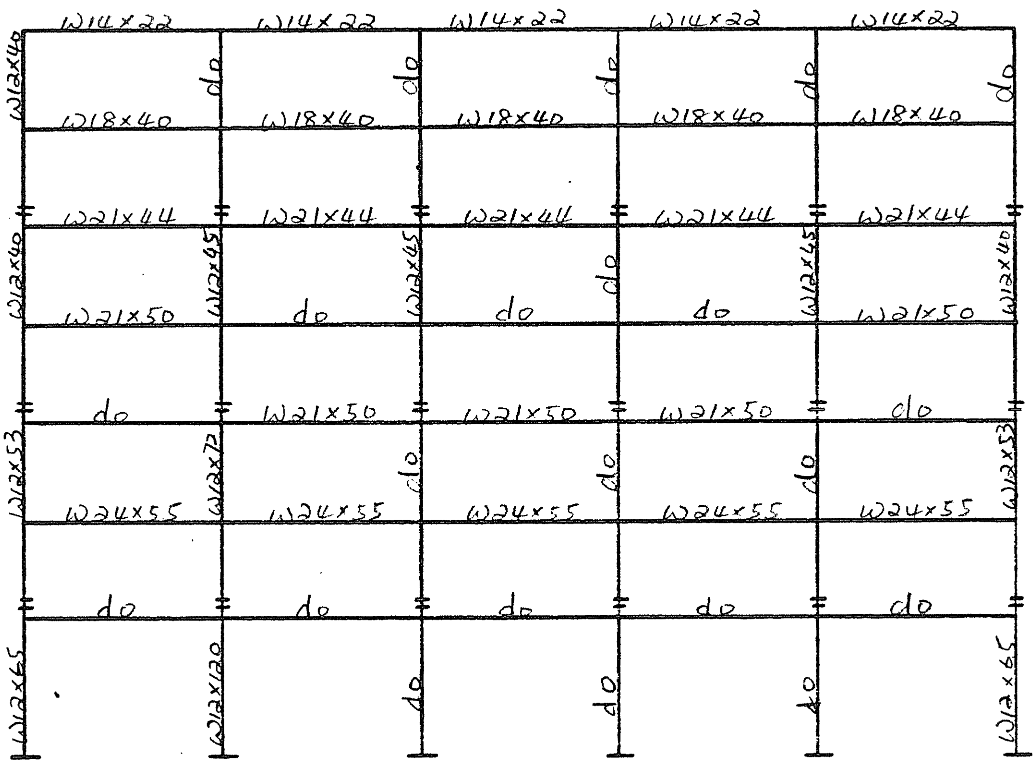


Figure D.8 Drift Index for Frames of Various Heights

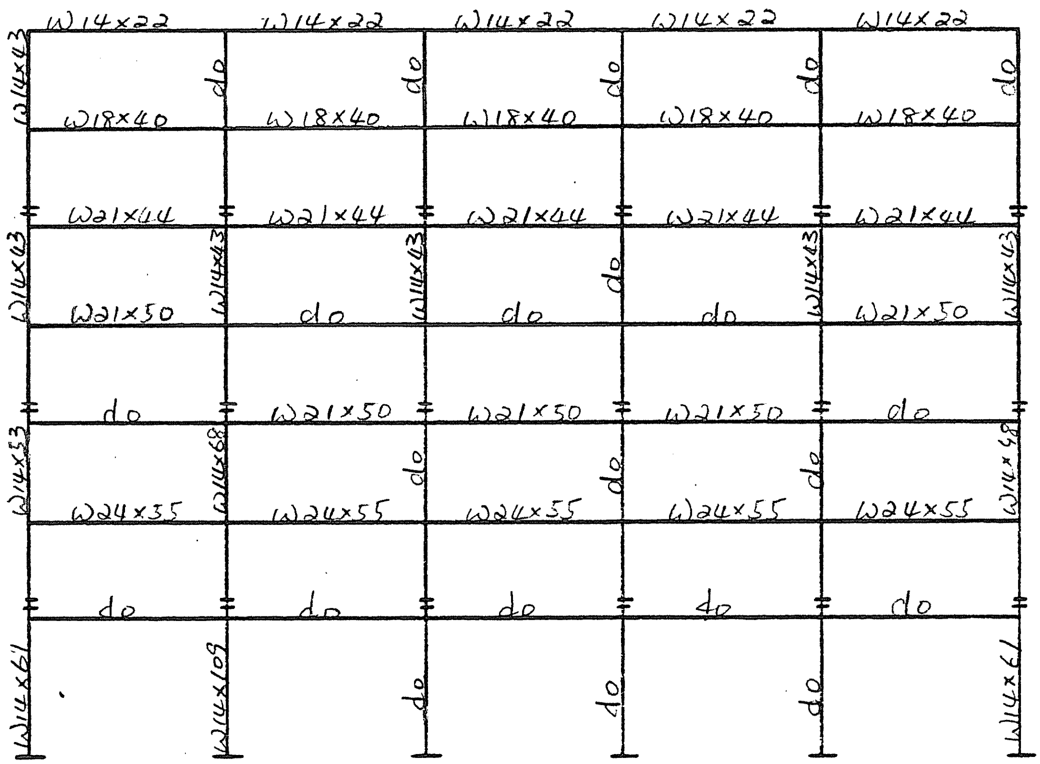
APPENDIX E

DESIGN EXAMPLES FOR HOUSTON, TEXAS



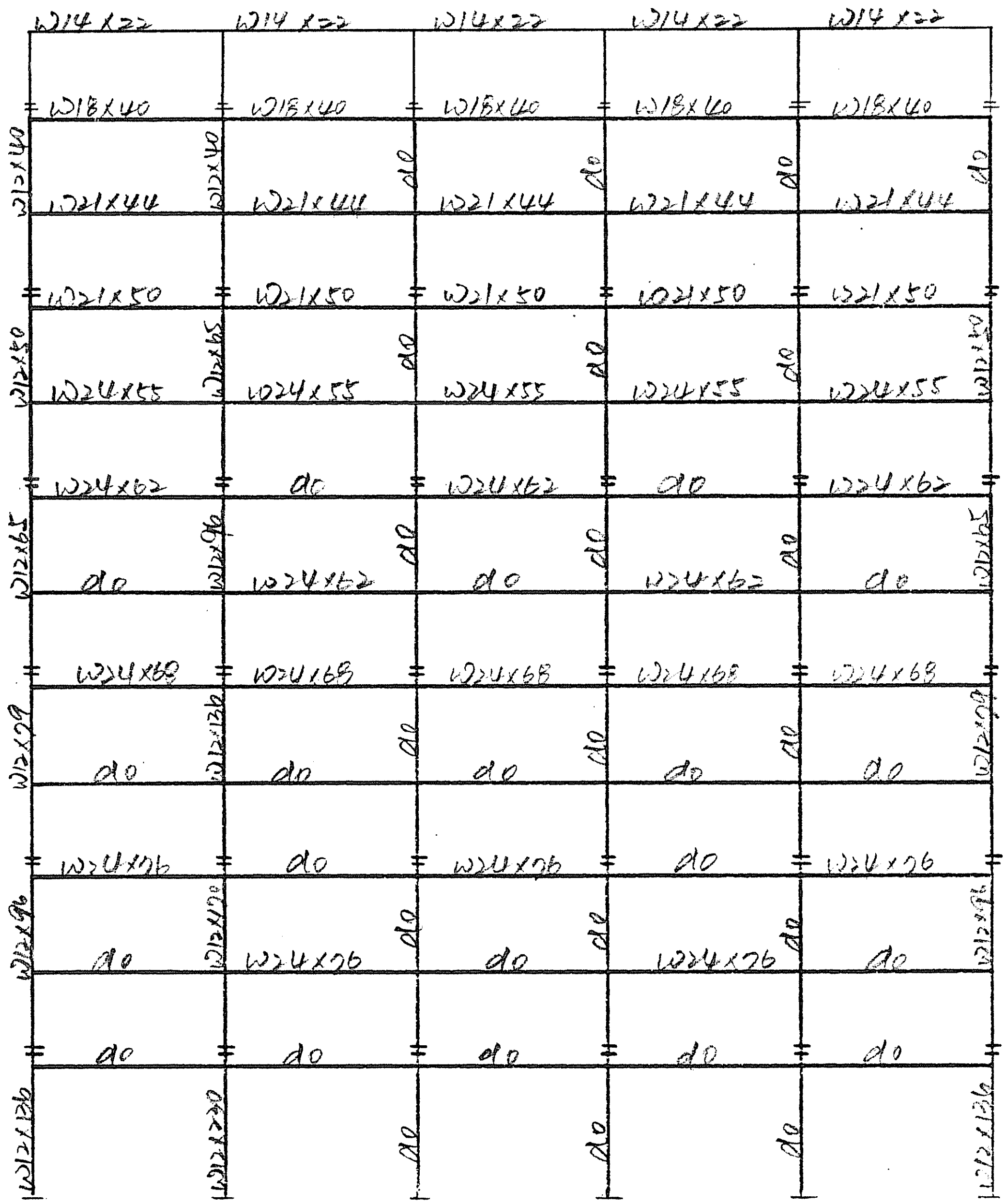
Frame Weight = 78.38 kips

Figure E.1 Design for 7 Stories, W12 Columns



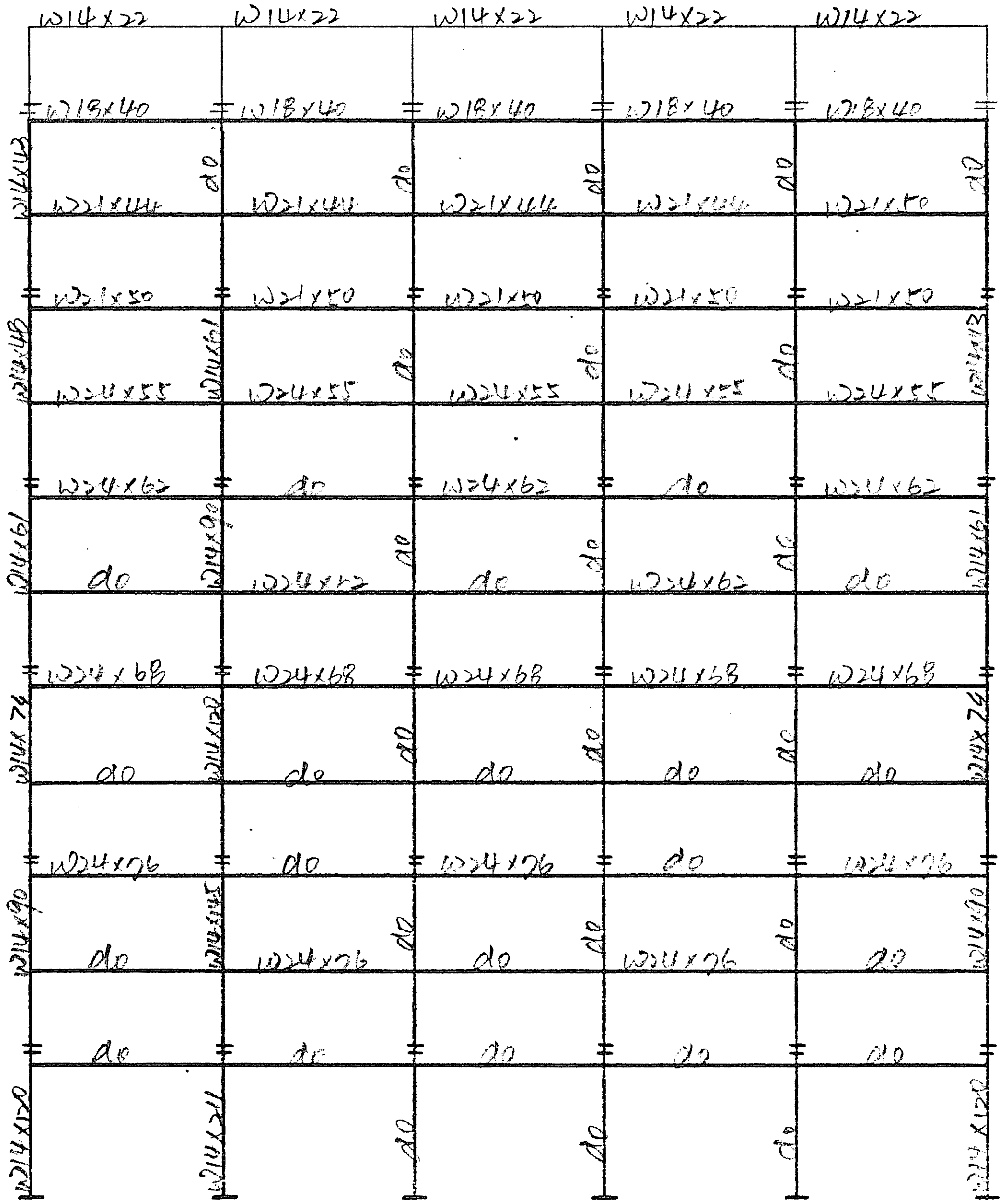
Frame Weight = 77.8 kips

Figure E.2 Design for 7 Stories, W14 Columns



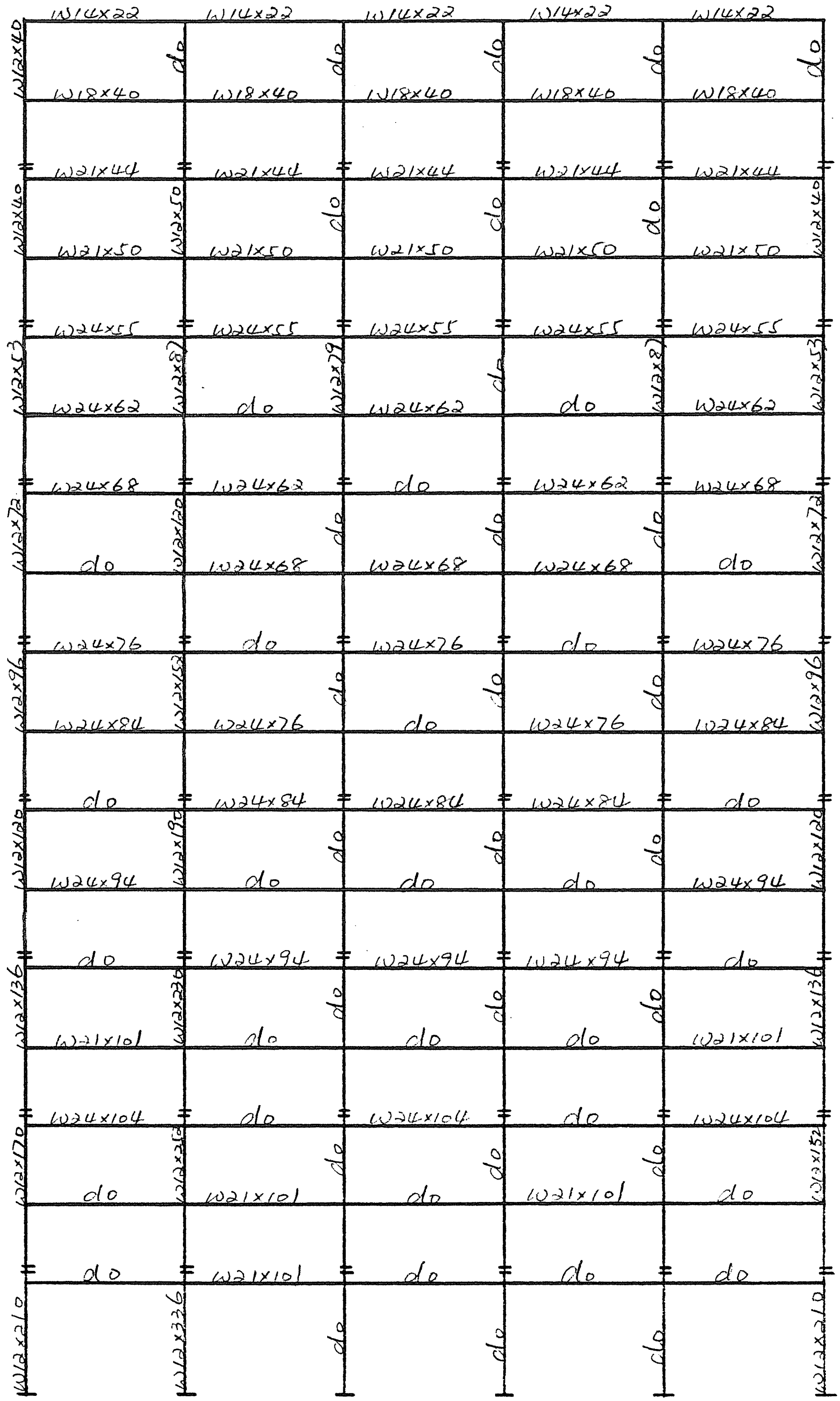
Frame Weight = 191.77 kips

Figure E.3 Design for 12 Stories, W12 Columns



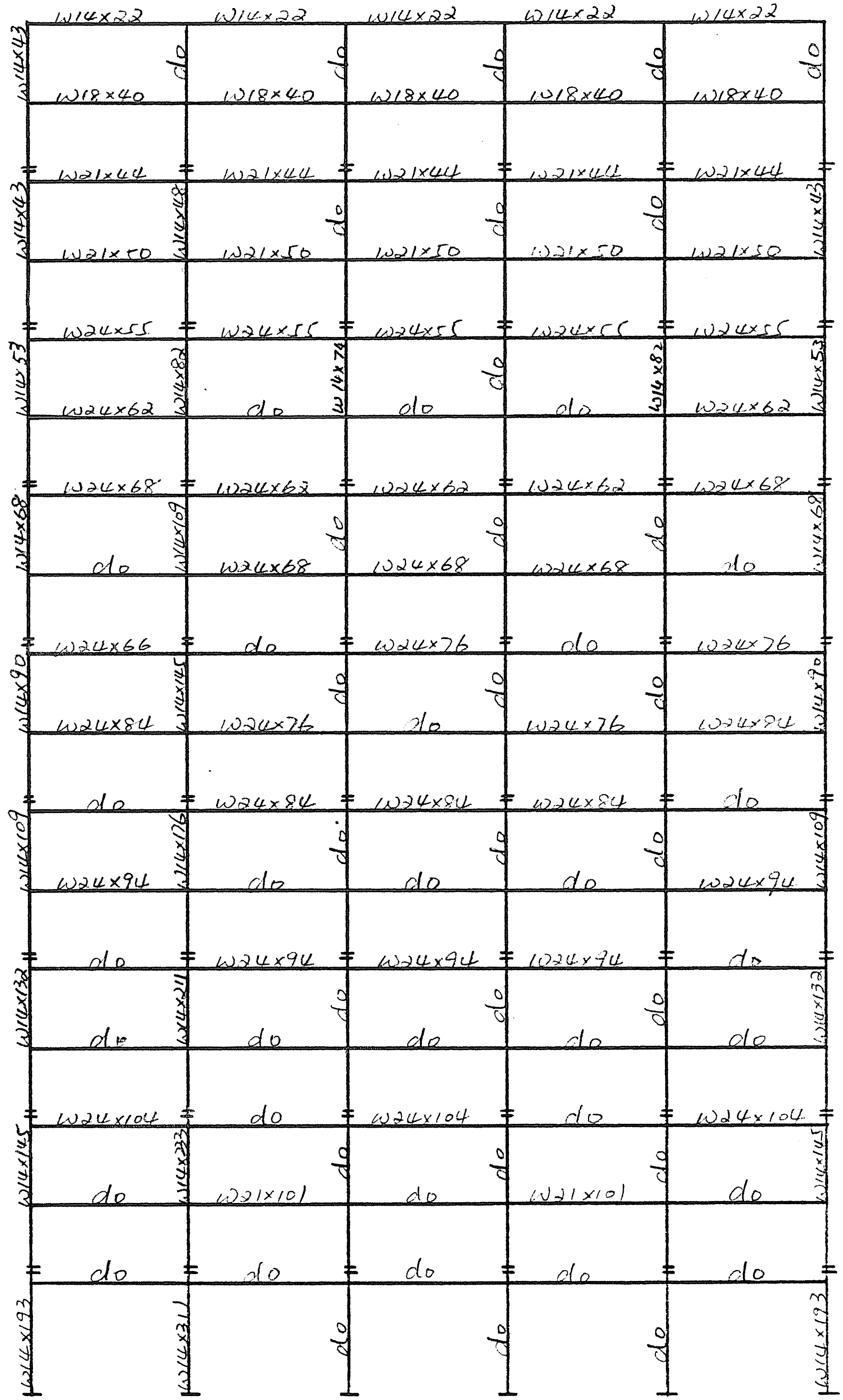
Frame Weight = 185.11 kips

Figure E.4 Design for 12 Stories, W14 Columns



Frame Weight = 357.43 kips

Figure E.5 Design for 17 Stories, W12 Columns



Frame Weight = 344.98 kips

Figure E.6 Design for 17 Stories, W14 Columns

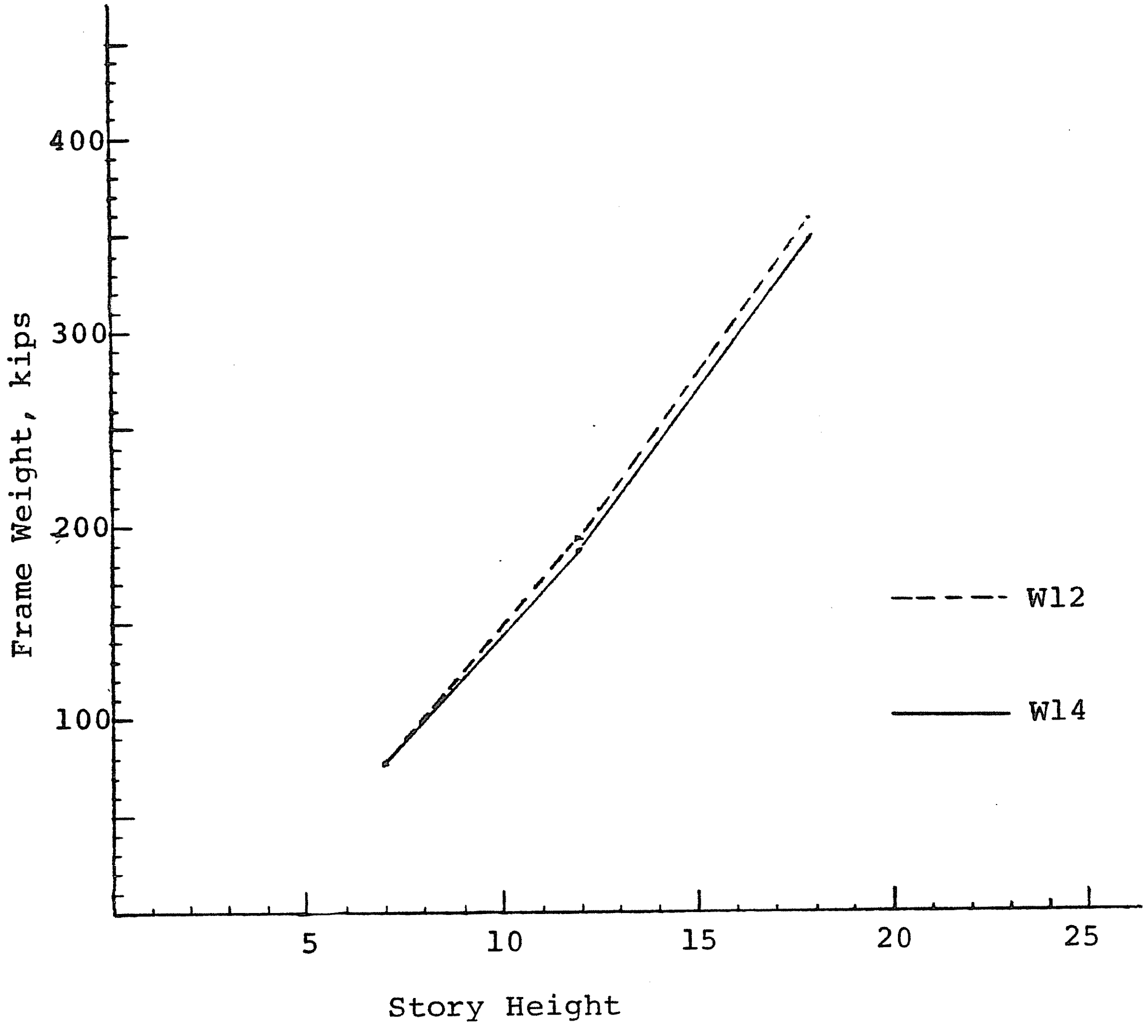


Figure E.7 Weight for Frames of Various Heights

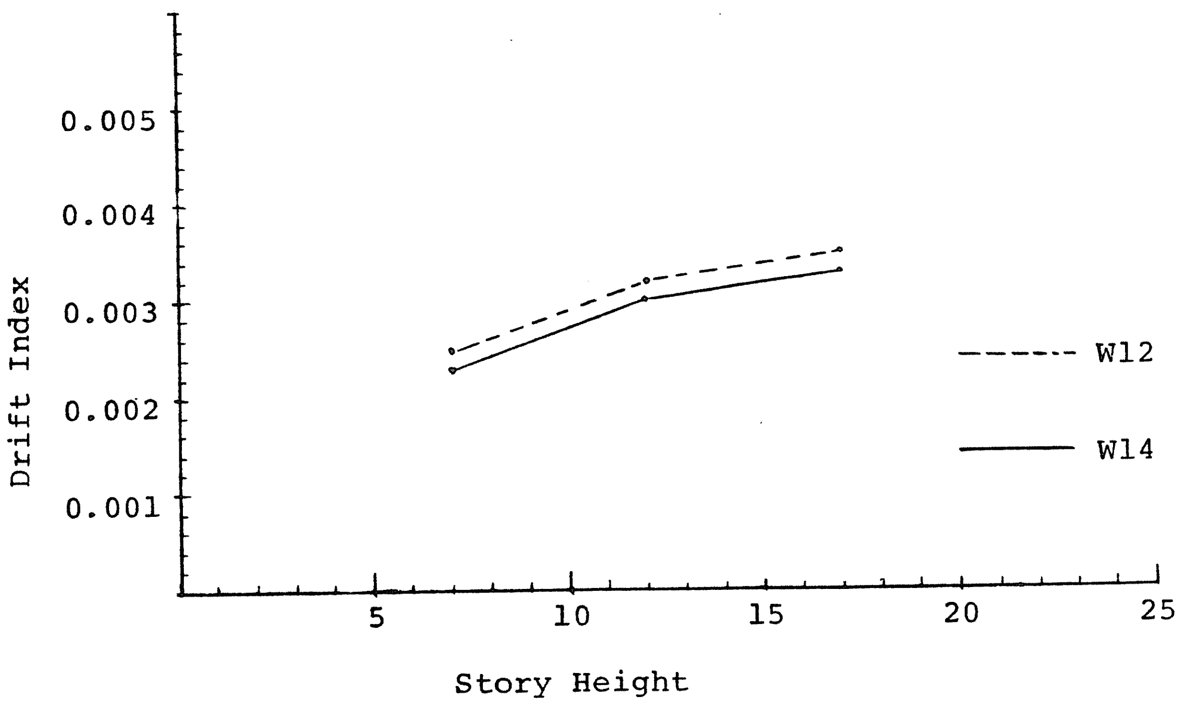
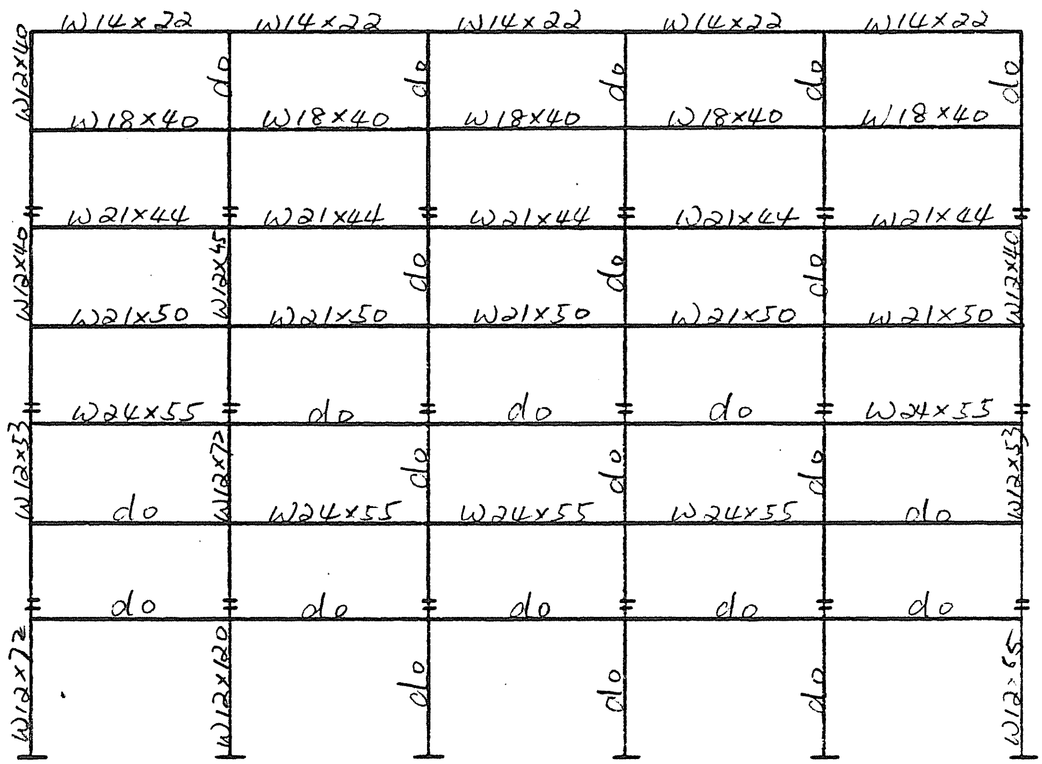


Figure E.8 Drift Index for Frames of Various Heights

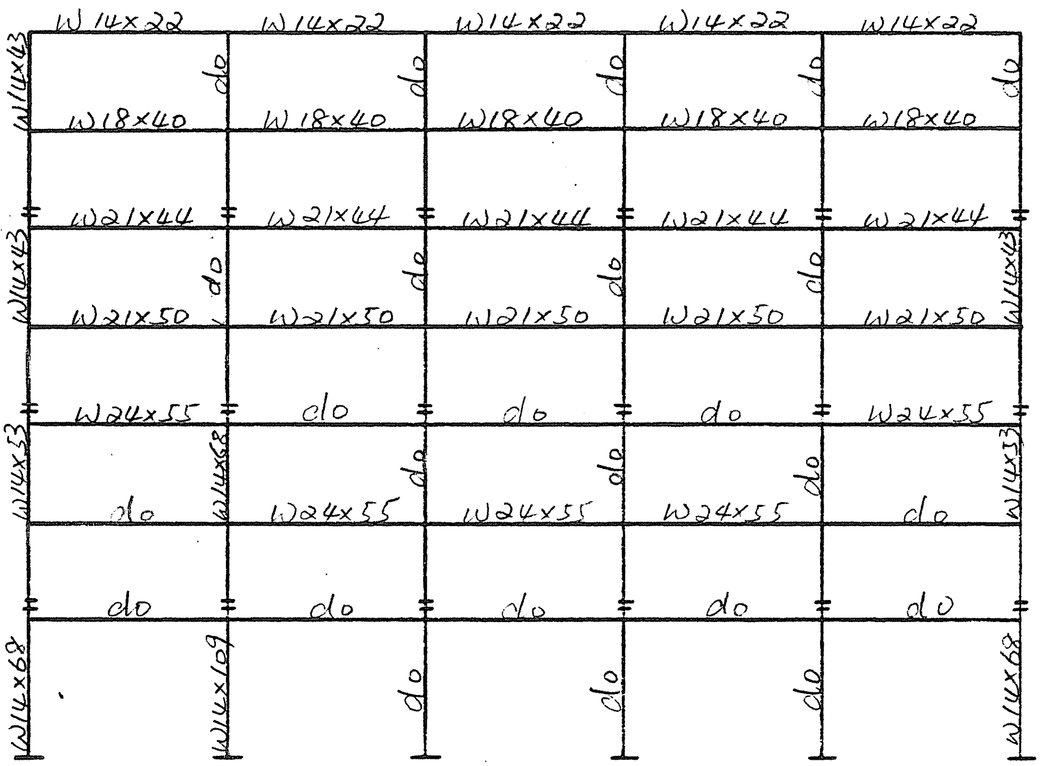
APPENDIX F

DESIGN EXAMPLES FOR JACKSONVILLE, FLORIDA



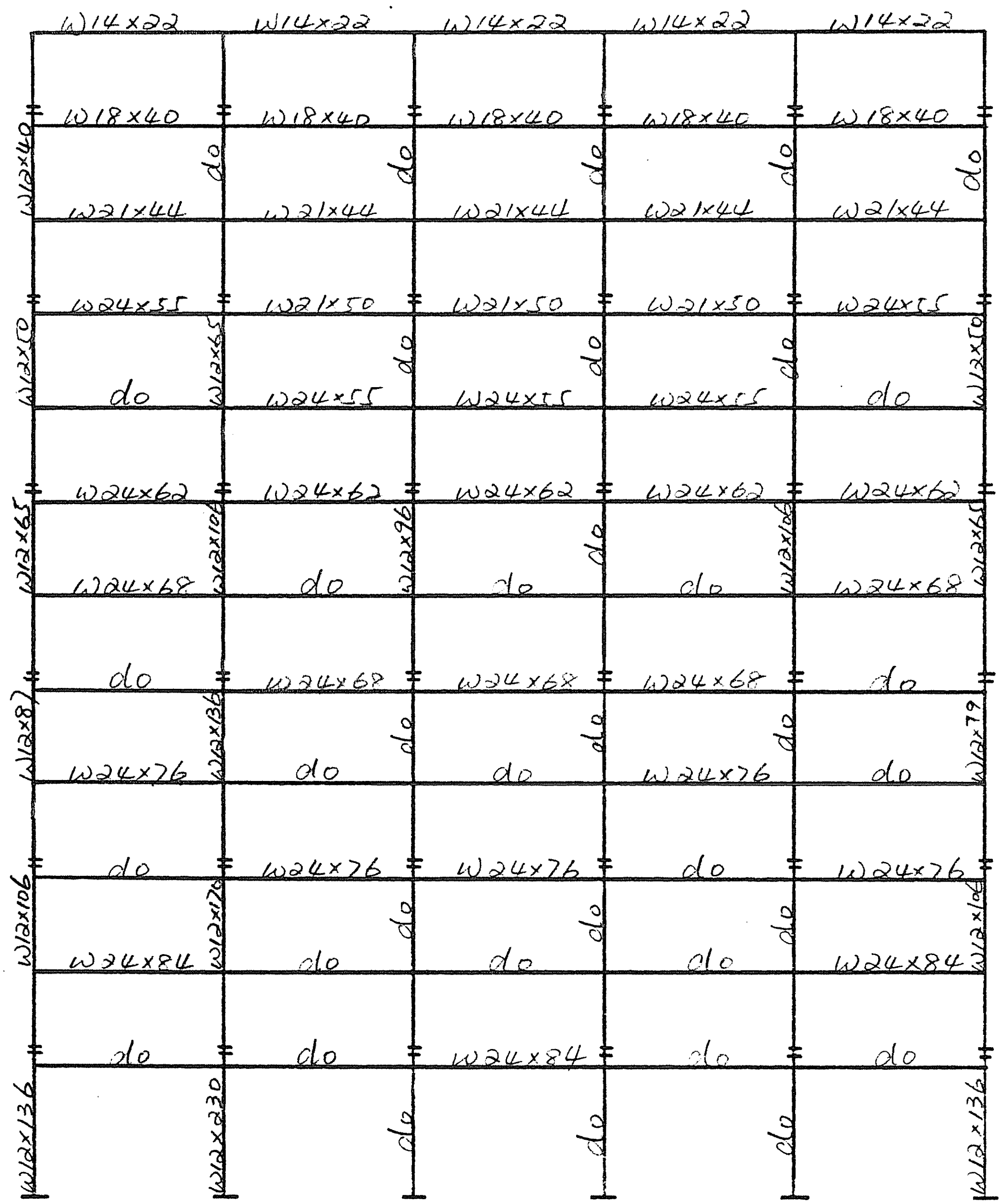
Frame Weight = 79.38 kips

Figure F.1 Design for 7 Stories, W12 Columns



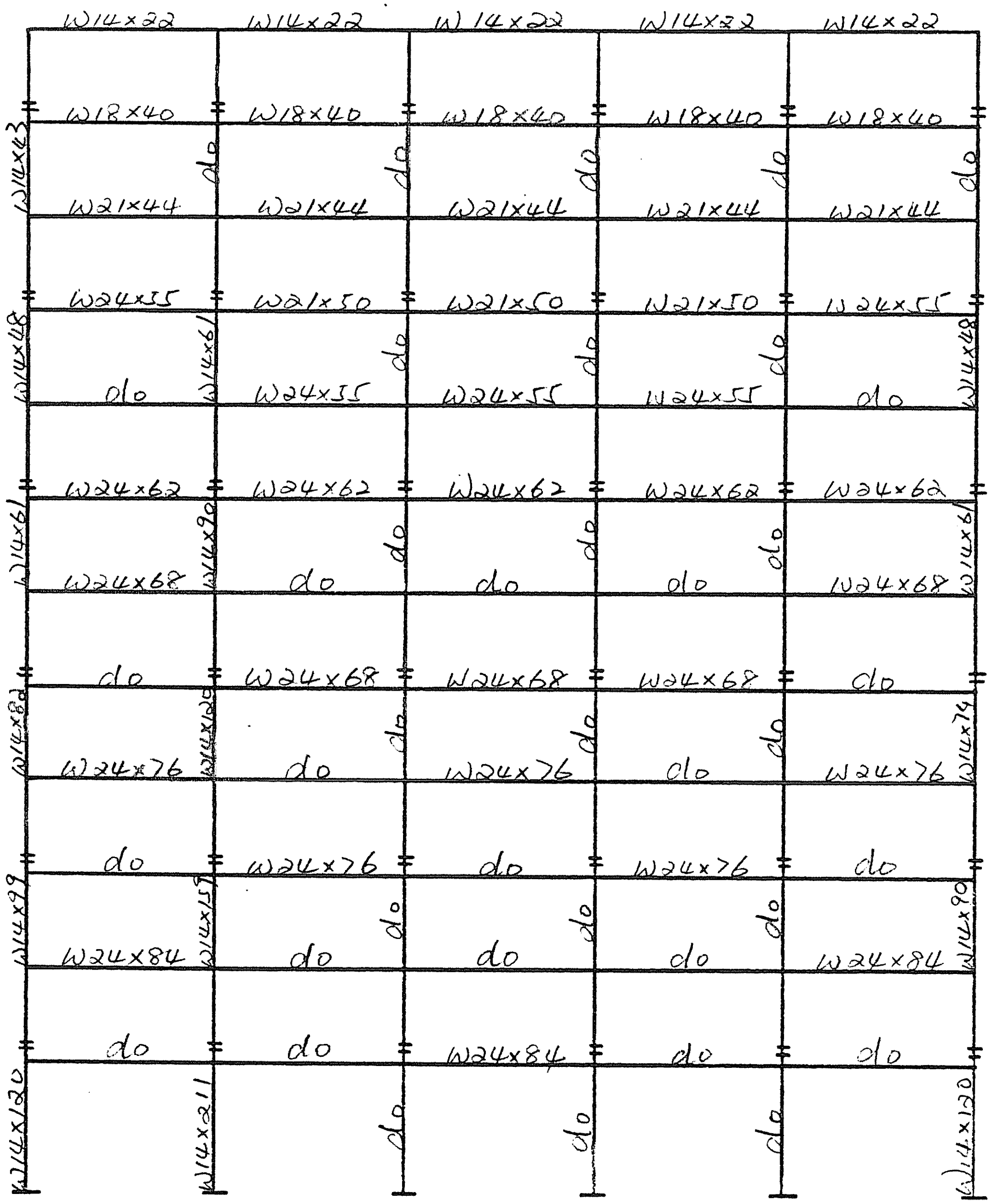
Frame Weight = 78.89 kips

Figure F.2 Design for 7 Stories, W14 Columns



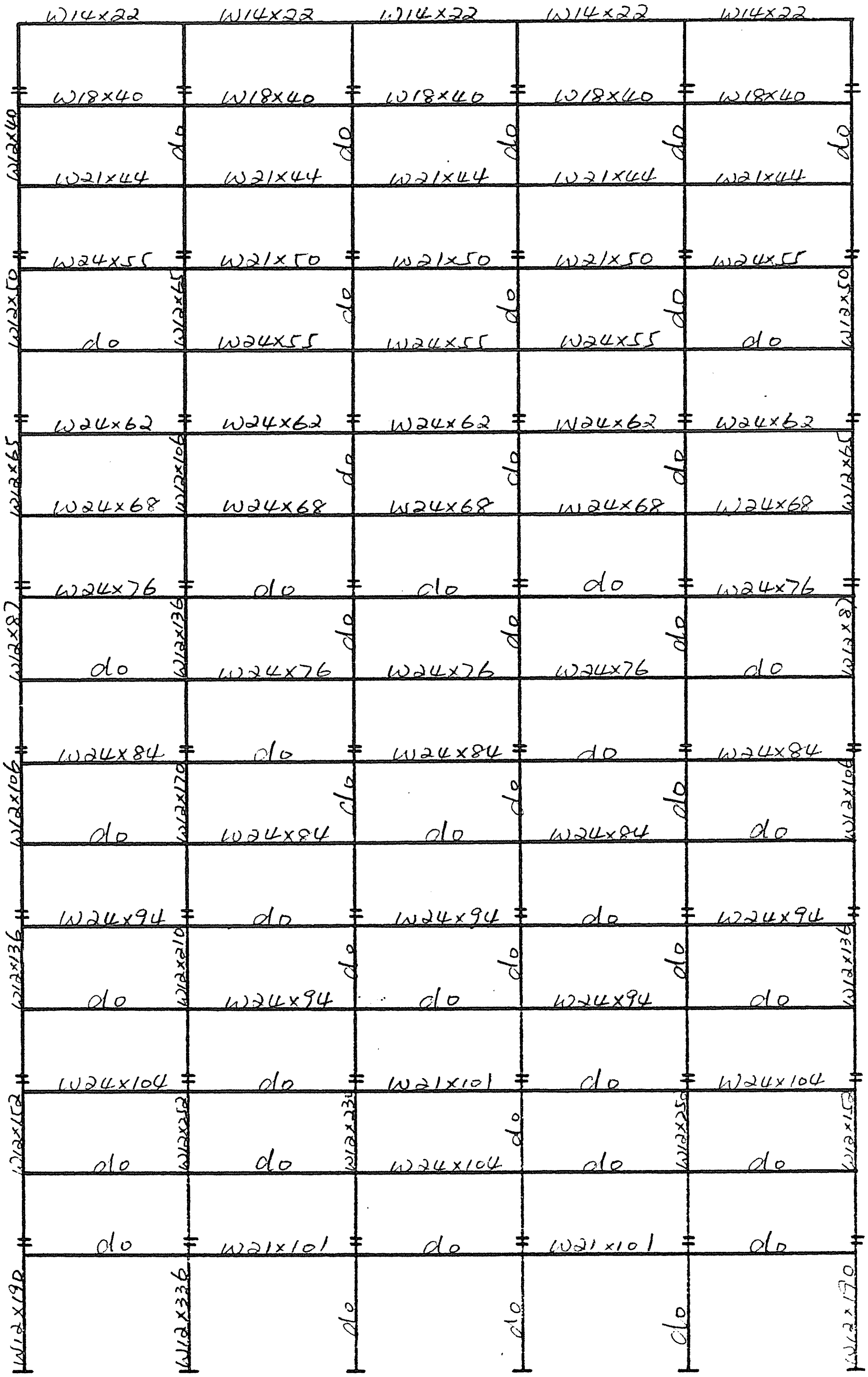
Frame Weight = 197.62 kips

Figure F.3 Design for 12 Stories, W12 Columns



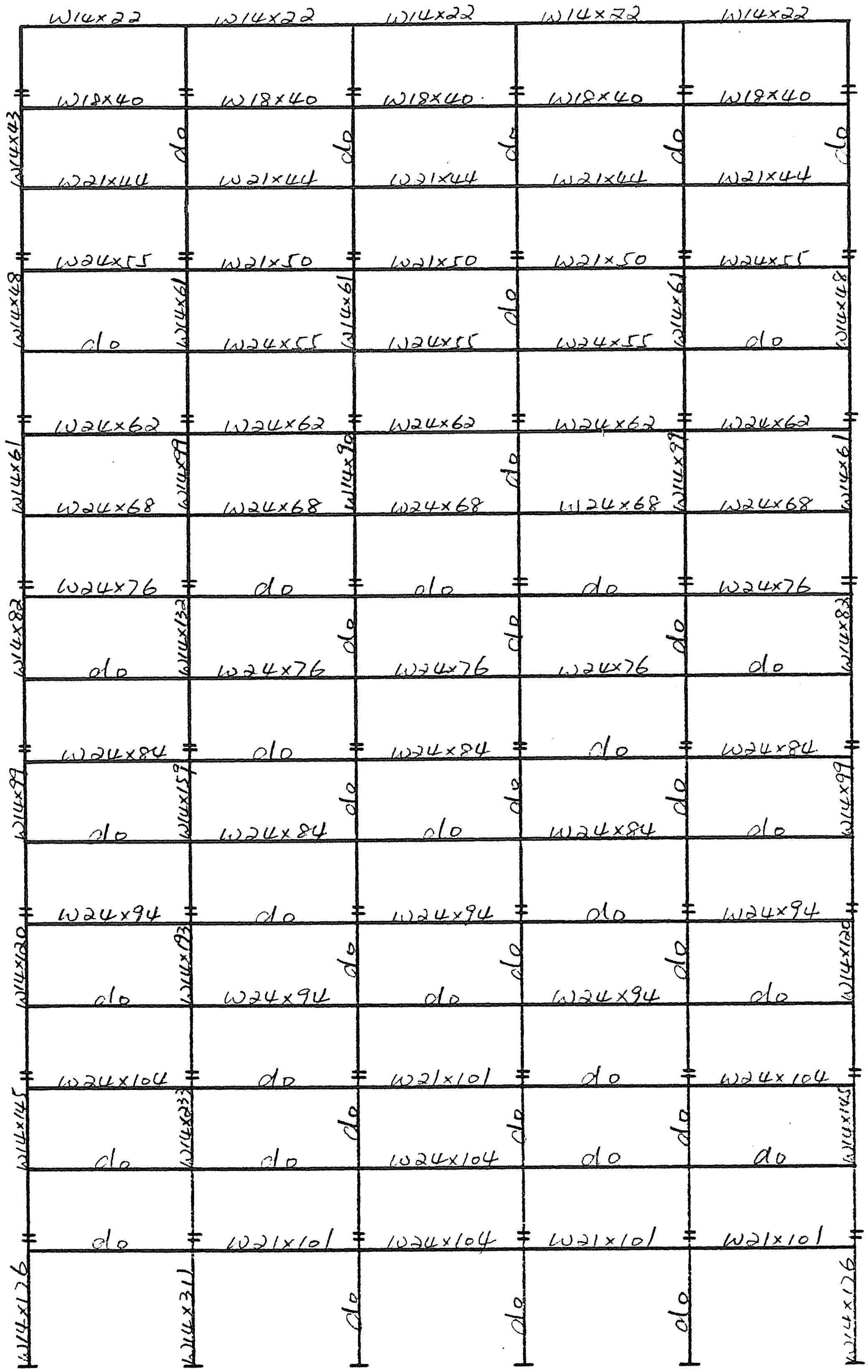
Frame Weight = 191.23 kips

Figure F.4 Design for 12 Stories, W14 Columns



Frame Weight = 329.13 kips

Figure F.5 Design for 16 Stories, W12 Columns



Frame Weight = 318.56 kips

Figure F.6 Design for 16 Stories, W14 Columns

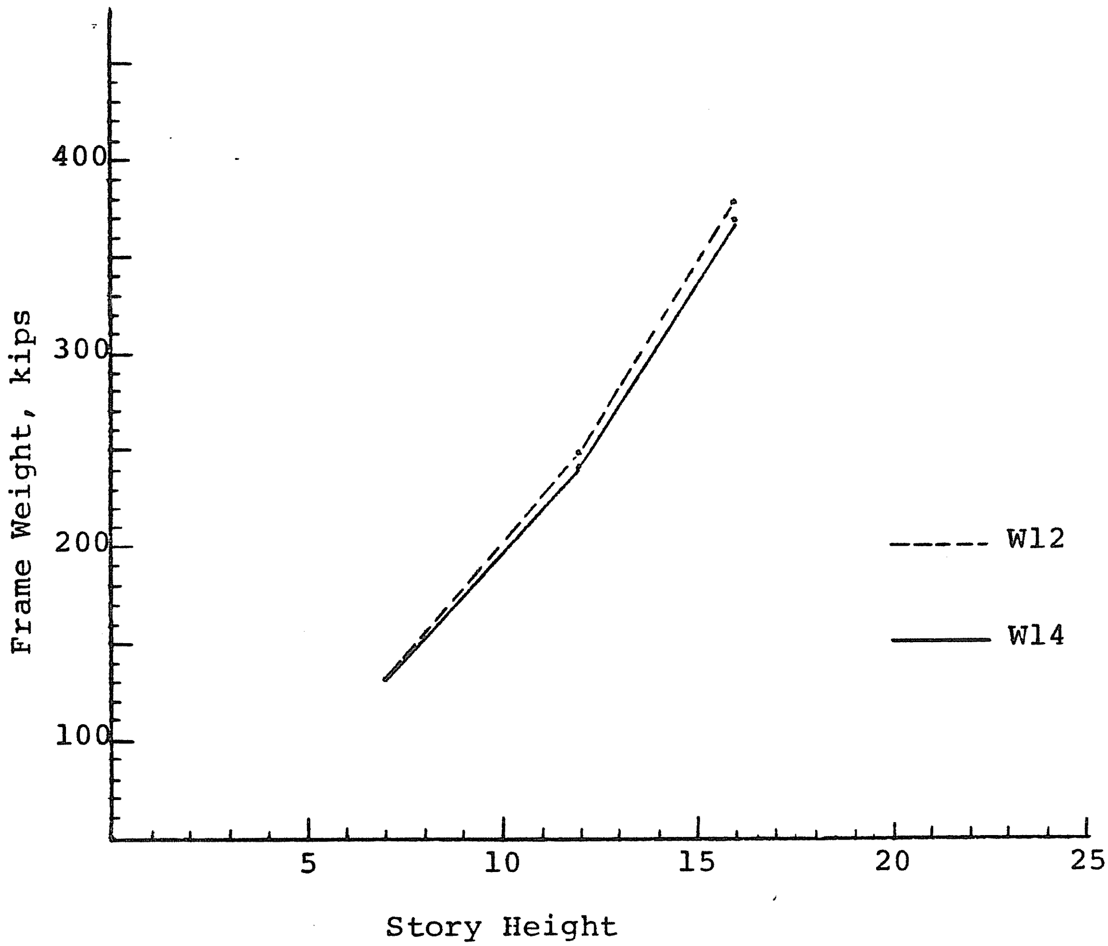


Figure F.7 Weight for Frames of Various Heights

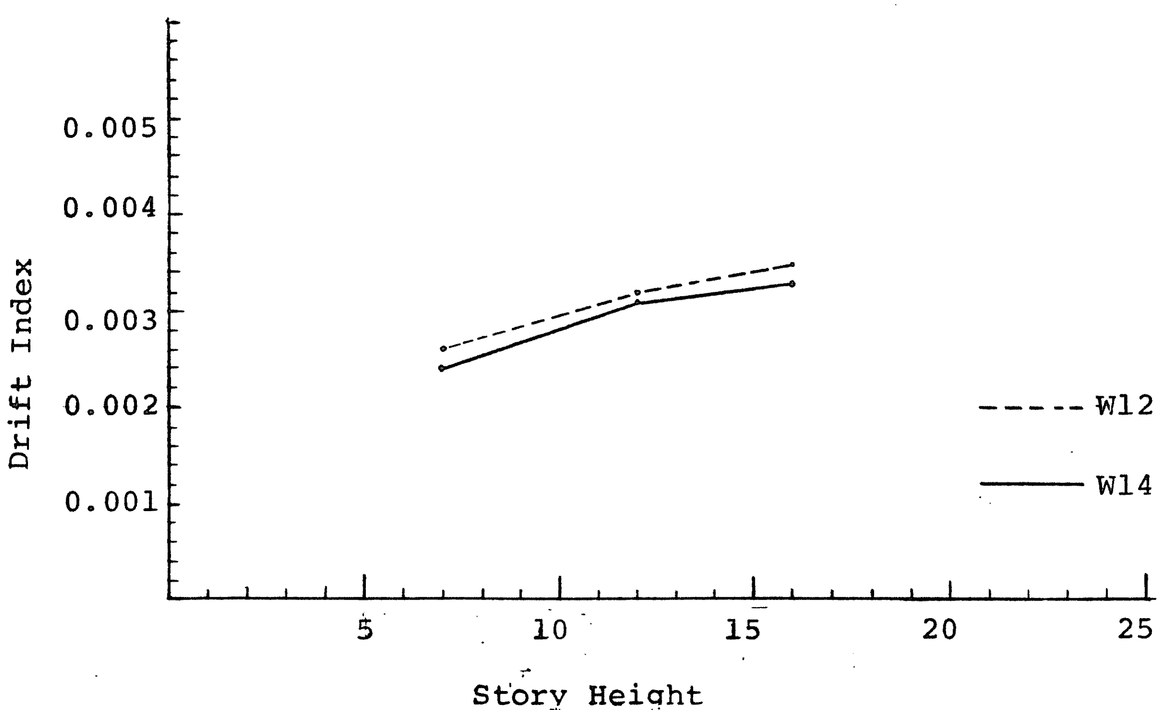
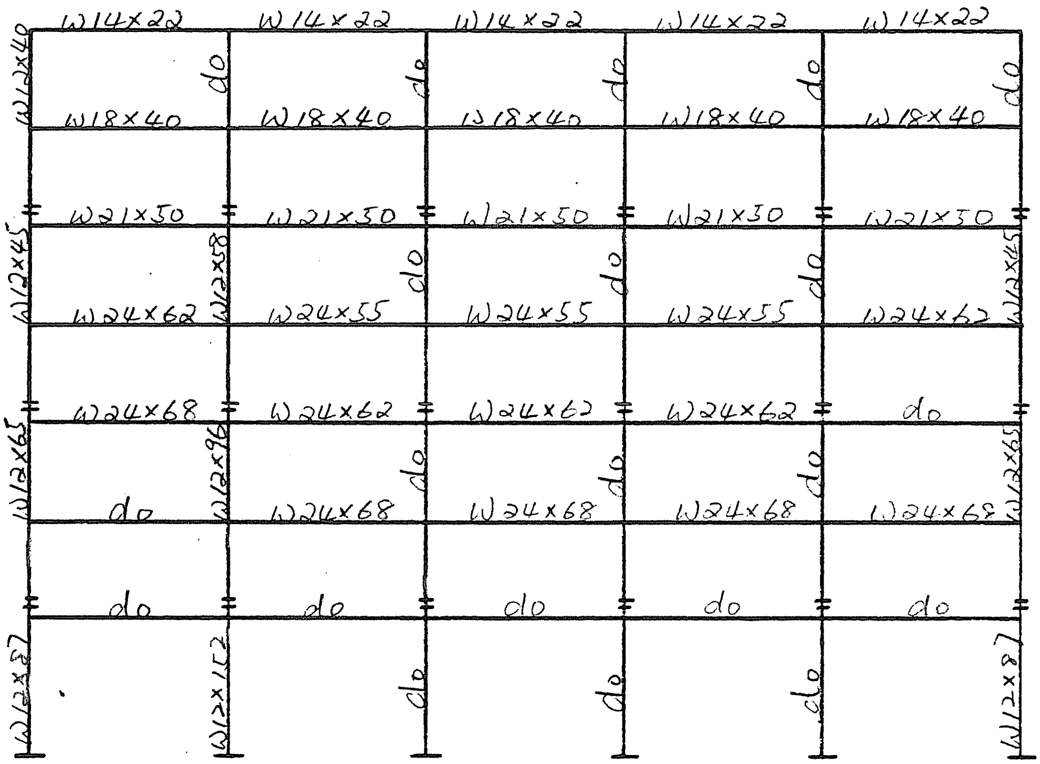


Figure F.8 Drift Index for Frames of Various Heights

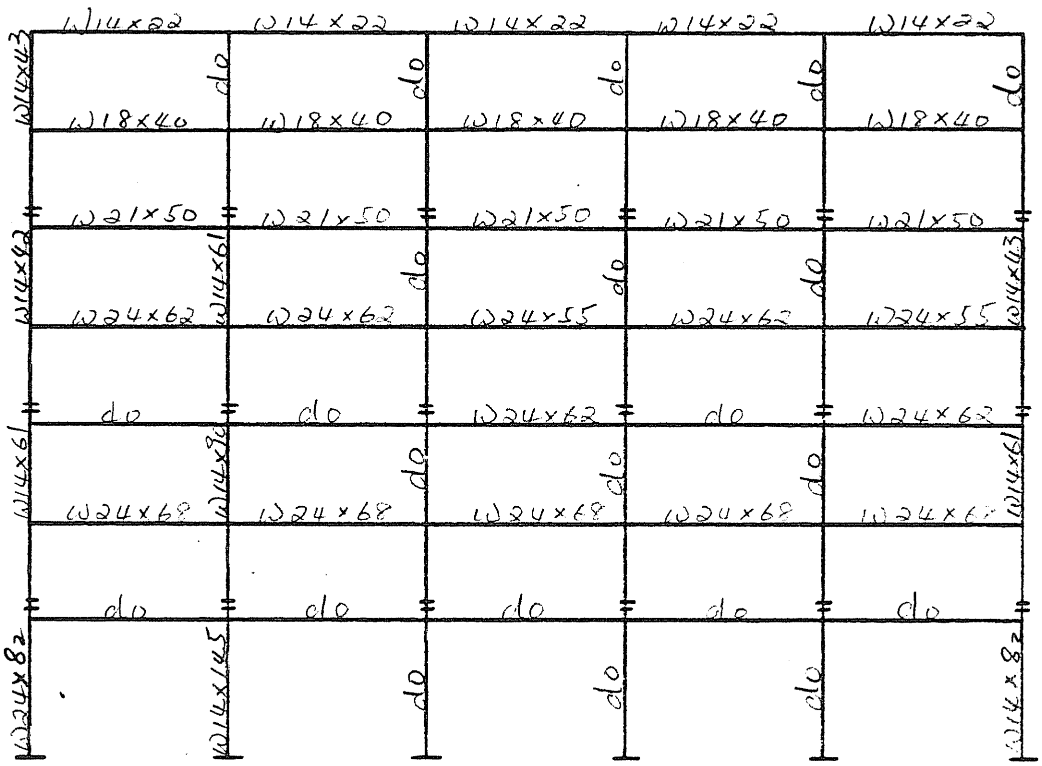
APPENDIX G

DESIGN EXAMPLES FOR LOS ANGELES, CALIFORNIA



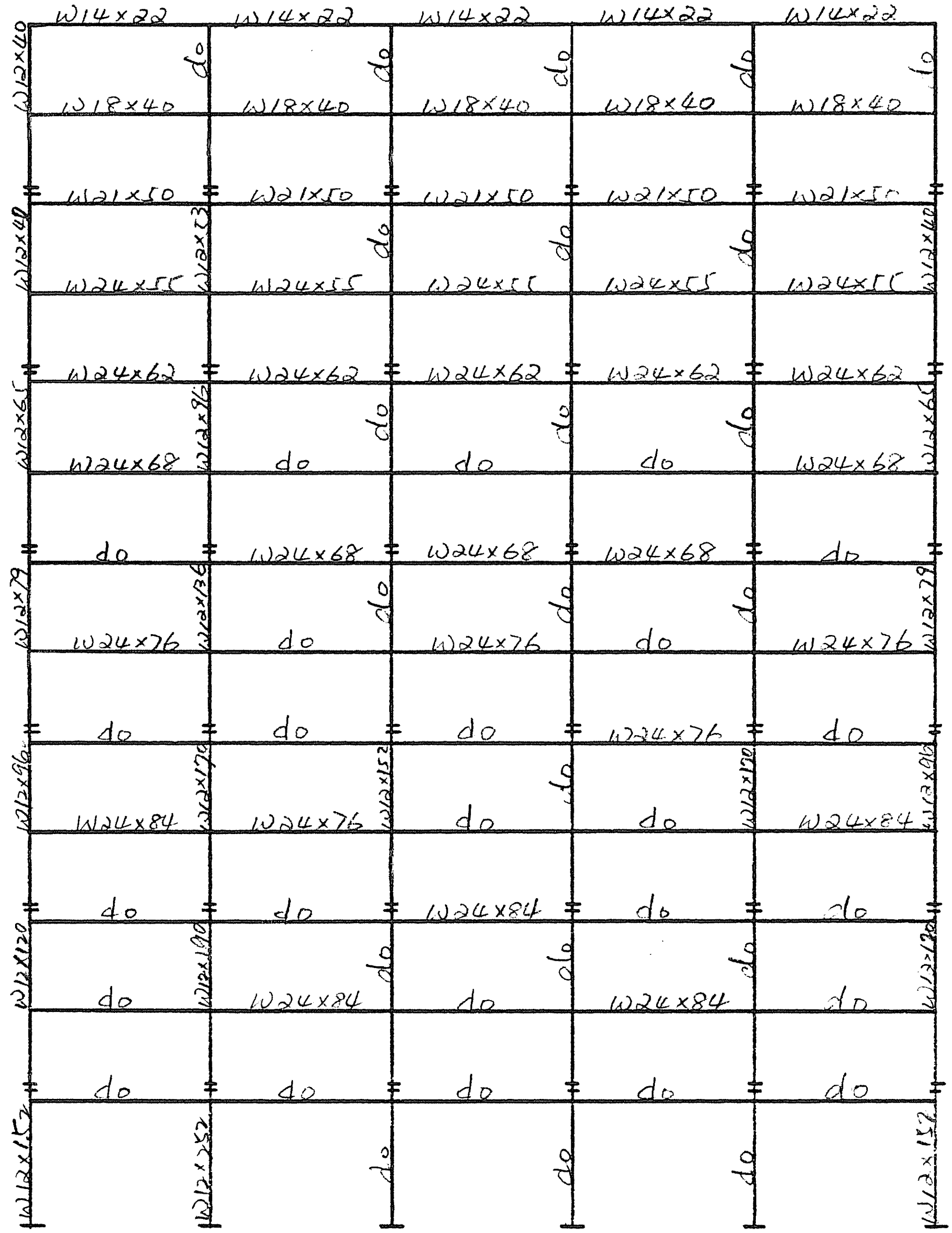
Frame Weight = 94.46 kips

Figure G.1 Design for 7 stories, W12 columns



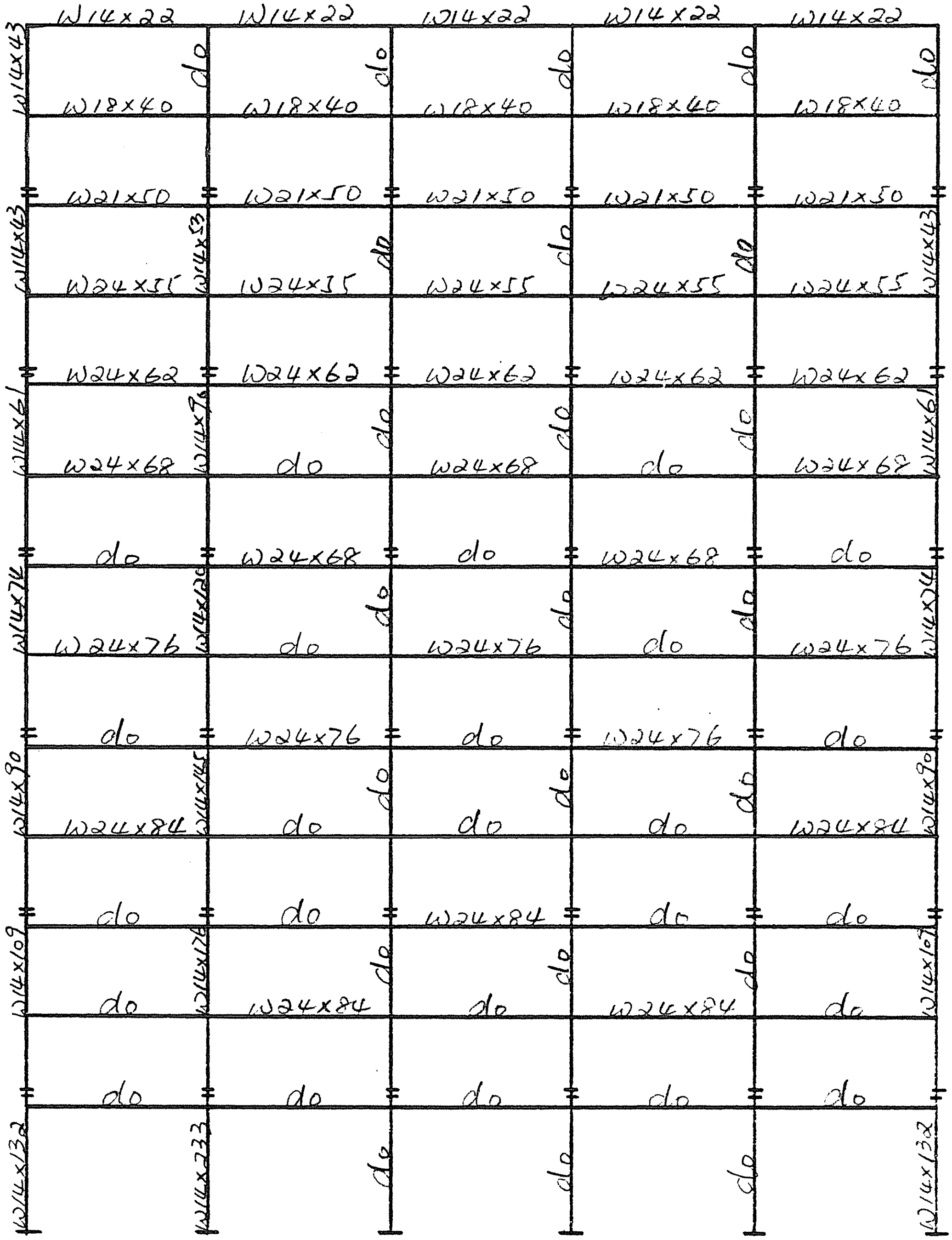
Frame Weight = 92.97 kips

Figure G.2 Design for 7 stories, W14 columns



Frame Weight = 234.04 kips

Figure G.3 Design for 13 stories, W12 columns



Frame Weight = 225.75 kips

Figure G.4 Design for 13 stories, W14 columns

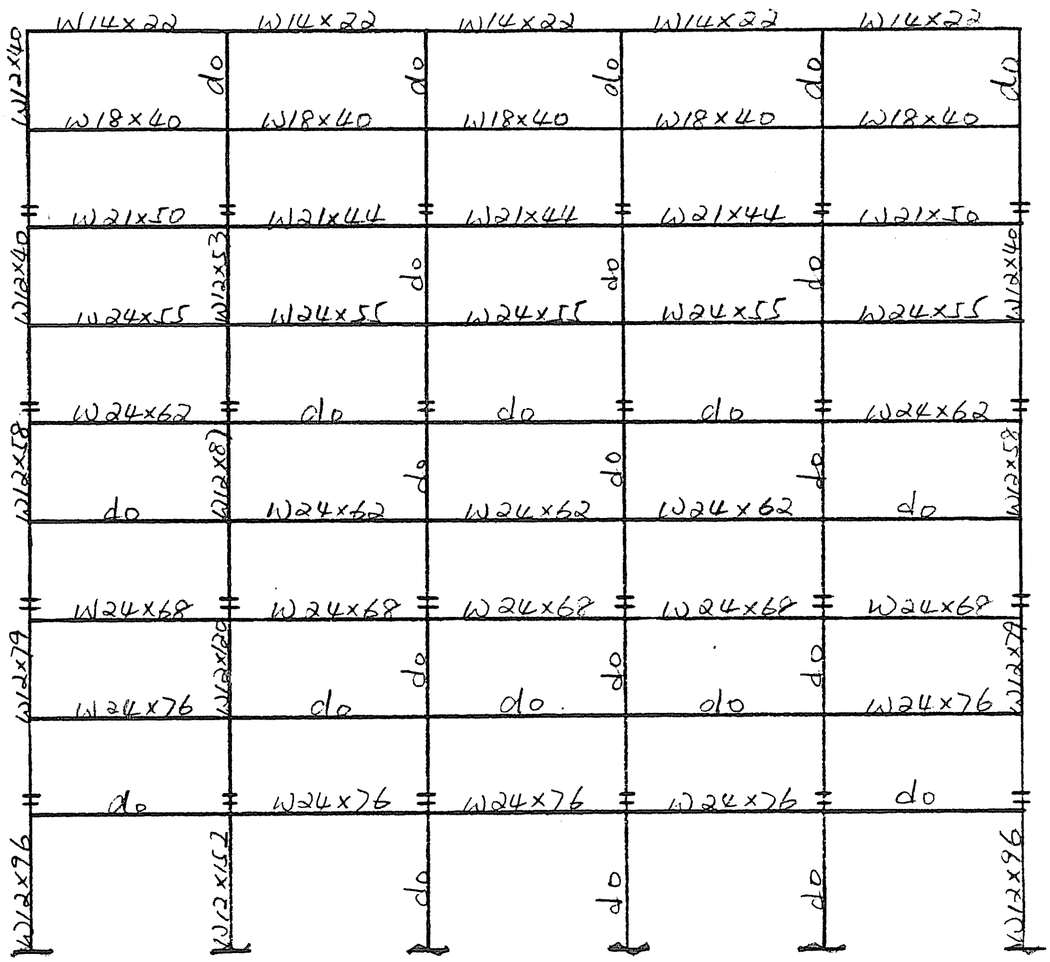
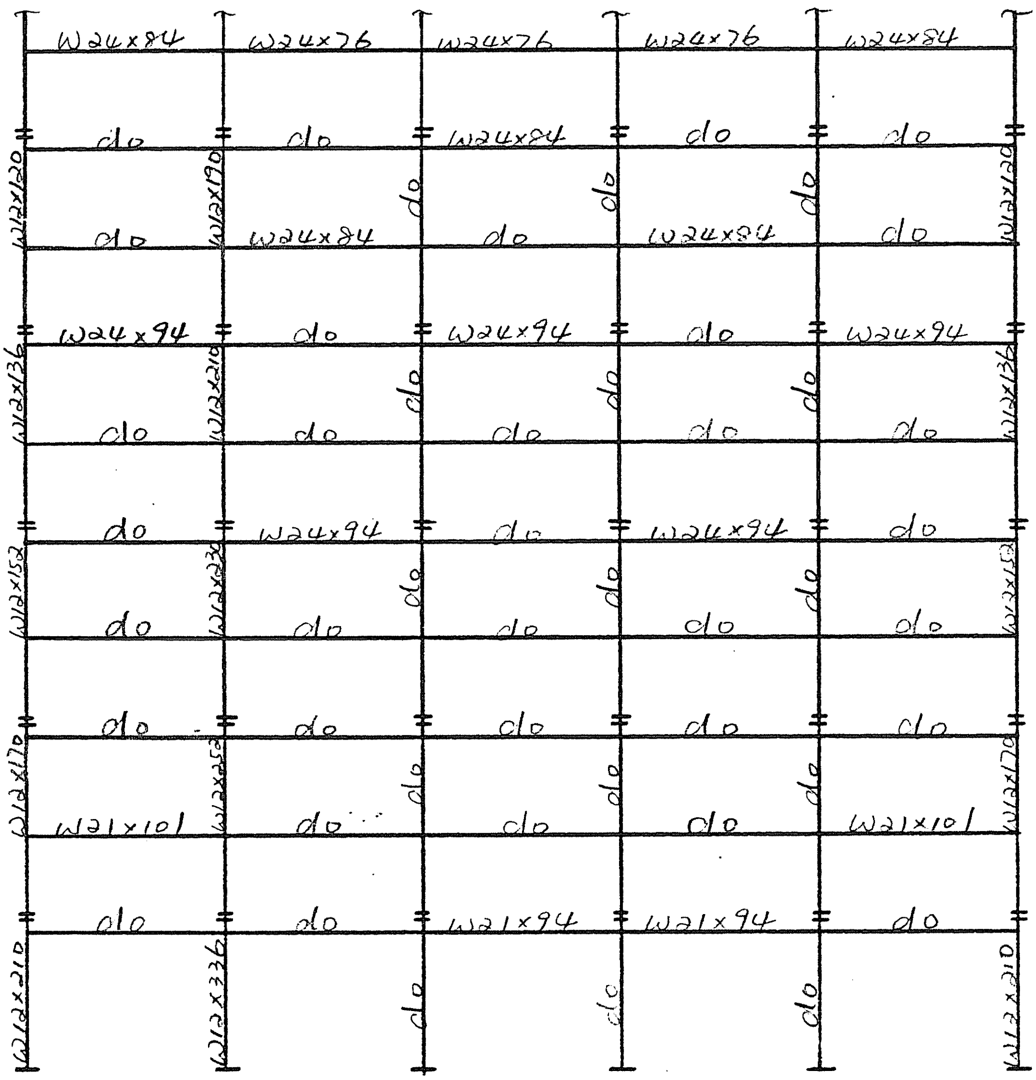


Figure G.5 Design for 19 stories, W12 columns



Frame Weight = 413.71 kips

Figure G.5 Design for 19 stories, W12 columns continued

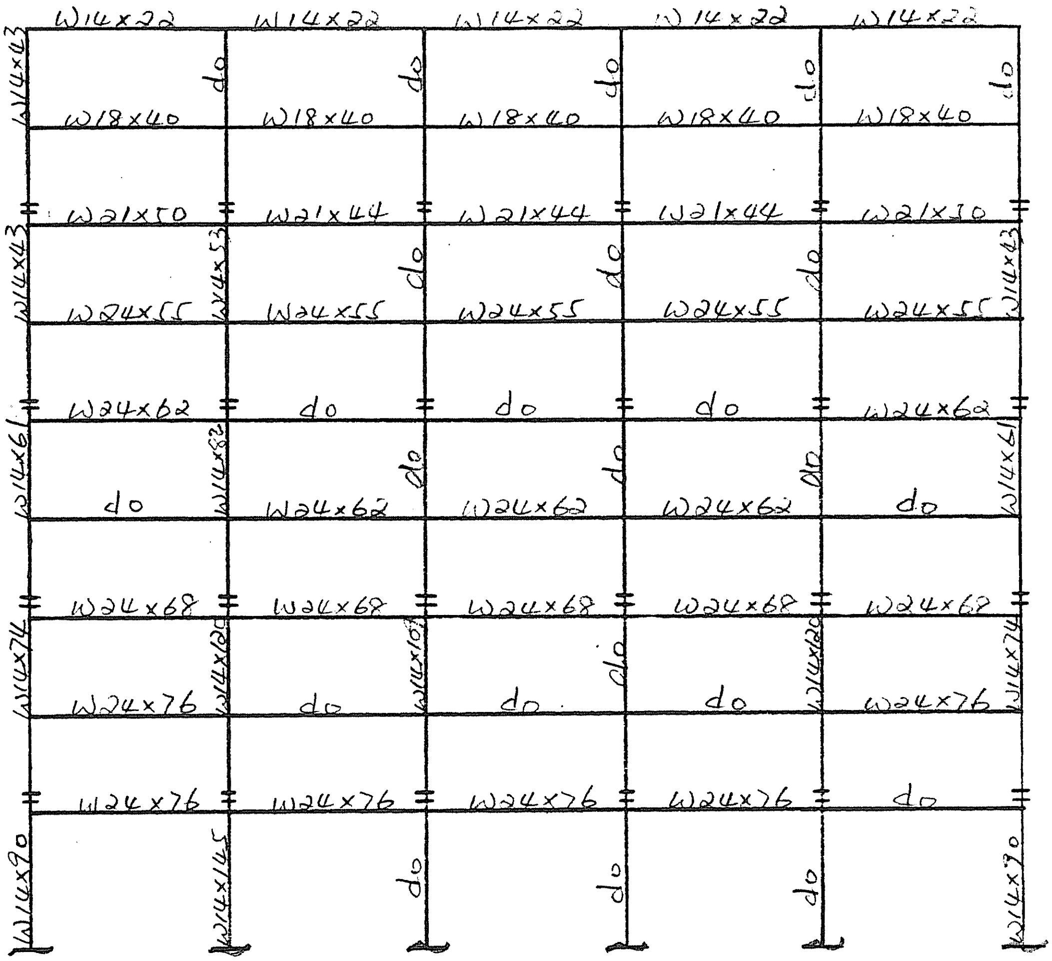
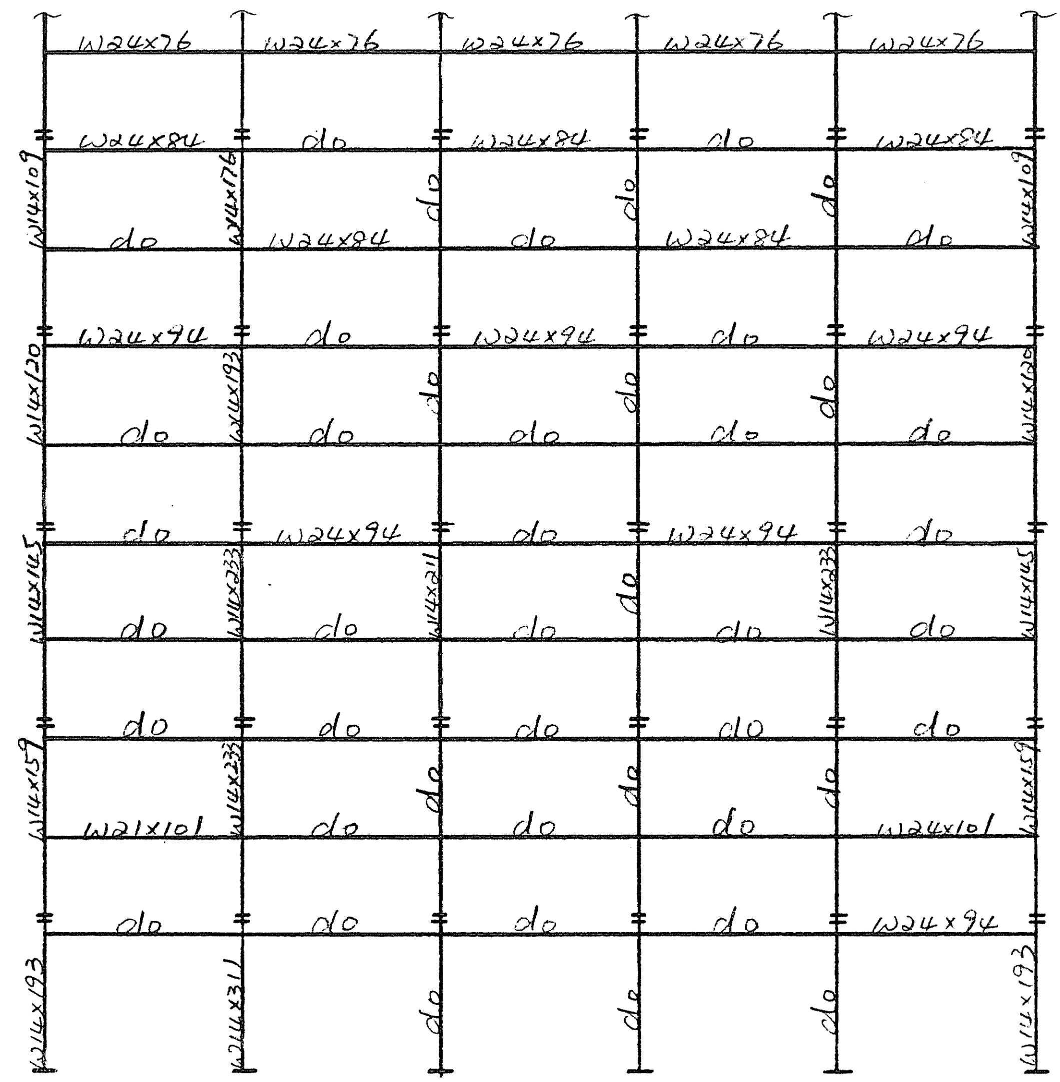


Figure G.6 Design for 19 stories, W14 columns



Frame Weight = 400.03 kips

Figure G.6 Design for 19 stories, W14 columns continued

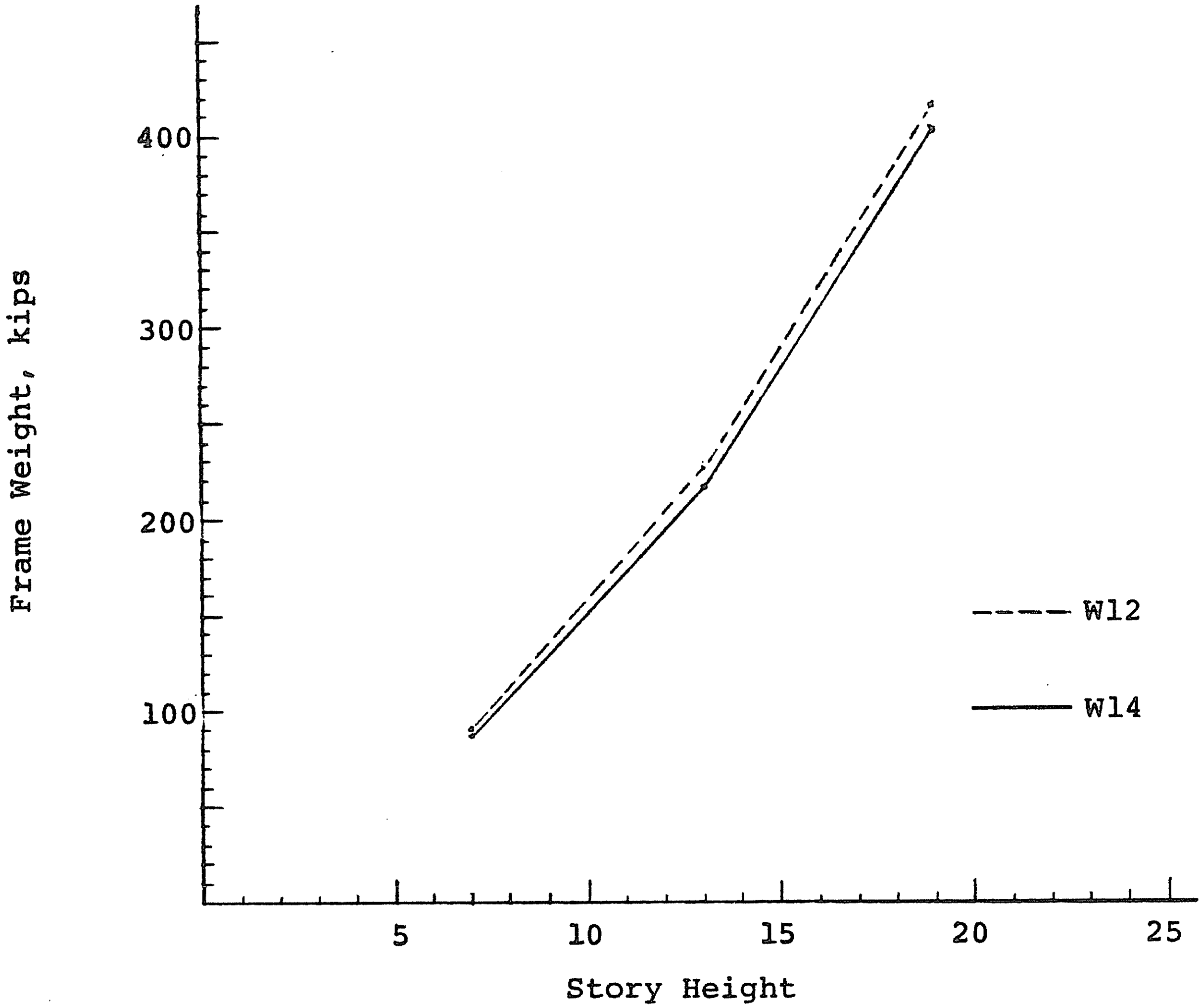


Figure G.7 Weight for Frames of Various Heights

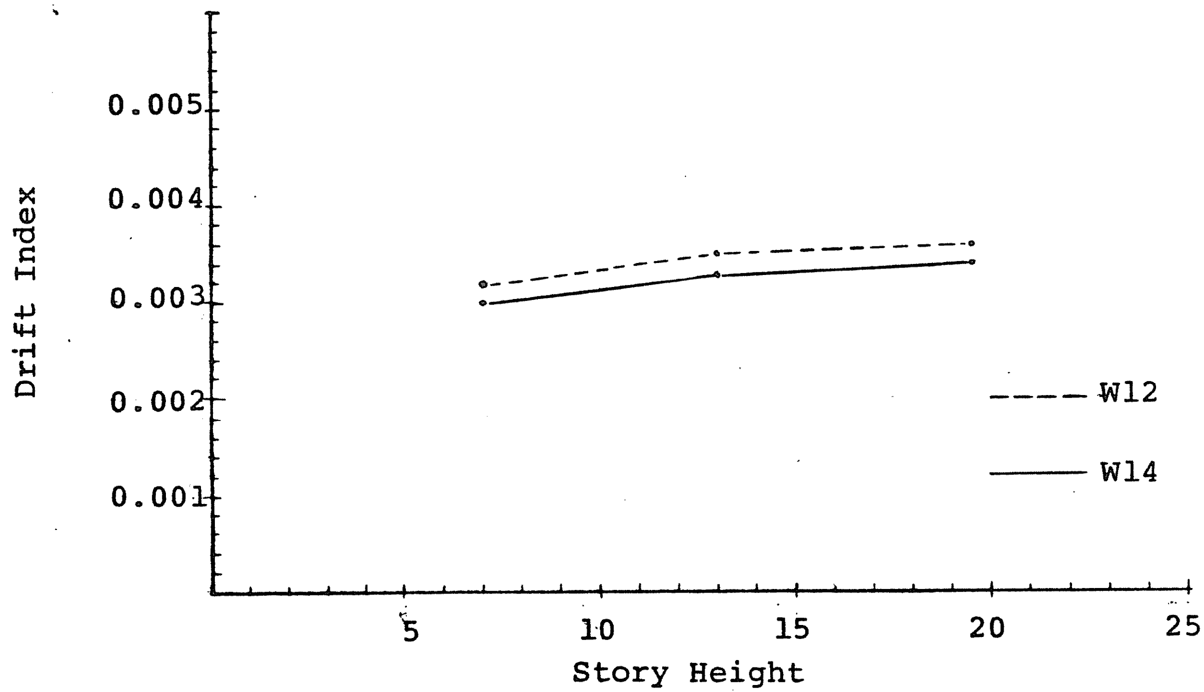
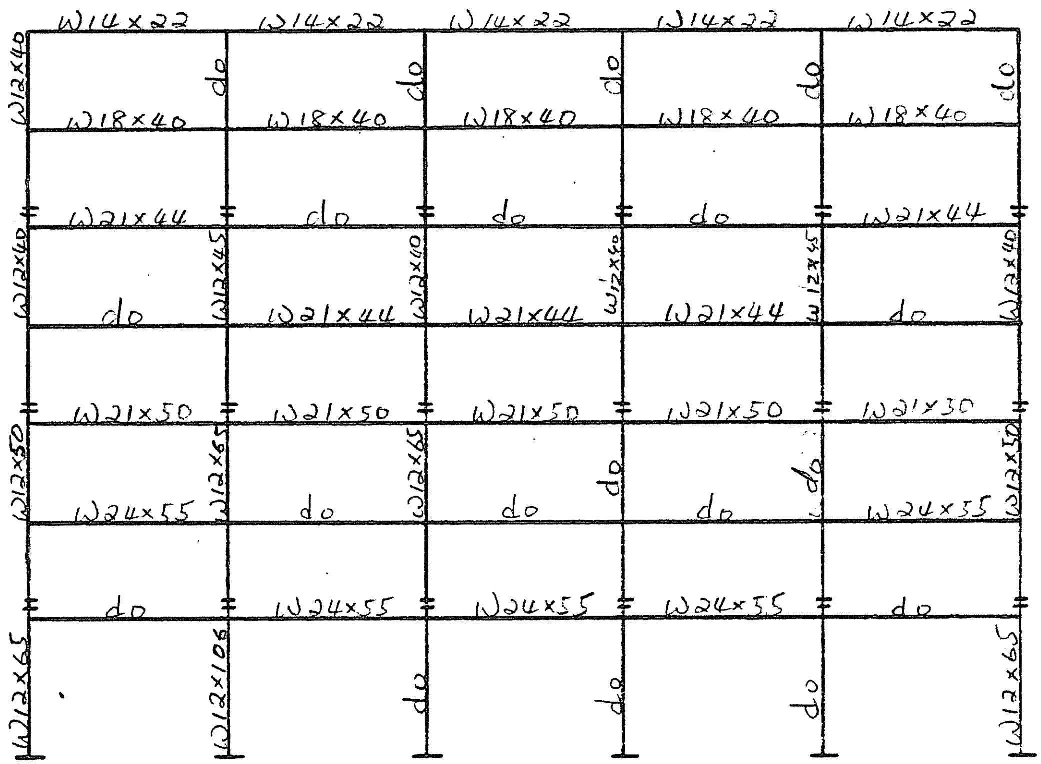


Figure G.8 Drift Index for Frames of Various Heights

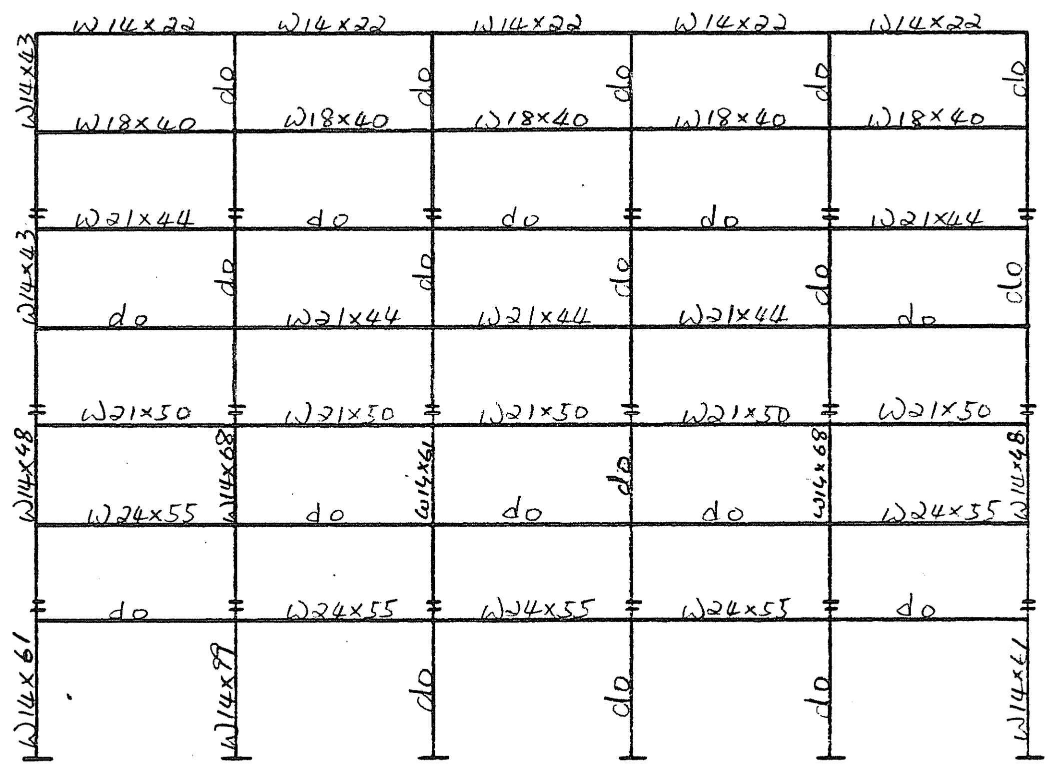
APPENDIX H

DESIGN EXAMPLES FOR NEW ORLEANS, LOUISIANA



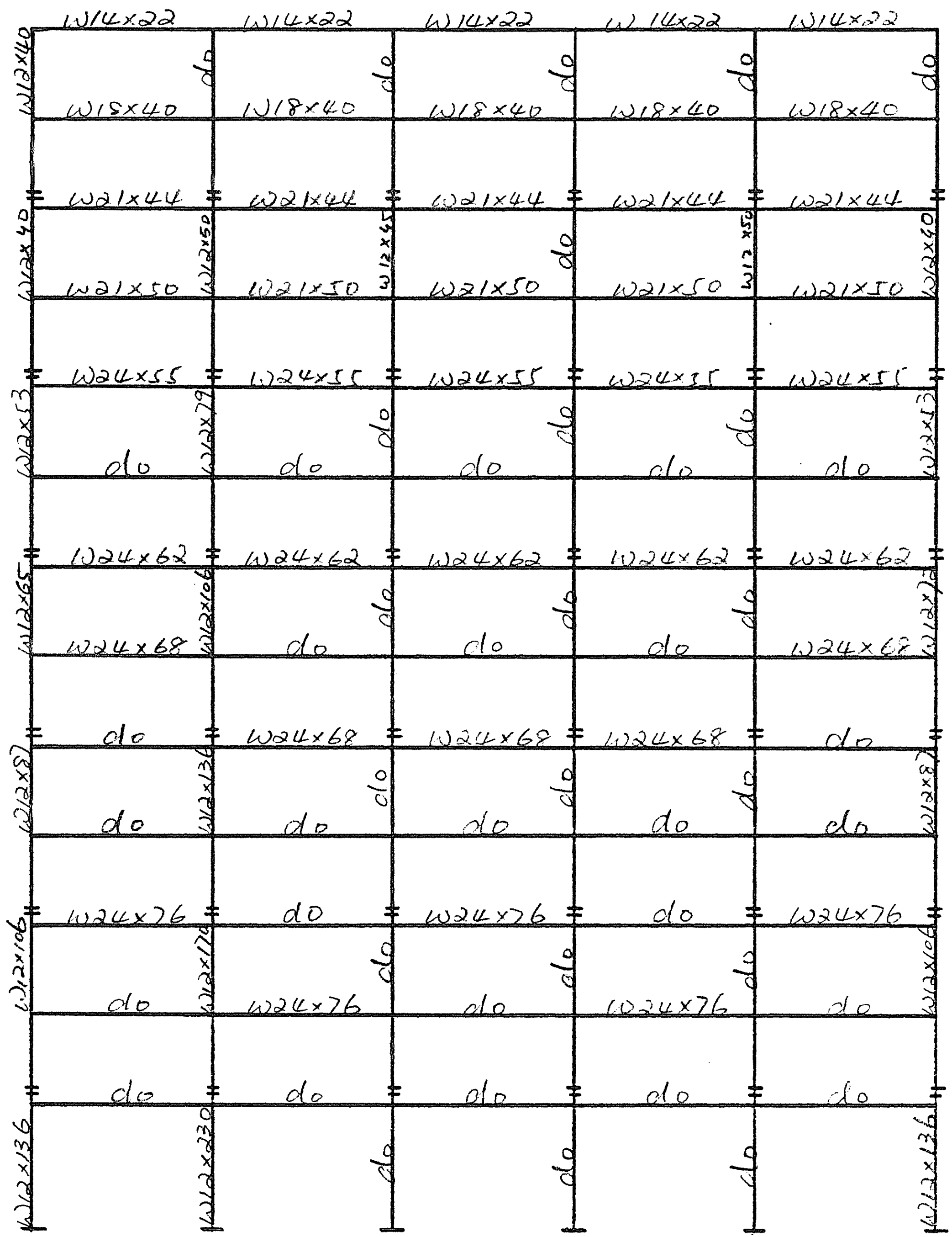
Frame Weight = 75.21 kips

Figure H.1 Design for 7 stories, W12 columns



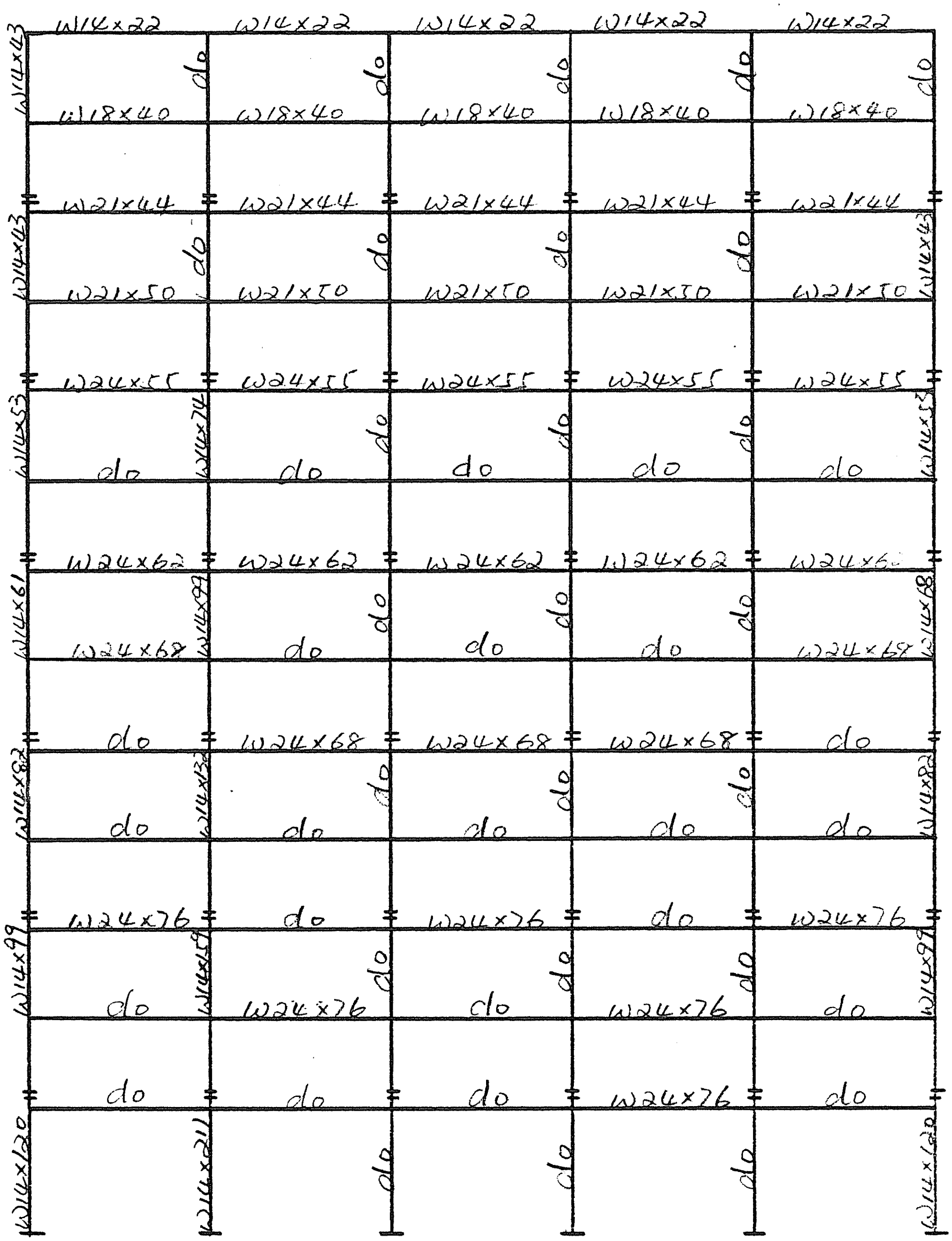
Frame Weight = 75.45 kips

Figure H.2 Design for 7 stories, W14 columns



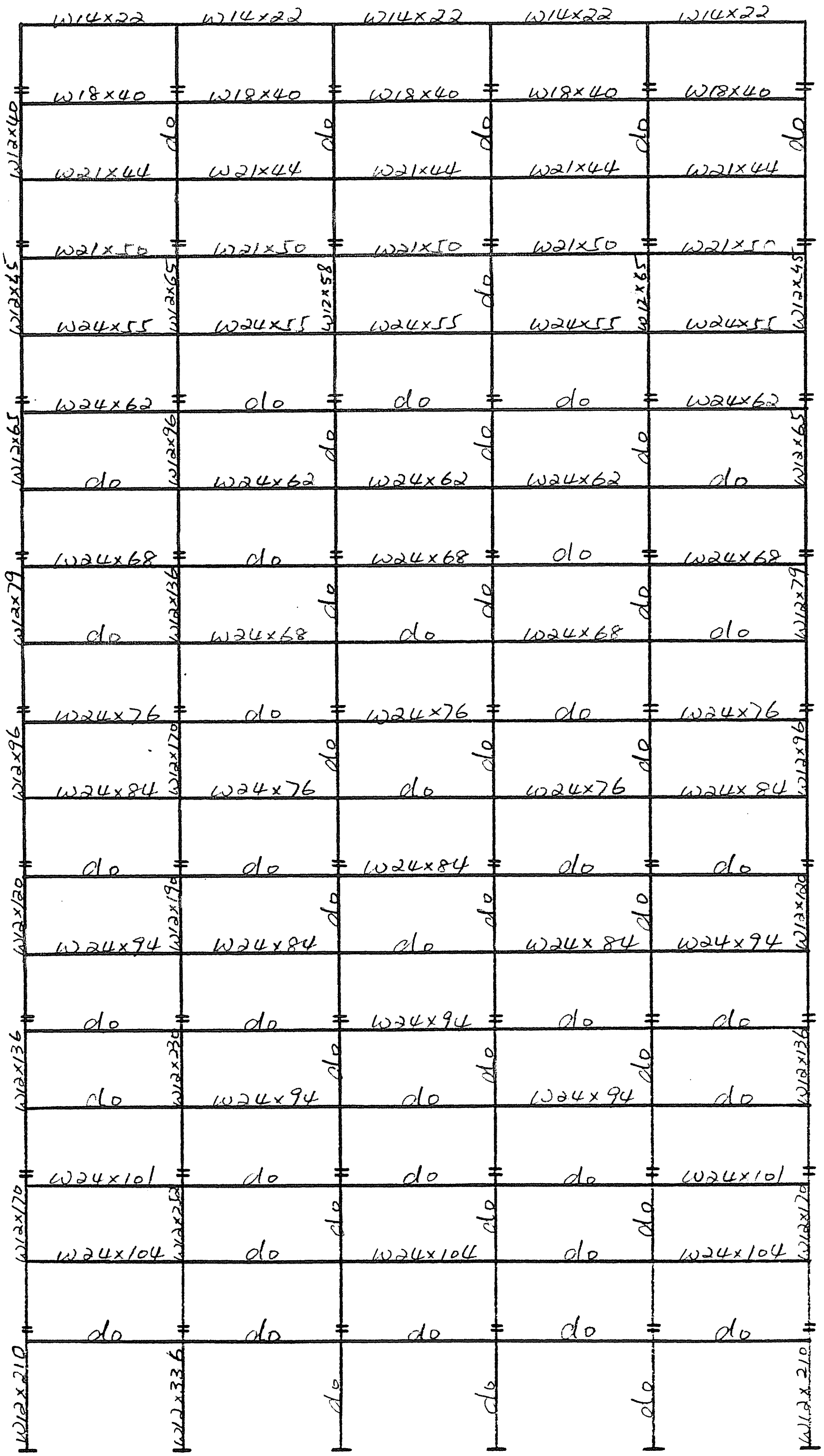
Frame Weight = 208.82 kips

Figure H.3 Design for 13 stories, W12 columns



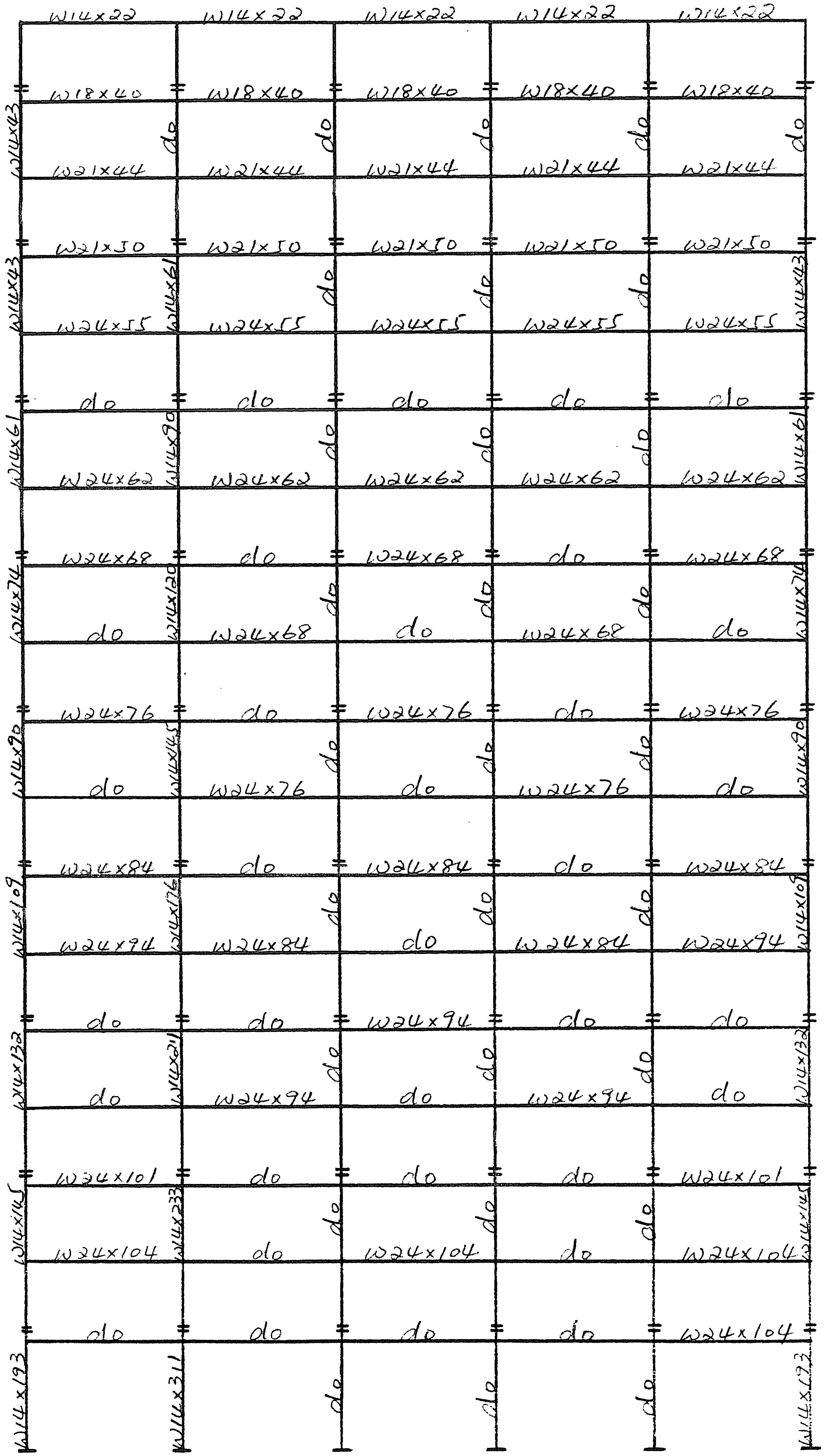
Frame Weight = 204.22 kips

Figure H.4 Design for 13 stories, W14 columns



Frame Weight =
374.46 kips

Figure H.5 Design for 18 stories, W12 columns



Frame Weight = 359.54 kips

Figure H.6 Design for 18 stories, W14 columns

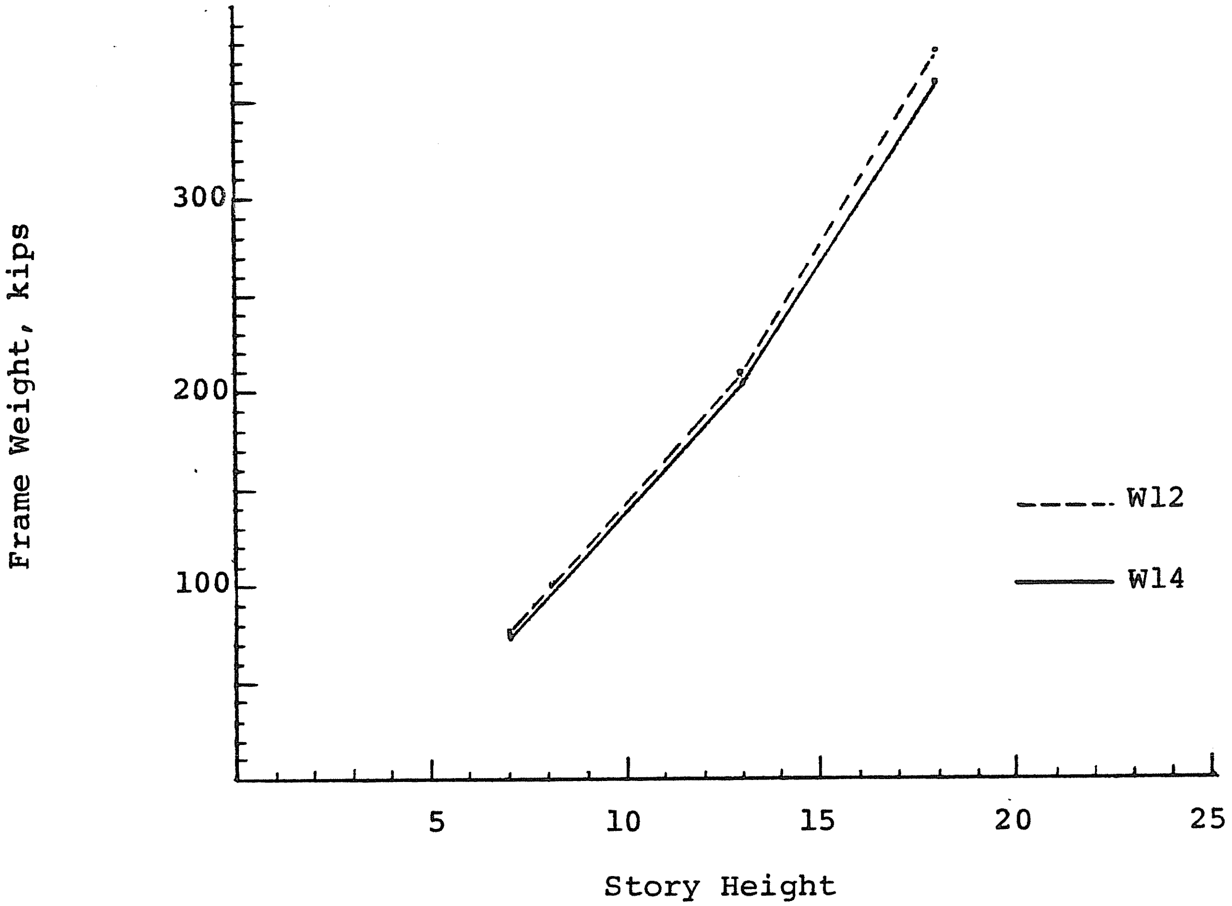


Figure H.7 Weight for Frames of Various Heights

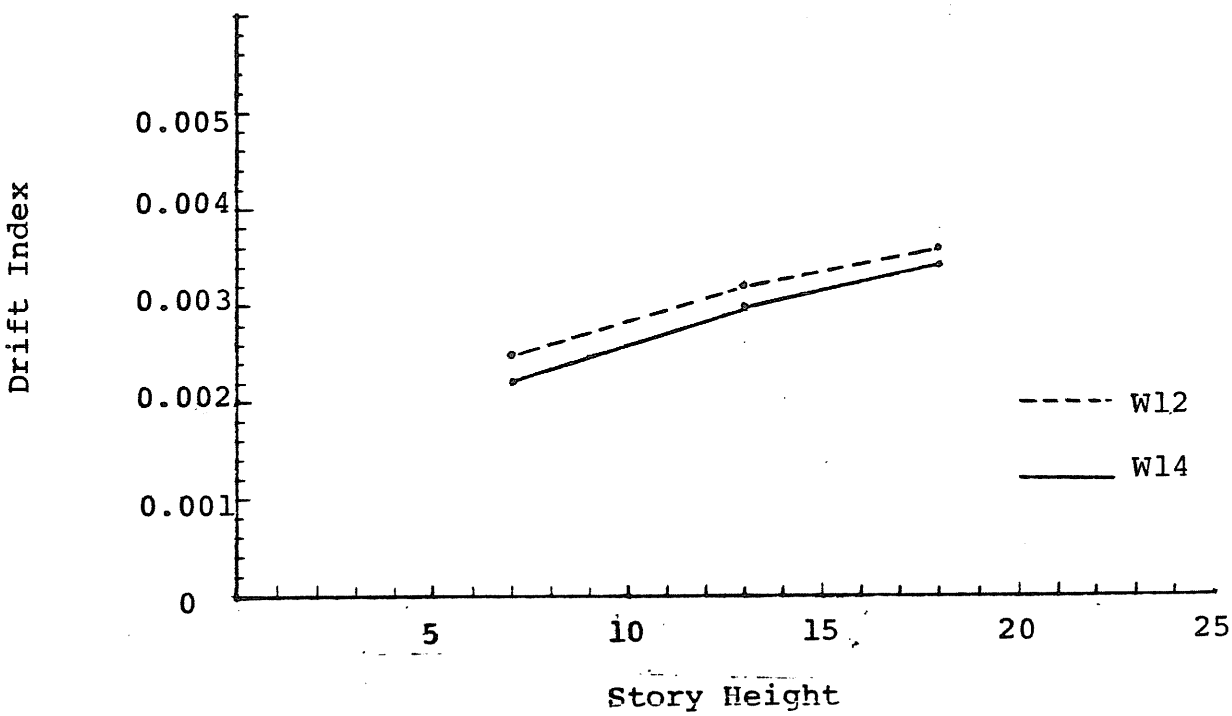


Figure H.8 Drift Index for Frames of Various Heights

APPENDIX I

PRELIMINARY DESIGN RESULTS FOR 7-STORY UNBRACED FRAME, HOUSTON, TEXAS

THE DESCRIPTICN CF FRAME DIMENSION ANC LCADING

THE NO OF EAYS NB = 5

THE NO OF STORIES NS = 7

STEEL YIELDS STRESS FY =36.00KSI

OUTSIDE WALL WT =20.00PSF

ROOF DEAD LCAD RDL =0.300KLF

ROCF LIVE LCAD RLL =0.300KLF

FLOOR DEAD LOAD FDL =0.460KLF

FLOOR LIVE LOAD FLL =C.820KLF

BAY NO	BAY WIDTH(FT)	STORY NO	STORY HEIGHT(FT)	LEVEL NO	LATERAL LOAD(K)
1	0.0	1	0.0	1	12.15
2	30.00	2	12.00	2	24.30
3	30.00	3	12.00	3	24.30
4	30.00	4	12.00	4	21.60
5	30.00	5	12.CC	5	18.52
6	30.00	6	12.00	6	14.70
7	C.0	7	12.00	7	14.63
8	0.0	8	14.00	8	0.0

RESULTS OF PRELIMINARY DESIGN

GRAVITY LOAD MOMENTS

	I	J	RM4	LM4	EM4	TM4	P1
JOINT	1	1	-22.50	0.0	22.50	0.0	9.00
JOINT	1	2	-48.75	52.50	-3.75	0.0	18.00
JOINT	1	3	-45.00	45.00	0.0	0.0	18.00
JOINT	1	4	-45.00	45.00	0.0	0.0	18.00
JOINT	1	5	-52.50	48.75	3.75	0.0	18.00
JOINT	1	6	0.0	22.50	-22.50	0.0	9.00
JOINT	2	1	-81.12	0.0	40.56	40.56	31.80
JOINT	2	2	-124.52	130.17	-2.83	-2.83	63.60
JOINT	2	3	-121.69	121.69	0.0	0.0	63.60
JOINT	2	4	-121.69	121.69	0.0	0.0	63.60
JOINT	2	5	-130.17	124.52	2.83	2.83	63.60
JOINT	2	6	0.0	81.12	-40.56	-40.56	31.80
JOINT	3	1	-81.12	0.0	40.56	40.56	54.60
JOINT	3	2	-124.52	130.17	-2.83	-2.83	109.20
JOINT	3	3	-121.69	121.69	0.0	0.0	109.20
JOINT	3	4	-121.69	121.69	0.0	0.0	109.20
JOINT	3	5	-130.17	124.52	2.83	2.83	109.20
JOINT	3	6	0.0	81.12	-40.56	-40.56	54.60
JOINT	4	1	-81.12	0.0	40.56	40.56	77.40
JOINT	4	2	-124.52	130.17	-2.83	-2.83	154.80
JOINT	4	3	-121.69	121.69	0.0	0.0	154.80
JOINT	4	4	-121.69	121.69	0.0	0.0	154.80
JOINT	4	5	-130.17	124.52	2.83	2.83	154.80
JOINT	4	6	0.0	81.12	-40.56	-40.56	77.40
JOINT	5	1	-81.12	0.0	40.56	40.56	100.20
JOINT	5	2	-124.52	130.17	-2.83	-2.83	200.40
JOINT	5	3	-121.69	121.69	0.0	0.0	200.40

JOINT	5	4	-121.69	121.69	0.0	0.0	200.40
JOINT	5	5	-130.17	124.52	2.83	2.83	200.40
JOINT	5	6	0.0	81.12	-40.56	-40.56	100.20
JOINT	6	1	-81.12	0.0	40.56	40.56	123.00
JOINT	6	2	-124.52	130.17	-2.83	-2.83	246.00
JOINT	6	3	-121.69	121.69	0.0	0.0	246.00
JOINT	6	4	-121.69	121.69	0.0	0.0	246.00
JOINT	6	5	-130.17	124.52	2.83	2.83	246.00
JOINT	6	6	0.0	81.12	-40.56	-40.56	123.00
JOINT	7	1	-81.12	0.0	37.44	43.68	145.80
JOINT	7	2	-124.52	130.17	-2.61	-3.05	291.60
JOINT	7	3	-121.69	121.69	0.0	0.0	291.60
JOINT	7	4	-121.69	121.69	0.0	0.0	291.60
JOINT	7	5	-130.17	124.52	2.61	3.05	291.60
JOINT	7	6	0.0	81.12	-37.44	-43.68	145.80
JOINT	8	1	0.0	0.0	0.0	18.72	0.0
JOINT	8	2	0.0	0.0	0.0	-1.31	0.0
JOINT	8	3	0.0	0.0	0.0	0.0	0.0
JOINT	8	4	0.0	0.0	0.0	0.0	0.0
JOINT	8	5	0.0	0.0	0.0	1.31	0.0
JOINT	8	6	0.0	0.0	0.0	-18.72	0.0

LATERAL LOAD MOMENTS

	I	J	RMS	LMS	BMS	TMS	P2
JOINT	1	1	7.29	0.0	7.29	0.0	0.49
JOINT	1	2	7.29	7.29	14.59	0.0	0.0
JOINT	1	3	7.29	7.29	14.58	0.0	0.0
JOINT	1	4	7.29	7.29	14.58	0.0	0.0
JOINT	1	5	7.29	7.29	14.58	0.0	0.0
JOINT	1	6	0.0	7.29	7.29	0.0	0.49
JOINT	2	1	29.16	0.0	21.87	7.29	2.43
JOINT	2	2	29.16	29.16	43.74	14.58	0.00
JOINT	2	3	29.16	29.16	43.74	14.58	0.00
JOINT	2	4	29.16	29.16	43.74	14.58	0.00
JOINT	2	5	29.16	29.16	43.74	14.58	0.00
JOINT	2	6	0.0	29.16	21.87	7.29	2.43
JOINT	3	1	58.32	0.0	36.45	21.87	6.32
JOINT	3	2	58.32	58.32	72.90	43.74	0.00
JOINT	3	3	58.32	58.32	72.90	43.74	0.00
JOINT	3	4	58.32	58.32	72.90	43.74	0.00
JOINT	3	5	58.32	58.32	72.90	43.74	0.00
JOINT	3	6	0.0	58.32	36.45	21.87	6.32
JOINT	4	1	85.86	0.0	49.41	36.45	12.04
JOINT	4	2	85.86	85.86	98.82	72.90	0.00
JOINT	4	3	85.86	85.86	98.82	72.90	0.00
JOINT	4	4	85.86	85.86	98.82	72.90	0.00
JOINT	4	5	85.86	85.86	98.82	72.90	0.00
JOINT	4	6	0.0	85.86	49.41	36.45	12.04
JOINT	5	1	109.93	0.0	60.52	49.41	19.37
JOINT	5	2	109.93	109.93	121.04	98.82	0.00
JOINT	5	3	109.93	109.93	121.04	98.82	0.00
JOINT	5	4	109.93	109.93	121.04	98.82	0.00
JOINT	5	5	109.93	109.93	121.04	98.82	0.00

JOINT	5	6	0.0	109.93	60.52	49.41	19.37
JOINT	6	1	129.86	0.0	69.34	60.52	28.03
JOINT	6	2	129.86	129.86	138.68	121.04	0.00
JOINT	6	3	129.86	129.86	138.68	121.04	0.00
JOINT	6	4	129.86	129.86	138.68	121.04	0.00
JOINT	6	5	129.86	129.86	138.68	121.04	0.00
JOINT	6	6	0.0	129.86	69.34	60.52	28.03
JOINT	7	1	142.25	0.0	72.91	69.34	37.51
JOINT	7	2	142.25	142.25	145.82	138.68	0.00
JOINT	7	3	142.25	142.25	145.82	138.68	0.00
JOINT	7	4	142.25	142.25	145.82	138.68	0.00
JOINT	7	5	142.25	142.25	145.82	138.68	0.00
JOINT	7	6	0.0	142.25	72.91	69.34	37.51
JOINT	8	1	0.0	0.0	0.0	109.37	0.0
JOINT	8	2	0.0	0.0	0.0	218.74	0.0
JOINT	8	3	0.0	0.0	0.0	218.74	0.0
JOINT	8	4	0.0	0.0	0.0	218.74	0.0
JOINT	8	5	0.0	0.0	0.0	218.74	0.0
JOINT	8	6	0.0	0.0	0.0	109.37	0.0

MAX MOMENTS SEC MODULUS AND SECS FOR BEAMS

	I	J	MAX MOMENT	REQUIRED SEC MODUUS	SUGGESTED SEC MODULUS	LIGHTEST SECTION	AX	IZ
MEMBER	1	2	52.50	26.52	29.00	W14*22	6.49	199.00
MEMBER	1	3	48.75	24.62	29.00	W14*22	6.49	199.00
MEMBER	1	4	45.00	22.73	29.00	W14*22	6.49	199.00
MEMBER	1	5	48.75	24.62	29.00	W14*22	6.49	199.00
MEMBER	1	6	52.50	26.52	29.00	W14*22	6.49	199.00
MEMBER	2	2	130.17	65.74	68.40	W18*40	11.80	612.00
MEMBER	2	3	124.52	62.89	68.40	W18*40	11.80	612.00
MEMBER	2	4	121.69	61.46	68.40	W18*40	11.80	612.00
MEMBER	2	5	124.52	62.89	68.40	W18*40	11.80	612.00
MEMBER	2	6	130.17	65.74	68.40	W18*40	11.80	612.00
MEMBER	3	2	141.37	71.40	81.60	W21*44	13.00	843.00
MEMBER	3	3	137.13	69.26	81.60	W21*44	13.00	843.00
MEMBER	3	4	135.01	68.18	68.40	W18*40	11.80	612.00
MEMBER	3	5	137.13	69.26	81.60	W21*44	13.00	843.00
MEMBER	3	6	141.37	71.40	81.60	W21*44	13.00	843.00
MEMBER	4	2	162.02	81.83	94.50	W21*50	14.70	984.00
MEMBER	4	3	157.78	79.69	81.60	W21*44	13.00	843.00
MEMBER	4	4	155.66	78.62	81.60	W21*44	13.00	843.00
MEMBER	4	5	157.78	79.69	81.60	W21*44	13.00	843.00
MEMBER	4	6	162.02	81.83	94.50	W21*50	14.70	984.00
MEMBER	5	2	180.08	90.95	94.50	W21*50	14.70	984.00
MEMBER	5	3	175.84	88.81	94.50	W21*50	14.70	984.00
MEMBER	5	4	173.71	87.73	94.50	W21*50	14.70	984.00
MEMBER	5	5	175.84	88.81	94.50	W21*50	14.70	984.00
MEMBER	5	6	180.08	90.95	94.50	W21*50	14.70	984.00
MEMBER	6	2	195.03	98.50	114.00	W24*55	16.20	1350.00
MEMBER	6	3	190.78	96.36	114.00	W24*55	16.20	1350.00

MEMBER	6	6	195.03	98.50	114.00	W24*55	16.20	1350.00
MEMBER	7	2	204.32	103.19	114.00	W24*55	16.20	1350.00
MEMBER	7	3	200.08	101.05	114.00	W24*55	16.20	1350.00
MEMBER	7	4	197.96	99.98	114.00	W24*55	16.20	1350.00
MEMBER	7	5	200.08	101.05	114.00	W24*55	16.20	1350.00
MEMBER	7	6	204.32	103.19	114.00	W24*55	16.20	1350.00

MAX AXIAL LOAD ,END MOMENTS AND COMPUTATION RESULTS FOR COLUMN SECTIONS

	I	J	PMAX	CM1	CM2	W14 SEC	AX	IZ	W12 SEC	AX	IZ
MEMBER	1	1	9.00	22.50	40.56	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	1	2	18.00	13.06	13.75	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	1	3	18.00	10.93	10.93	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	1	4	18.00	10.93	10.93	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	1	5	18.00	13.06	13.75	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	1	6	9.00	22.50	40.56	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	2	1	31.80	46.82	46.82	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	2	2	63.60	34.93	34.93	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	2	3	63.60	32.80	32.80	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	2	4	63.60	32.80	32.80	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	2	5	63.60	34.93	34.93	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	2	6	31.80	46.82	46.82	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	3	1	54.60	57.76	57.76	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	3	2	109.20	56.80	56.80	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	3	3	109.20	54.67	54.67	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	3	4	109.20	54.67	54.67	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	3	5	109.20	56.80	56.80	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	3	6	54.60	57.76	57.76	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	4	1	77.40	67.48	67.48	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	4	2	154.80	76.24	76.24	W14*53	15.60	541.00	W12*58	17.00	475.00
MEMBER	4	3	154.80	74.11	74.11	W14*53	15.60	541.00	W12*53	15.60	425.00
MEMBER	4	4	154.80	74.11	74.11	W14*53	15.60	541.00	W12*53	15.60	425.00
MEMBER	4	5	154.80	76.24	76.24	W14*53	15.60	541.00	W12*58	17.00	475.00
MEMBER	4	6	77.40	67.48	67.48	W14*43	12.60	428.00	W12*40	11.80	310.00
MEMBER	5	1	100.20	75.81	75.81	W14*43	12.60	428.00	W12*50	14.70	394.00
MEMBER	5	2	200.40	92.90	92.90	W14*68	20.00	723.00	W12*72	21.10	597.00
MEMBER	5	3	200.40	90.78	90.78	W14*68	20.00	723.00	W12*72	21.10	597.00
MEMBER	5	4	200.40	90.78	90.78	W14*68	20.00	723.00	W12*72	21.10	597.00

MEMBER	5	6	100.20	75.81	75.81	W14*43	12.60	428.00	W12*50	14.70	394.00
MEMBER	6	1	123.00	82.43	84.77	W14*53	15.60	541.00	W12*53	15.60	425.00
MEMBER	6	2	246.00	106.13	106.30	W14*82	24.10	882.00	W12*79	23.20	662.00
MEMBER	6	3	246.00	104.01	104.01	W14*74	21.80	796.00	W12*79	23.20	662.00
MEMBER	6	4	246.00	104.01	104.01	W14*74	21.80	796.00	W12*79	23.20	662.00
MEMBER	6	5	246.00	106.13	106.30	W14*82	24.10	882.00	W12*79	23.20	662.00
MEMBER	6	6	123.00	82.43	84.77	W14*53	15.60	541.00	W12*53	15.60	425.00
MEMBER	7	1	145.80	82.77	96.07	W14*61	17.90	640.00	W12*65	19.10	533.00
MEMBER	7	2	291.60	111.33	165.03	W14*99	29.10	1110.00	W12*120	35.30	1070.00
MEMBER	7	3	291.60	109.37	164.05	W14*99	29.10	1110.00	W12*120	35.30	1070.00
MEMBER	7	4	291.60	109.37	164.05	W14*99	29.10	1110.00	W12*120	35.30	1070.00
MEMBER	7	5	291.60	111.33	165.03	W14*99	29.10	1110.00	W12*120	35.30	1070.00
MEMBER	7	6	145.80	82.77	96.07	W14*61	17.90	640.00	W12*65	19.10	533.00

ESTIMATED TOTAL REAM WEIGHT COLUMN WEIGHT AND FRAME WEIGHT

TOTAL BM WEIGHT	TOTAL W14 COL WT	TOTAL W12 COL WT	TOTAL FRM1 WT	TOTAL FRM2 WT
46.74KIPS	25.43KIPS	30.52KIPS	76.17KIPS	77.26KIPS

FRAME DEFLECTION OF 1ST AND 2ND ORDER

FLCCR LEVEL	1ST CEFL WITH W14 COL	1ST DEFL WITH W12 CCL	2ND DEFL WITH W14 COL	2ND DEFL WITH W12 COL
1	0.1309	0.1431	0.1318	0.1442
2	0.2884	0.3246	0.2936	0.3311
3	0.4049	0.4645	0.4154	0.4784
4	0.4257	0.4425	0.4379	0.4557
5	0.4364	0.4568	0.4499	0.4716
6	0.4013	0.4639	0.4135	0.4804
7	0.3653	0.3650	0.3744	0.3741

TOTAL DEFLECTION

FLOOR LEVEL	1ST DEFL WITH W14 COL	1ST DEFL WITH W12 COL	2ND DEFL WITH W14 COL	2ND DEFL WITH W12 COL
1	2.4529	2.6604	2.5165	2.7354
2	2.3220	2.5173	2.3847	2.5913
3	2.0336	2.1927	2.0911	2.2602
4	1.6287	1.7282	1.6758	1.7818
5	1.2029	1.2857	1.2378	1.3261
6	0.7665	0.8289	0.7879	0.8545
7	0.3653	0.3650	0.3744	0.3741

DRIFT INDEX

1ST IND W14	1ST IND W12	2NC IND W14	2NC IND W12
.0024	0.0026	0.0024	0.0027

RESULTS OF REDESIGN FOR W14 COLUMNS

GRAVITY LOAD MOMENTS

	I	J	RM4	LM4	BM4	TM4	P1
JOINT	1	1	-39.33	0.0	39.33	0.0	9.30
JOINT	1	2	-47.15	49.81	-2.67	0.0	18.00
JOINT	1	3	-46.65	46.65	0.0	0.0	18.00
JOINT	1	4	-46.65	46.65	0.0	0.0	18.00
JOINT	1	5	-49.81	47.15	2.67	0.0	18.00
JOINT	1	6	0.0	39.33	-39.33	0.0	9.30
JOINT	2	1	-95.25	0.0	47.63	47.63	33.98
JOINT	2	2	-123.94	128.66	-2.36	-2.36	65.32
JOINT	2	3	-122.59	122.59	0.0	0.0	65.32
JOINT	2	4	-122.59	122.59	0.0	0.0	65.32
JOINT	2	5	-128.66	123.94	2.36	2.36	65.32
JOINT	2	6	0.0	95.25	-47.63	-47.63	33.98
JOINT	3	1	-88.95	0.0	44.47	44.47	58.71
JOINT	3	2	-126.60	131.82	-2.61	-2.61	112.75
JOINT	3	3	-122.53	123.64	-0.56	-0.56	112.69
JOINT	3	4	-123.64	122.53	0.56	0.56	112.69
JOINT	3	5	-131.82	126.60	2.61	2.61	112.75
JOINT	3	6	0.0	88.95	-44.47	-44.47	58.71
JOINT	4	1	-85.51	0.0	42.75	42.75	83.84
JOINT	4	2	-126.13	133.36	-4.04	-3.19	160.40
JOINT	4	3	-123.56	123.41	0.08	0.07	160.25
JOINT	4	4	-123.41	123.56	-0.08	-0.07	160.25
JOINT	4	5	-133.36	126.13	4.04	3.19	160.40
JOINT	4	6	0.0	85.51	-42.75	-42.75	83.84
JOINT	5	1	-84.68	0.0	42.34	42.34	108.36
JOINT	5	2	-126.08	133.87	-4.46	-3.33	208.31

JOINT	5	4	-123.65	123.65	0.0	0.0	208.16
JOINT	5	5	-133.87	126.08	4.46	3.33	208.31
JOINT	5	6	0.0	84.68	-42.34	-42.34	108.36
JOINT	6	1	-79.82	0.0	44.57	35.26	133.38
JOINT	6	2	-127.48	136.29	-4.84	-3.97	256.55
JOINT	6	3	-124.47	124.35	0.06	0.06	256.30
JOINT	6	4	-124.35	124.47	-0.06	-0.06	256.30
JOINT	6	5	-136.29	127.48	4.84	3.97	256.55
JOINT	6	6	0.0	79.82	-44.57	-35.26	133.38
JOINT	7	1	-82.79	0.0	41.68	41.11	158.62
JOINT	7	2	-126.54	135.16	-4.47	-4.15	305.18
JOINT	7	3	-123.96	123.86	0.06	0.05	304.94
JOINT	7	4	-123.86	123.96	-0.06	-0.05	304.94
JOINT	7	5	-135.16	126.54	4.47	4.15	305.18
JOINT	7	6	0.0	82.79	-41.68	-41.11	158.62
JOINT	8	1	0.0	0.0	0.0	19.11	0.0
JOINT	8	2	0.0	0.0	0.0	-1.99	0.0
JOINT	8	3	0.0	0.0	0.0	0.02	0.0
JOINT	8	4	0.0	0.0	0.0	-0.02	0.0
JOINT	8	5	0.0	0.0	0.0	1.99	0.0
JOINT	8	6	0.0	0.0	0.0	-19.11	0.0

LATERAL LOAD MCMENTS

	I	J	RMS	LMS	BMS	TMS	P2
JOINT	1	1	7.53	0.0	7.53	0.0	0.50
JOINT	1	2	7.05	7.53	14.58	0.0	0.03
JOINT	1	3	7.53	7.05	14.58	0.0	0.03
JOINT	1	4	7.05	7.53	14.58	0.0	0.03
JOINT	1	5	7.53	7.05	14.58	0.0	0.03
JOINT	1	6	0.0	7.29	7.29	0.0	0.50
JOINT	2	1	30.13	0.0	22.60	7.53	2.51
JOINT	2	2	28.19	30.13	43.74	14.58	0.16
JOINT	2	3	30.13	28.19	43.74	14.58	0.16
JOINT	2	4	28.19	30.13	43.74	14.58	0.16
JOINT	2	5	30.13	28.19	43.74	14.58	0.16
JOINT	2	6	0.0	29.16	21.87	7.29	2.51
JOINT	3	1	60.26	0.0	37.66	22.60	6.53
JOINT	3	2	56.38	60.26	72.90	43.74	0.42
JOINT	3	3	60.26	56.38	72.90	43.74	0.42
JOINT	3	4	56.38	60.26	72.90	43.74	0.42
JOINT	3	5	60.26	56.38	72.90	43.74	0.42
JOINT	3	6	0.0	58.32	36.45	21.87	6.53
JOINT	4	1	88.72	0.0	51.06	37.66	12.44
JOINT	4	2	83.00	88.72	98.82	72.90	0.80
JOINT	4	3	88.72	83.00	98.82	72.90	0.80
JOINT	4	4	83.00	88.72	98.82	72.90	0.80
JOINT	4	5	88.72	83.00	98.82	72.90	0.80
JOINT	4	6	0.0	85.86	49.41	36.45	12.44
JOINT	5	1	113.60	0.0	62.54	51.06	20.02
JOINT	5	2	106.27	113.60	121.04	98.82	1.29
JOINT	5	3	113.60	106.27	121.04	98.82	1.29
JOINT	5	4	106.27	113.60	121.04	98.82	1.29
JOINT	5	5	113.60	106.27	121.04	98.82	1.29

JOINT	5	6	0.0	109.93	60.52	49.41	20.02
JOINT	6	1	134.19	0.0	71.65	62.54	28.96
JOINT	6	2	125.54	134.19	138.68	121.04	1.87
JOINT	6	3	134.19	125.54	138.68	121.04	1.87
JOINT	6	4	125.54	134.19	138.68	121.04	1.87
JOINT	6	5	134.19	125.54	138.68	121.04	1.87
JOINT	6	6	0.0	129.86	69.34	60.52	28.96
JOINT	7	1	147.00	0.0	75.34	71.65	38.76
JOINT	7	2	137.51	147.00	145.82	138.68	2.50
JOINT	7	3	147.00	137.51	145.82	138.68	2.50
JOINT	7	4	137.51	147.00	145.82	138.68	2.50
JOINT	7	5	147.00	137.51	145.82	138.68	2.50
JOINT	7	6	0.0	142.25	72.91	69.34	38.76
JOINT	8	1	0.0	0.0	0.0	113.01	0.0
JOINT	8	2	0.0	0.0	0.0	218.74	0.0
JOINT	8	3	0.0	0.0	0.0	218.74	0.0
JOINT	8	4	0.0	0.0	0.0	218.74	0.0
JOINT	8	5	0.0	0.0	0.0	218.74	0.0
JOINT	8	6	0.0	0.0	0.0	109.37	0.0

MAX MOMENTS SEC MODULUS AND SECS FOR BEAMS

	I	J	MAX MOMENT	REQUIRED SEC MODUUS	SUGGESTED SEC MODULUS	LIGHTEST SECTION	AX	IZ
MEMBER	1	2	49.81	25.16	29.00	W14*22	6.49	199.00
MEMBER	1	3	47.15	23.81	29.00	W14*22	6.49	199.00
MEMBER	1	4	46.65	23.56	29.00	W14*22	6.49	199.00
MEMBER	1	5	47.15	23.81	29.00	W14*22	6.49	199.00
MEMBER	1	6	49.81	25.16	29.00	W14*22	6.49	199.00
MEMBER	2	2	128.66	64.98	68.40	W18*40	11.80	612.00
MEMBER	2	3	123.94	62.60	68.40	W18*40	11.80	612.00
MEMBER	2	4	122.59	61.92	68.40	W18*40	11.80	612.00
MEMBER	2	5	123.94	62.60	68.40	W18*40	11.80	612.00
MEMBER	2	6	128.66	64.98	68.40	W18*40	11.80	612.00
MEMBER	3	2	144.06	72.76	81.60	W21*44	13.00	843.00
MEMBER	3	3	137.23	69.31	81.60	W21*44	13.00	843.00
MEMBER	3	4	137.09	69.24	81.60	W21*44	13.00	843.00
MEMBER	3	5	137.23	69.31	81.60	W21*44	13.00	843.00
MEMBER	3	6	144.06	72.76	81.60	W21*44	13.00	843.00
MEMBER	4	2	166.56	84.12	94.50	W21*50	14.70	984.00
MEMBER	4	3	156.84	79.21	81.60	W21*44	13.00	843.00
MEMBER	4	4	159.21	80.41	81.60	W21*44	13.00	843.00
MEMBER	4	5	156.84	79.21	81.60	W21*44	13.00	843.00
MEMBER	4	6	166.56	84.12	94.50	W21*50	14.70	984.00
MEMBER	5	2	185.60	93.74	94.50	W21*50	14.70	984.00
MEMBER	5	3	174.26	88.01	94.50	W21*50	14.70	984.00
MEMBER	5	4	177.94	89.87	94.50	W21*50	14.70	984.00
MEMBER	5	5	174.26	88.01	94.50	W21*50	14.70	984.00
MEMBER	5	6	185.60	93.74	94.50	W21*50	14.70	984.00
MEMBER	6	2	202.87	102.46	114.00	W24*55	16.20	1350.00
MEMBER	6	3	189.76	95.84	114.00	W24*55	16.20	1350.00

MEMEER	6	6	202.87	102.46	114.00	W24*55	16.20	1350.00
MEMBER	7	2	211.61	106.88	114.00	W24*55	16.20	1350.00
MEMBER	7	3	198.04	100.02	114.00	W24*55	16.20	1350.00
MEMBER	7	4	203.22	102.64	114.00	W24*55	16.20	1350.00
MEMEEP	7	5	198.04	100.02	114.00	W24*55	16.20	1350.00
MEMBER	7	6	211.61	106.88	114.00	W24*55	16.20	1350.00

MAX AXIAL LOAD ,END MOMENTS AND COMPUTATION RESULTS FOR COLUMN SECTIONS

	I	J	PMAX	CM1	CM2	W14 SEC	AX	IZ
MEMBER	1	1	9.30	39.33	47.63	W14*43	12.60	428.00
MEMBER	1	2	18.00	12.70	12.93	W14*43	12.60	428.00
MEMBER	1	3	18.00	10.93	10.93	W14*43	12.60	428.00
MEMBER	1	4	18.00	10.93	10.93	W14*43	12.60	428.00
MEMBER	1	5	18.00	12.70	12.93	W14*43	12.60	428.00
MEMBER	1	6	9.30	39.33	47.63	W14*43	12.60	428.00
MEMBER	2	1	33.98	50.30	52.67	W14*43	12.60	428.00
MEMBER	2	2	65.32	34.57	34.76	W14*43	12.60	428.00
MEMBER	2	3	65.32	32.80	33.22	W14*43	12.60	428.00
MEMBER	2	4	65.32	32.80	33.22	W14*43	12.60	428.00
MEMBER	2	5	65.32	34.57	34.76	W14*43	12.60	428.00
MEMBER	2	6	33.98	49.76	52.12	W14*43	12.60	428.00
MEMBER	3	1	58.71	60.31	61.60	W14*43	12.60	428.00
MEMBER	3	2	112.75	56.63	57.07	W14*43	12.60	428.00
MEMBER	3	3	112.69	54.72	55.09	W14*43	12.60	428.00
MEMBER	3	4	112.69	54.72	55.09	W14*43	12.60	428.00
MEMBER	3	5	112.75	56.63	57.07	W14*43	12.60	428.00
MEMBER	3	6	58.71	59.40	60.69	W14*43	12.60	428.00
MEMBER	4	1	83.54	70.05	70.36	W14*43	12.60	428.00
MEMBER	4	2	160.40	76.62	77.14	W14*53	15.60	541.00
MEMBER	4	3	160.25	74.11	74.18	W14*53	15.60	541.00
MEMBER	4	4	160.25	74.11	74.18	W14*53	15.60	541.00
MEMBER	4	5	160.40	76.62	77.14	W14*53	15.60	541.00
MEMBER	4	6	83.54	68.81	69.12	W14*43	12.60	428.00
MEMBER	5	1	108.36	73.35	78.66	W14*48	14.10	485.00
MEMBER	5	2	208.31	93.76	94.13	W14*68	20.00	723.00
MEMBER	5	3	208.16	90.78	90.63	W14*68	20.00	723.00

MEMBER	5	6	108.36	71.83	77.15	W14*48	14.10	485.00
MEMBER	6	1	133.38	84.57	87.17	W14*53	15.60	541.00
MEMBER	6	2	256.55	107.12	107.65	W14*82	24.10	882.00
MEMBER	6	3	256.30	104.05	104.06	W14*82	24.10	882.00
MEMBER	6	4	256.30	104.05	104.06	W14*82	24.10	882.00
MEMBER	6	5	256.55	107.12	107.65	W14*82	24.10	882.00
MEMBER	6	6	133.38	82.84	85.43	W14*53	15.60	541.00
MEMBER	7	1	158.62	87.77	99.09	W14*61	17.90	640.00
MEMBER	7	2	305.18	112.72	165.54	W14*109	32.00	1240.00
MEMBER	7	3	304.94	109.41	164.07	W14*109	32.00	1240.00
MEMBER	7	4	304.94	109.41	164.07	W14*109	32.00	1240.00
MEMBER	7	5	305.18	112.72	165.54	W14*109	32.00	1240.00
MEMBER	7	6	158.62	85.95	96.36	W14*61	17.90	640.00

ESTIMATED TOTAL REAM WEIGHT COLUMN WEIGHT AND FRAME WEIGHT

TCTAL EM WEIGHT	TOTAL W14 COL WT	TOTAL FRM1 WT
46.86KIPS	30.30KIPS	77.16KIPS

FRAME CEFLECTION CF 1ST ANC 2NC ORDER

FLOOR LEVEL	1ST DEL WITH W14 COL	2ND DELF WITH W14 COL
1	0.1309	0.1318
2	0.2884	0.2936
3	0.3924	0.4022
4	0.4257	0.4379
5	0.4261	0.4390
6	0.3924	0.4041
7	0.3384	0.3462

TOTAL DEFLECTION

FLOOR LEVEL	1ST DEL WITH W14 COL	2ND DELF WITH W14 COL
1	2.3944	2.4548
2	2.2634	2.3230
3	1.9750	2.0295
4	1.5826	1.6272
5	1.1569	1.1893
6	0.7308	0.7503
7	0.3384	0.3462

DRIFT INDEX

1ST DI WITH W14 COL	2ND DI WITH W14 COL
0.0023	0.0024

RESULTS OF REDESIGN FOR W12 COLUMNS

GRAVITY LOAD MOMENTS

	I	J	RM4	LM4	BM4	TM4	P1
JOINT	1	1	-37.12	0.0	37.12	0.0	9.30
JOINT	1	2	-47.46	50.61	-3.15	0.0	18.00
JOINT	1	3	-46.65	46.65	0.0	0.0	18.00
JOINT	1	4	-46.65	46.65	0.0	0.0	18.00
JOINT	1	5	-50.61	47.46	3.15	0.0	18.00
JOINT	1	6	0.0	37.12	-37.12	0.0	9.30
JOINT	2	1	-88.66	0.0	44.33	44.33	33.94
JOINT	2	2	-125.94	131.40	-2.73	-2.73	65.28
JOINT	2	3	-123.78	123.78	0.0	0.0	65.28
JOINT	2	4	-123.78	123.78	0.0	0.0	65.28
JOINT	2	5	-131.40	125.94	2.73	2.73	65.28
JOINT	2	6	0.0	88.66	-44.33	-44.33	33.94
JOINT	3	1	-81.10	0.0	40.55	40.55	58.64
JOINT	3	2	-128.61	134.67	-3.03	-3.03	112.68
JOINT	3	3	-125.31	125.31	0.0	0.0	112.68
JOINT	3	4	-125.31	125.31	0.0	0.0	112.68
JOINT	3	5	-134.67	128.61	3.03	3.03	112.68
JOINT	3	6	0.0	81.10	-40.55	-40.55	58.64
JOINT	4	1	-78.73	0.0	41.75	36.98	83.49
JOINT	4	2	-127.82	135.76	-4.81	-3.14	160.39
JOINT	4	3	-124.33	124.16	0.10	0.07	160.30
JOINT	4	4	-124.16	124.33	-0.10	-0.07	160.30
JOINT	4	5	-135.76	127.82	4.81	3.14	160.39
JOINT	4	6	0.0	78.73	-41.75	-36.98	83.49
JOINT	5	1	-81.24	0.0	43.02	38.22	108.40
JOINT	5	2	-127.19	135.19	-4.45	-3.54	208.35

JOINT	5	4	-124.26	124.26	0.0	0.0	208.26
JOINT	5	5	-135.19	127.19	4.45	3.54	208.35
JOINT	5	6	0.0	81.24	-43.02	-38.22	108.40
JOINT	6	1	-77.09	0.0	42.14	34.95	133.48
JOINT	6	2	-128.52	137.24	-4.83	-3.89	256.64
JOINT	6	3	-124.99	124.99	0.0	0.0	256.55
JOINT	6	4	-124.99	124.99	0.0	0.0	256.55
JOINT	6	5	-137.24	128.52	4.83	3.89	256.64
JOINT	6	6	0.0	77.09	-42.14	-34.95	133.48
JOINT	7	1	-78.63	0.0	38.55	40.08	158.78
JOINT	7	2	-127.27	136.72	-5.23	-4.22	305.57
JOINT	7	3	-124.19	124.19	0.0	0.0	305.48
JOINT	7	4	-124.19	124.19	0.0	0.0	305.48
JOINT	7	5	-136.72	127.27	5.23	4.22	305.57
JOINT	7	6	0.0	78.63	-38.55	-40.08	158.78
JOINT	8	1	0.0	0.0	0.0	18.14	0.0
JOINT	8	2	0.0	0.0	0.0	-2.18	0.0
JOINT	8	3	0.0	0.0	0.0	0.0	0.0
JOINT	8	4	0.0	0.0	0.0	0.0	0.0
JOINT	8	5	0.0	0.0	0.0	2.18	0.0
JOINT	8	6	0.0	0.0	0.0	-18.14	0.0

LATERAL LOAD MOMENTS

	I	J	RM5	LM5	BM5	TM5	P2
JOINT	1	1	7.53	0.0	7.53	0.0	0.50
JOINT	1	2	7.05	7.53	14.58	0.0	0.03
JOINT	1	3	7.53	7.05	14.58	0.0	0.03
JOINT	1	4	7.05	7.53	14.58	0.0	0.03
JOINT	1	5	7.53	7.05	14.58	0.0	0.03
JOINT	1	6	0.0	7.29	7.29	0.0	0.50
JOINT	2	1	30.13	0.0	22.60	7.53	2.51
JOINT	2	2	28.19	30.13	43.74	14.58	0.16
JOINT	2	3	30.13	28.19	43.74	14.58	0.16
JOINT	2	4	28.19	30.13	43.74	14.58	0.16
JOINT	2	5	30.13	28.19	43.74	14.58	0.16
JOINT	2	6	0.0	29.16	21.87	7.29	2.51
JOINT	3	1	60.26	0.0	37.66	22.60	6.53
JOINT	3	2	56.38	60.26	72.90	43.74	0.42
JOINT	3	3	60.26	56.38	72.90	43.74	0.42
JOINT	3	4	56.38	60.26	72.90	43.74	0.42
JOINT	3	5	60.26	56.38	72.90	43.74	0.42
JOINT	3	6	0.0	58.32	36.45	21.87	6.53
JOINT	4	1	88.72	0.0	51.06	37.66	12.44
JOINT	4	2	83.00	88.72	98.82	72.90	0.80
JOINT	4	3	88.72	83.00	98.82	72.90	0.80
JOINT	4	4	83.00	88.72	98.82	72.90	0.80
JOINT	4	5	88.72	83.00	98.82	72.90	0.80
JOINT	4	6	0.0	85.86	49.41	36.45	12.44
JOINT	5	1	113.60	0.0	62.54	51.06	20.02
JOINT	5	2	106.27	113.60	121.04	98.82	1.29
JOINT	5	3	113.60	106.27	121.04	98.82	1.29
JOINT	5	4	106.27	113.60	121.04	98.82	1.29

JOINT	5	6	0.0	109.93	60.52	49.41	20.02
JOINT	6	1	134.19	0.0	71.65	62.54	28.96
JOINT	6	2	125.54	134.19	138.68	121.04	1.87
JOINT	6	3	134.19	125.54	138.68	121.04	1.87
JOINT	6	4	125.54	134.19	138.68	121.04	1.87
JOINT	6	5	134.19	125.54	138.68	121.04	1.87
JOINT	6	6	0.0	129.86	69.34	60.52	28.96
JOINT	7	1	147.00	0.0	75.34	71.65	38.76
JOINT	7	2	137.51	147.00	145.82	138.68	2.50
JOINT	7	3	147.00	137.51	145.82	138.68	2.50
JOINT	7	4	137.51	147.00	145.82	138.68	2.50
JOINT	7	5	147.00	137.51	145.82	138.68	2.50
JOINT	7	6	0.0	142.25	72.91	69.34	38.76
JOINT	8	1	0.0	0.0	0.0	113.01	0.0
JOINT	8	2	0.0	0.0	0.0	218.74	0.0
JOINT	8	3	0.0	0.0	0.0	218.74	0.0
JOINT	8	4	0.0	0.0	0.0	218.74	0.0
JOINT	8	5	0.0	0.0	0.0	218.74	0.0
JOINT	8	6	0.0	0.0	0.0	109.37	0.0

MAX MOMENTS SEC MODULUS AND SECS FOR BEAMS

	I	J	MAX MOMENT	REQUIRED SEC MODUUS	SUGGESTED SEC MODULUS	LIGHTEST SECTION	AX	IZ
MEMBER	1	2	50.61	25.56	29.00	W14*22	6.49	199.00
MEMBER	1	3	47.46	23.97	29.00	W14*22	6.49	199.00
MEMBER	1	4	46.65	23.56	29.00	W14*22	6.49	199.00
MEMBER	1	5	47.46	23.97	29.00	W14*22	6.49	199.00
MEMBER	1	6	50.61	25.56	29.00	W14*22	6.49	199.00
MEMBER	2	2	131.40	66.37	68.40	W18*40	11.80	612.00
MEMBER	2	3	125.94	63.61	68.40	W18*40	11.80	612.00
MEMBER	2	4	123.78	62.52	68.40	W18*40	11.80	612.00
MEMBER	2	5	125.94	63.61	68.40	W18*40	11.80	612.00
MEMBER	2	6	131.40	66.37	68.40	W18*40	11.80	612.00
MEMBER	3	2	146.20	73.84	81.60	W21*44	13.00	843.00
MEMBER	3	3	138.74	70.07	81.60	W21*44	13.00	843.00
MEMBER	3	4	139.18	70.29	81.60	W21*44	13.00	843.00
MEMBER	3	5	138.74	70.07	81.60	W21*44	13.00	843.00
MEMBER	3	6	146.20	73.84	81.60	W21*44	13.00	843.00
MEMBER	4	2	168.36	85.03	94.50	W21*50	14.70	984.00
MEMBER	4	3	158.11	79.85	81.60	W21*44	13.00	843.00
MEMBER	4	4	159.79	80.70	81.60	W21*44	13.00	843.00
MEMBER	4	5	158.11	79.85	81.60	W21*44	13.00	843.00
MEMBER	4	6	168.36	85.03	94.50	W21*50	14.70	984.00
MEMBER	5	2	186.59	94.24	94.50	W21*50	14.70	984.00
MEMBER	5	3	175.10	88.43	94.50	W21*50	14.70	984.00
MEMBER	5	4	178.39	90.10	94.50	W21*50	14.70	984.00
MEMBER	5	5	175.10	88.43	94.50	W21*50	14.70	984.00
MEMBER	5	6	186.59	94.24	94.50	W21*50	14.70	984.00
MEMBER	6	2	203.57	102.81	114.00	W24*55	16.20	1350.00
MEMBER	6	3	190.54	96.23	114.00	W24*55	16.20	1350.00

MEMBER	6	6	203.57	102.81	114.00	W24*55	16.20	1350.00
MEMBER	7	2	212.78	107.47	114.00	W24*55	16.20	1350.00
MEMBER	7	3	198.59	100.30	114.00	W24*55	16.20	1350.00
MEMBER	7	4	203.39	102.72	114.00	W24*55	16.20	1350.00
MEMBER	7	5	198.59	100.30	114.00	W24*55	16.20	1350.00
MEMBER	7	6	212.78	107.47	114.00	W24*55	16.20	1350.00

MAX AXIAL LOAD ,END MOMENTS AND COMPUTATION RESULTS FOR COLUMN SECTIONS

	I	J	PMAX	CM1	CM2	W12 SEC	AX	IZ
MEMBER	1	1	9.30	37.12	44.33	W12*40	11.80	310.00
MEMBER	1	2	18.00	12.98	13.30	W12*40	11.80	310.00
MEMBER	1	3	18.00	10.93	10.93	W12*40	11.80	310.00
MEMBER	1	4	18.00	10.93	10.93	W12*40	11.80	310.00
MEMBER	1	5	18.00	12.98	13.30	W12*40	11.80	310.00
MEMBER	1	6	9.30	37.12	44.33	W12*40	11.80	310.00
MEMBER	2	1	33.94	47.36	50.19	W12*40	11.80	310.00
MEMBER	2	2	65.28	34.85	35.08	W12*40	11.80	310.00
MEMBER	2	3	65.28	32.80	32.80	W12*40	11.80	310.00
MEMBER	2	4	65.28	32.80	32.80	W12*40	11.80	310.00
MEMBER	2	5	65.28	34.85	35.08	W12*40	11.80	310.00
MEMBER	2	6	33.94	46.81	49.65	W12*40	11.80	310.00
MEMBER	3	1	58.64	55.98	56.66	W12*40	11.80	310.00
MEMBER	3	2	112.68	56.95	57.03	W12*40	11.80	310.00
MEMBER	3	3	112.68	54.67	54.73	W12*40	11.80	310.00
MEMBER	3	4	112.68	54.67	54.73	W12*40	11.80	310.00
MEMBER	3	5	112.68	56.95	57.03	W12*40	11.80	310.00
MEMBER	3	6	58.64	55.07	57.75	W12*40	11.80	310.00
MEMBER	4	1	83.49	66.96	69.61	W12*45	13.20	350.00
MEMBER	4	2	160.39	76.77	77.72	W12*58	17.00	475.00
MEMBER	4	3	160.30	74.11	74.19	W12*58	17.00	475.00
MEMBER	4	4	160.30	74.11	74.19	W12*58	17.00	475.00
MEMBER	4	5	160.39	76.77	77.72	W12*58	17.00	475.00
MEMBER	4	6	83.49	65.72	68.37	W12*40	11.80	310.00
MEMBER	5	1	108.40	73.12	75.17	W12*50	14.70	394.00
MEMBER	5	2	208.35	93.70	94.12	W12*72	21.10	597.00
MEMBER	5	3	208.26	90.78	90.78	W12*72	21.10	597.00
MEMBER	5	4	208.26	90.78	90.78	W12*72	21.10	597.00

MEMBER	5	6	108.40	71.61	77.66	W12*50	14.70	394.00
MEMBER	6	1	133.48	83.80	85.34	W12*58	17.00	475.00
MEMBER	6	2	256.64	107.18	107.63	W12*87	25.60	740.00
MEMBER	6	3	256.55	104.01	104.01	W12*87	25.60	740.00
MEMBER	6	4	256.55	104.01	104.01	W12*87	25.60	740.00
MEMBER	6	5	256.64	107.18	107.63	W12*87	25.60	740.00
MEMBER	6	6	133.48	82.07	83.61	W12*53	15.60	425.00
MEMBER	7	1	158.78	85.42	98.37	W12*65	19.10	533.00
MEMBER	7	2	305.57	113.29	165.69	W12*120	35.30	1070.00
MEMBER	7	3	305.48	109.37	164.05	W12*120	35.30	1070.00
MEMBER	7	4	305.48	109.37	164.05	W12*120	35.30	1070.00
MEMBER	7	5	305.57	113.29	165.69	W12*120	35.30	1070.00
MEMBER	7	6	158.78	83.60	95.63	W12*65	19.10	533.00

ESTIMATED TOTAL REAM WEIGHT COLUMN WEIGHT AND FRAME WEIGHT

TOTAL BM WEIGHT	TOTAL W12 COL WT	TOTAL FRM2 WT
46.86KIPS	31.15KIPS	78.01KIPS

FRAME CEFLECTION OF 1ST AND 2ND CRDER

FLOOR LEVEL	1ST DEL WITH W12 COL	2ND DELF WITH W12 COL
1	0.1431	0.1442
2	0.3246	0.3311
3	0.4522	0.4654
4	0.4189	0.4306
5	0.4714	0.4873
6	0.4198	0.4332
7	0.3752	0.3848

TOTAL DEFLECTICN

FLOOR LEVEL	1ST DEL WITH W12 COL	2ND DELF WITH W12 COL
1	2.6052	2.6766
2	2.4621	2.5324
3	2.1375	2.2013
4	1.6852	1.7359
5	1.2664	1.3053
6	0.7949	0.8180
7	0.3752	0.3848

DRIFT INDEX

1ST DI WITH W12 COL	2ND DI WITH W12 COL
0.0025	0.0026

APPENDIX J

PRELIMINARY DESIGN RESULTS FOR 7-STORY BRACED FRAME,

HOUSTON, TEXAS

THE DESCRIPTION CF FRAME DIMENSION ANC LCACING

THE NC CF BAYS NE = 3

THE NC OF STORIES NS = 7

STEEL YIELCS STRESS FY =36.0CKSI

CUTSIDE WALL WT =20.00PSF

ROOF DEAD LOAD RDL =0.100KLF

ROOF LIVE LCAD RLL =0.100KLF

FLCCR DEAD LCAD FDL =0.153KLF

FLOOR LIVE LOAD FLL =0.272KLF

BAY NO	BAY WICTH(FT)	STORY NO	STORY HEIGHT(FT)	LEVEL NO	LATERAL LCAD(K)
1	30.00	1	12.00	1	20.25
2	30.00	2	12.00	2	40.50
3	30.00	3	12.00	3	40.50
4	0.00	4	12.00	4	36.00
5	0.00	5	12.00	5	30.87
6	0.00	6	12.00	6	24.50
7	0.00	7	14.00	7	24.00

COMPUTATION RESULTS FOR UNBRACING PART IN FRAME

	SPAN NO	ROOF BM SR	FLOOR BM SR
BEAM	1	11.54	24.52
BEAM	2	11.54	24.52
BEAM	3	11.54	24.52

	I	J	COL AXIAL LOAD
COLUMN	1	1	3.00
COLUMN	1	4	3.00
COLUMN	2	1	13.17
COLUMN	2	4	12.97
COLUMN	3	1	23.35
COLUMN	3	4	22.95
COLUMN	4	1	33.52
COLUMN	4	4	32.92
COLUMN	5	1	43.70
COLUMN	5	4	42.90
COLUMN	6	1	53.87
COLUMN	6	4	52.87
COLUMN	7	1	64.66
COLUMN	7	4	63.45

COMPUTATION RESULTS FOR CROSS DIAGONAL BRACING

STORY NO	LEFT COL	RIGHT COL	BRACINGMEMBER
1	9.04	9.04	10.90
2	41.66	41.66	32.71
3	86.83	86.83	54.52
4	143.91	143.91	73.91
5	211.43	211.43	90.54

```
                    6       287.70      267.70      103.73

                    7       378.33      378.33      119.52

STATEMENTS EXECUTED=     275

CORE USACE       CBJECT CODE=    8312 BYTES,ARRAY AREA=    3080 BYTES,TCTAL AREA AVAILABLE=   47104  BYTES

DIAGNOSTICS        NUMBER CF ERRCRS=       0, NUMBEF CF WARNINGS=       0, NUMEEP OF EXTENSICNS=       0

CCMPILE TIME=     0.49 SEC,EXECUTION TIME=     0.09 SEC,     17.35.47     SATUFDAY     21 JUN 80    WATFIV - JUN 1977 V1L6
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Mr. J. L. Garrett
Senior Engineer-Technical Services
ARMCO, Inc.
1455 West Loop SOuth
Houston, TX 77027

Dear Joe:

Enclosed are two copies of Jim Lin's final report concerning the economics of using W12 column sections in multistory buildings. The results ~~I believe from your viewpoint,~~ are quite encouraging. The use of W12 column sections only slightly increases frame weight and frame drift. ~~Most likely,~~ The increased cost of the steel can be easily compensated for by reduced freight weight.

The study concentrated on unbraced frames ~~for~~ per Don Ballard's direction. However, the program developed for braced frames is operational and can be quite useful for their design.

Concerning your request that the programs be ~~possibly~~ used by the design profession, probably the best way to handle it would be to use me as a consultant. This summer I have worked with a steel fabricator and a consulting structural engineer on the preliminary design of multistory frames. To further test the accuracy of Jim Lin's programs, the designs were based on his results. The final designs were very close to the preliminary designs ~~and~~ in situations ~~for~~ where the framing plan was not changed. Therefore, I am quite confident that the results are reasonable and I would be happy to work with you on a trial basis to provide alternate designs to the steel industry and design profession. If this situation is suitable, please contact me and we can negotiate fees. If it is your plan to provide the services yourself, I would be most happy to work with you to install~~ing~~ the program on your computer system.

We appreciate the opportunity to work with you and we trust that the results of our study will be of some value to ARMCO, Inc.

Sincerely,

Thomas M. Murray
PIC
FSEL

TMM:sbs