KANI'S METHOD OF ANALYZING
MULTISTORY BUILDING
FRAMES

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1961

Submitted to the Faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
August, 1962

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PREFACE

By using the principal concept of Professor Kani, a method of ılysis of multistory frames is presented. This method is compared :h two other methods commonly used.

In writing this report, I am indebted to Dr. James W. Gillespie : his expert advice and not too infrequent aid. In formulating this ·k, extensive use was made of Dr. Gillespie's lectures and notes in : Civil Engineering courses: Theory of Structures II, and Theory of ·uctures III.

I am also indebted to many scholars and friends; specifically my ınks go to Mr. C. M. Diri who sparked my interest in this subject. rould like to express my appreciation to Mrs. Frank Roberts and 3. Arlene Starwalt for their assistance in completion of this work.

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PART I

INTRODUCTION

l General

Many methods are available for the analysis of multistory frames. ›bably the most widely used are the methods of slope deflection and nent distribution. Recently, the method of carry-over joint moments s been introduced by Tuma and presented in M.S. theses by Gregory (1) d Sturm (2).

A modified iterative procedure for analyzing multistory frames has en developed by Kani (3). It is the purpose of this report to preat Kani's method of analyzing building frames, and to compare the nerical procedure of Kani's method with that of moment distribution an rry-over joint moments. This comparison is accomplished by means of numerical example.

The moments of inertia of the individual members may be constant variable. The customary assumptions of elastic analysis are made, d the sign convention of slope deflection is used.

The general procedure of application of Kani's method is as follows

(1) Evaluate all necessary constants (carry-over factors, distribution factors, etc.).

(2) Compute the fixed end moments due to loads, and the sum of fixed end moments at each joint.

(3) Compute the shear moment for each story.

(4) Select an arbitrary sequence for the iteration, and iterate the joint moments and shear moments in that order.

(5) Compute the final end moments from the results of Step 4.

The general procedure for the application of the moment distribution hod is well established and is not shown. The procedure for analysis the method of carry-over joint moments is available elsewhere.(1,2).

PART II

BASIC CONCEPTS OF KANI'S METHOD

Joint Translation Prevented

A typical bar of a continuous structure of variable cross-section d by a general system of transverse forces is considered (Fig.1). ing that the ends of the beam are restrained against displacement, inal end moments are composed of (Fig.1)

a) Fixed End Moments Due to Loads

b) Rotational Moments Due to Rotation of End i

c) Rotational Moments Due to Rotation of End j.

in terms of the notation introduced in Fig. 1, the final end mo- become

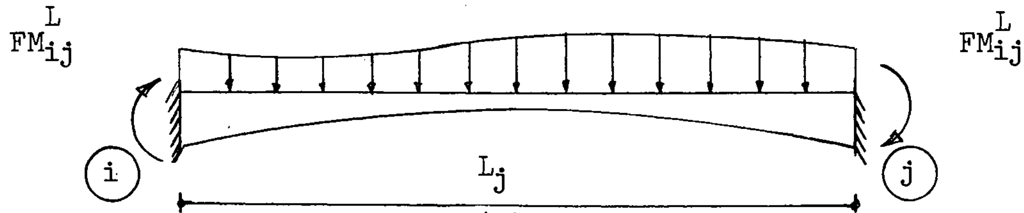
$$M_{ij} = RM'_{ij} + RM''_{ij} + FM^{L}_{ij}$$

$$M_{ij} = RM'_{ji} + RM''_{ji} + FM^{L}_{ji} \quad . \qquad (1)$$

'rom the general slope deflection equations

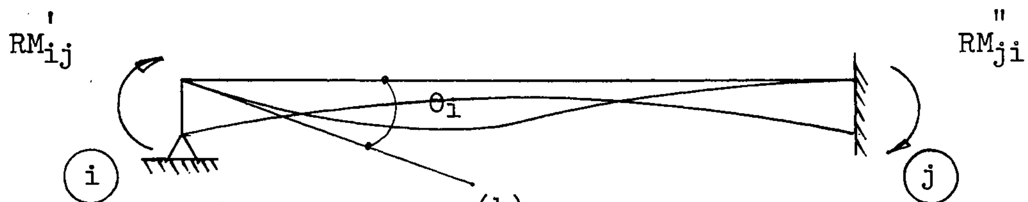
$$RM_{ij} = RM'_{ij} + RM''_{ij}$$

$$RM_{ji} = RM'_{ji} + RM''_{ji} \quad , \qquad (1a)$$



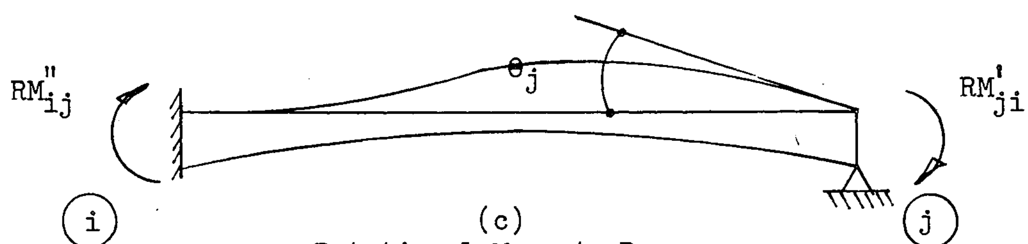
(a)
Fixed End Moments

Due to Loads



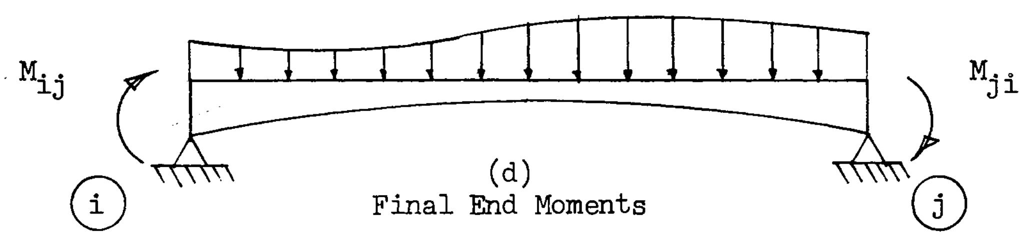
(b)
Rotational Moments Due

to Rotation of End i



(c)
Rotational Moments Due

to Rotation of End j



(d)
Final End Moments

Fig. 1

END MOMENTS ON BAR $\overline{ij}$

re

$$RM'_{ij} = K_{ij}\,\theta_i \qquad (1b)$$

$$RM'_{ji} = K_{ji}\,\theta_j$$

$$RM''_{ij} = C_{ji}\,K_{ji}\,\theta_j = C_{ji}\,RM'_{ji} \qquad (1c)$$

$$RM''_{ji} = C_{ij}\,K_{ij}\theta_i = C_{ij}\,RM'_{ij}\ .$$

From the equilibrium of moments at joint j

$$\Sigma M_j = \Sigma RM'_j + \Sigma RM''_j + \Sigma FM^L_j = 0\ , \qquad (2)$$

ere

ΣM_j = summation of all end moments at joint j.

lving Eq.(2) for the sum of the rotational moments at joint j due to tation of joint j

$$\Sigma RM'_j = -(\Sigma RM''_j + \Sigma FM^L_j)$$

$$(3)$$

$$\Sigma K_j\,\theta_j = -\,(\Sigma RM''_j + \Sigma FM^L_j)\ .$$

om this

$$\theta_j = -\frac{1}{\Sigma K_j}\,(\Sigma RM''_j + \Sigma FM^L_j)\ . \qquad (3a)$$

stituting into Eq.(1b), the rotational moment becomes

$$RM'_{ji} = -\frac{K_{ji}}{\Sigma K_j} (\Sigma RM''_j + \Sigma FM^L_j) \quad . \qquad (4)$$

oting

$$D_{ji} = \frac{K_{ji}}{\Sigma K_j} \quad \text{, distribution factor,} \qquad (4a)$$

rotational moment becomes

$$RM'_{ji} = - D_{ji} (\Sigma RM''_j + \Sigma FM^L_j) \qquad (4b)$$

$$RM'_{ji} = - D_{ji} (\Sigma C_{ij} RM'_{ij} + \Sigma FM^L_j) \quad , \qquad (4c)$$

re $\Sigma C_{ij} RM'_{ij}$ includes the effect of rotation of the far ends of all bers framing into joint j.

Joint Translation Permitted

If the ends of bar $\overline{ij}$ are allowed to undergo translation normal to bar axis, one additional contribution to the final end moment must considered (Fig.2)

(d) Fixed End Moments Due to Joint Translation.

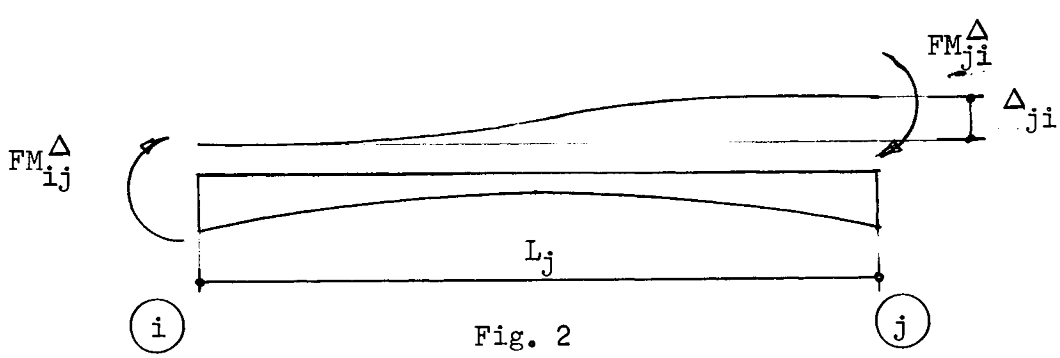


Fig. 2

FIXED END MOMENTS DUE

TO RELATIVE JOINT TRANSLATION.

ı the general slope deflection equations, the fixed end moments due ·elative translation of the ends are

$$FM^{\Delta}_{ij} = S_{ij} \frac{\Delta ji}{L_j} = K_{ij} (1 + C_{ij}) \frac{\Delta ji}{L_j}$$
$$FM^{\Delta}_{ji} = S_{ji} \frac{\Delta ji}{L_j} = K_{ji}(1 + C_{ji}) \frac{\Delta ji}{L_j} \quad . \qquad (5)$$

;, the final end moments become

$$M_{ij} = RM'_{ij} + RM''_{ij} + FM^{L}_{ij} + FM^{\Delta}_{ij}$$
$$M_{ji} = RM'_{ji} + RM''_{ji} + FM^{L}_{ji} + FM^{\Delta}_{ji} \qquad (6)$$

n the equilibrium of moments at joint j

$$\Sigma M_j = \Sigma RM'_j + \Sigma RM''_j + \Sigma FM^{L}_j + \Sigma FM^{\Delta}_j = 0 \ , \qquad (7)$$

solving for the sum of the rotational moments due to θ_j

$$\Sigma RM_j = - (\Sigma RM''_j + \Sigma FM^{L}_j + \Sigma FM^{\Delta}_j) \ . \qquad (7a)$$

rotational moment on member $\overline{ij}$ at end j due to θ_j is

$$RM_{ji} = -D_{ji} (\Sigma RM''_j + \Sigma FM^{L}_j + \Sigma FM^{\Delta}_j) \ , \qquad (8)$$

re

$$D_{ji} = \frac{K_{ji}}{\Sigma K_j} \ ,$$

is the same as in Eq. (4).

In order to completely satisfy equilibrium of the structure, the ar must be balanced at each story level. A section of a multistory lding frame is considered (Fig. 3). The shear at the top of a typical umn $\overline{jk}$ due to the end moments is

$$H_{jk} = - \frac{M_{jk} + M_{kj}}{h_{jk}} \quad . \qquad (9)$$

, the total column shear at a typical story is

$$\Sigma H_{jk} = -\Sigma \frac{M_{jk} + M_{kj}}{h_{jk}} \quad , \tag{10}$$

e the summation includes all columns of the story.

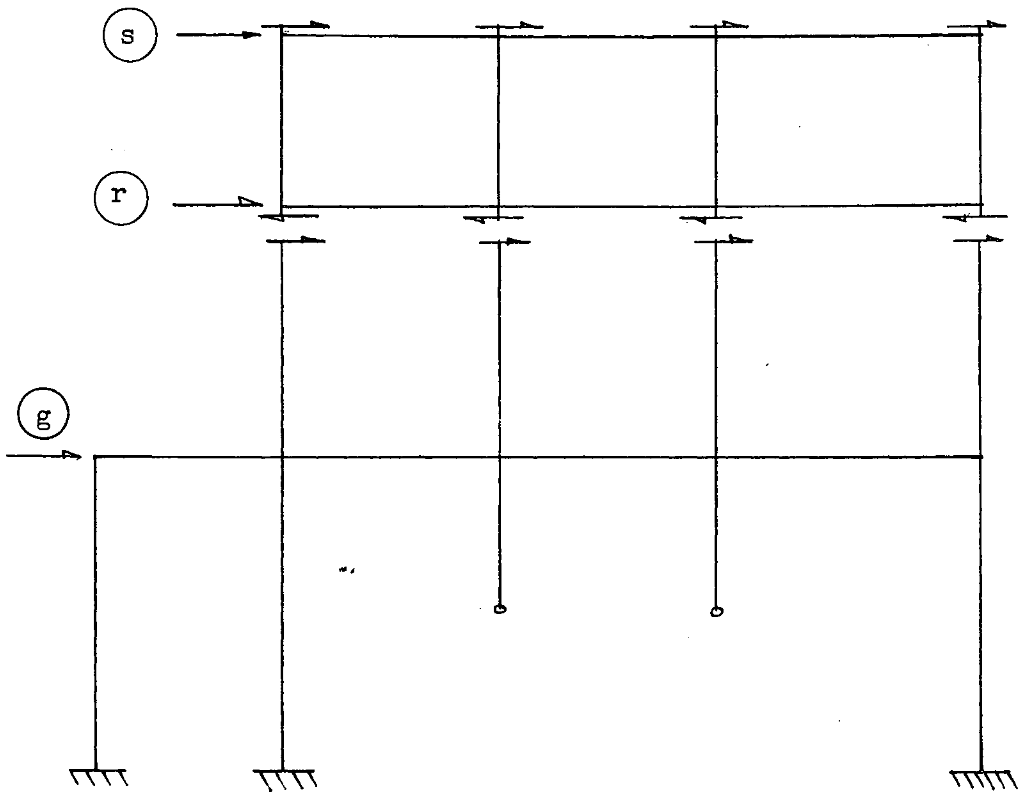


Fig. 3

SECTION OF A BUILDING FRAME

m the condition of horizontal shear equilibrium at any story r

$$\Sigma V_r = \Sigma H_{jk} \quad , \tag{11}$$

re

ΣV_r = total shear at story r.

anding Eq. 10

$$\Sigma H_{jk} = -\Sigma \frac{1}{h_{jk}} \left[RM'_{jk} + RM''_{jk} + FM^{L}_{jk} + FM^{\Delta}_{jk} + RM'_{kj} + RM''_{kj} + FM^{L}_{kj} + FM^{\Delta}_{kj} \right] \tag{12}$$

$$h_r \Sigma H_{jk} = -\Sigma \frac{h_r}{h_{jk}} \left[(1 + C_{jk}) RM'_{jk} + (1 + C_{kj}) RM'_{kj} + FM^{L}_{jk} + FM^{L}_{kj} + \frac{(S_{jk} + S_{kj})}{h_{jk}} \Delta_{jk} \right] \tag{12a}$$

ere

h_r = any convenient column height.

noting

$$B_{jk} = \frac{h_r}{h_{jk}} (1 + C_{jk})$$

$$B_{kj} = \frac{h_r}{h_{jk}} (1 + C_{kj}) \quad ,$$

d solving Eq. (12a) for the relative translation

$$\Delta_{jk} = - \frac{\left[h_r \Sigma V_r + \Sigma B_{jk} RM'_{jk} + \Sigma B_{kj} RM'_{kj} + \Sigma (FM^{L}_{jk} + FM^{L}_{kj}) \right]}{\Sigma \frac{h_r}{h_{jk}} \quad \frac{S_{jk} + S_{kj}}{h_{jk}}} \tag{13}$$

bstituting into Eq's. (5), fixed end moments due to translation becom

$$FM^{\Delta}_{jk} = - D'_{jk} \left[h_r \Sigma V_r + \Sigma B_{jk} RM'_{jk} + \Sigma B_{kj} RM'_{kj} + \Sigma (FM^{L}_{jk} + FM^{L}_{kj}) \right]$$

$$FM^{\Delta}_{kj} = - D'_{kj} \left[h_r \Sigma V_r + \Sigma B_{jk} RM'_{jk} + \Sigma B_{kj} RM'_{kj} + \Sigma (FM^{L}_{jk} + FM^{L}_{kj}) \right], \tag{14}$$

re

$$D'_{jk} = \frac{\frac{S_{jk}}{h_{jk}}}{\Sigma \frac{h_r}{h_{jk}} \frac{S_{jk} + S_{kj}}{h_{jk}}} \qquad (15)$$

$$D'_{kj} = \frac{\frac{S_{kj}}{h_{jk}}}{\Sigma \frac{h_r}{h_{jk}} \frac{S_{jk} + S_{kj}}{h_{jk}}} ,$$

l are called translation distribution factors, and

$h_r \, \Sigma V_r$ is denoted as the shear moment.

PART III

COMPARATIVE EXAMPLE

-1 General

A three-story building frame is considered (Fig. 4). All embers are of constant cross-section, and the relative stiffnesses re indicated on the members. There is no restraint against sidesway, nd the structure is loaded by a uniformly distributed wind load.

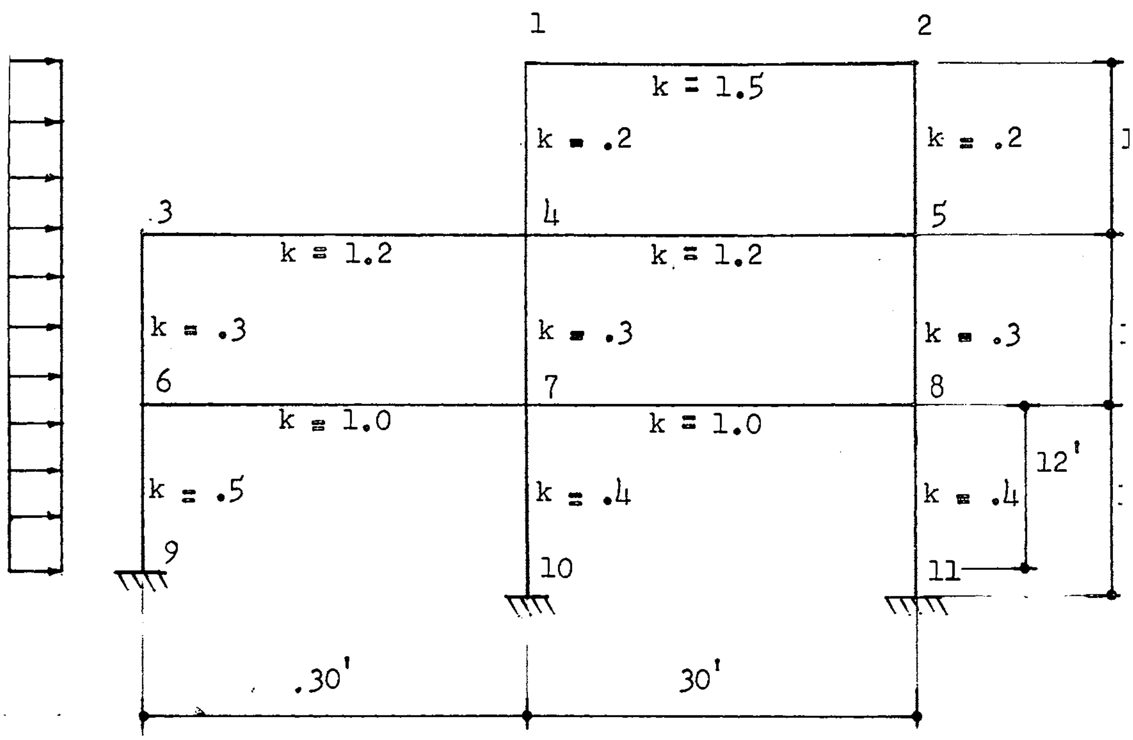


Fig.4

THREE-STORY BUILDING FRAME

This structure is analyzed by

(a) Kani's Method

(b) Moment Distribution

(c) Carry-over Joint Moments.

procedures and results of these methods are compared and discussed.

Kani's Method

The structure in Fig. 3 is analyzed by the method described in ; II of this report.

The necessary constants are evaluated using the appropriate ations from Part II. These constants are tabulated in Table 1 . ;e the members are of constant cross-section, all carry-over factors

$C = + .500.$

arbitrary height dimension is chosen as

$h_r = 12'$

all stories.

For the calculation of shear forces, generally, any kind of load can be replaced by an equivalent concentrated force which is applied the joints. This equivalent concentrated force is equal to the end ction of a simply supported bar with a similar loading. Therefore, i s frame, the equivalent concentrated forces are

BLE 1 CONSTANTS

STA.	D	D'	FM(L)
12	.882	.000	0.0
14	.118	.250	12.0
21	.882	.000	0.0
25	.118	.250	0.0
34	.800	.000	0.0
36	.200	.167	12.0
41	.068	.250	-12.0
43	.414	.000	0.0
45	.414	.000	0.0
47	.104	.167	0.0
52	.118	.250	0.0
54	.706	.000	0.0
58	.176	.167	0.0
63	.167	.167	-12.0
67	.555	.000	0.0
69	.278	.247	12.0
74	.112	.167	0.0
76	.370	.000	0.0
78	.370	.000	0.0
710	.148	.158	0.0
85	.176	.167	0.0
87	.588	.000	0.0
811	.236	.158	0.0
96	.000	.247	-12.0
107	.000	.158	0.0
118	.000	.158	0.0

$$P_I = \frac{(12)1}{2} = 6\ k \qquad \text{(upper story)}$$

$$P_{II} = \frac{(12+12)1}{2} = 12\ k \qquad \text{(middle story)}$$

$$P_{III} = \frac{(12+12)1}{2} = 12\ k\ , \qquad \text{(lower story)}$$

the shear moments are

$$M_I = (12)\ (6) = 72\ \text{k-ft}$$

$$M_{II} = (12)\ (6+12) = 216\ \text{k-ft}$$

$$M_{III} = (12)(6+12+12) = 360\ \text{k-ft.}$$

e moments are written on the left side of the corresponding story, the constants from Table 1 are entered in the appropriate places ›le 2).

The method of analysis is an iteration procedure which is re- ed until the desired degree of accuracy is obtained. One cycle of ation consists of the solution of Eq.(13a) for the sidesway effect, owed by iteration of Eq.(8) from joint to joint in an arbitrary ence. The sequence chosen is in order of Joints 1, 2, 5, 4, 3, 6, 7,

The calculation is started with the determination of FM_{14}^{Δ} and . Since there are, as yet, no approximate values for the rotational ributions, the sums consist only of the corresponding shear moments. fixed end moments due to load are eliminated, because in the case of tant cross-section and uniform loading, the term

$$\Sigma\ (FM_{jk}^{L} + FM_{kj}^{L}) = 0.$$

$$FM_{14}^{\Delta} = FM_{14}^{\Delta} = -.25(+72+0+0) = -18.00 .$$

same procedure is used in the middle and the lower story columns, and results are tabulated in Table 2 . Now, the rotational contributions calculated at Joint (1)

$$RM'_{12} = -.882 (+12.00+0+0-18.00) = -13.58$$

$$RM'_{14} = -.118(+12.00+0+0-18.00) = -1.81 .$$

general procedure is repeated until the desired results are obtained.

The iteration is interrupted after the fifth cycle in Table 2 , iteration of the last cycle, for clarity, is shown in Table 3 .

he upper story,

$$FM_{14}^{\Delta} = -.25 \left[72 + \frac{3}{2} (+.01+4.12+2.30+6.22)\right] = + 22.74.$$

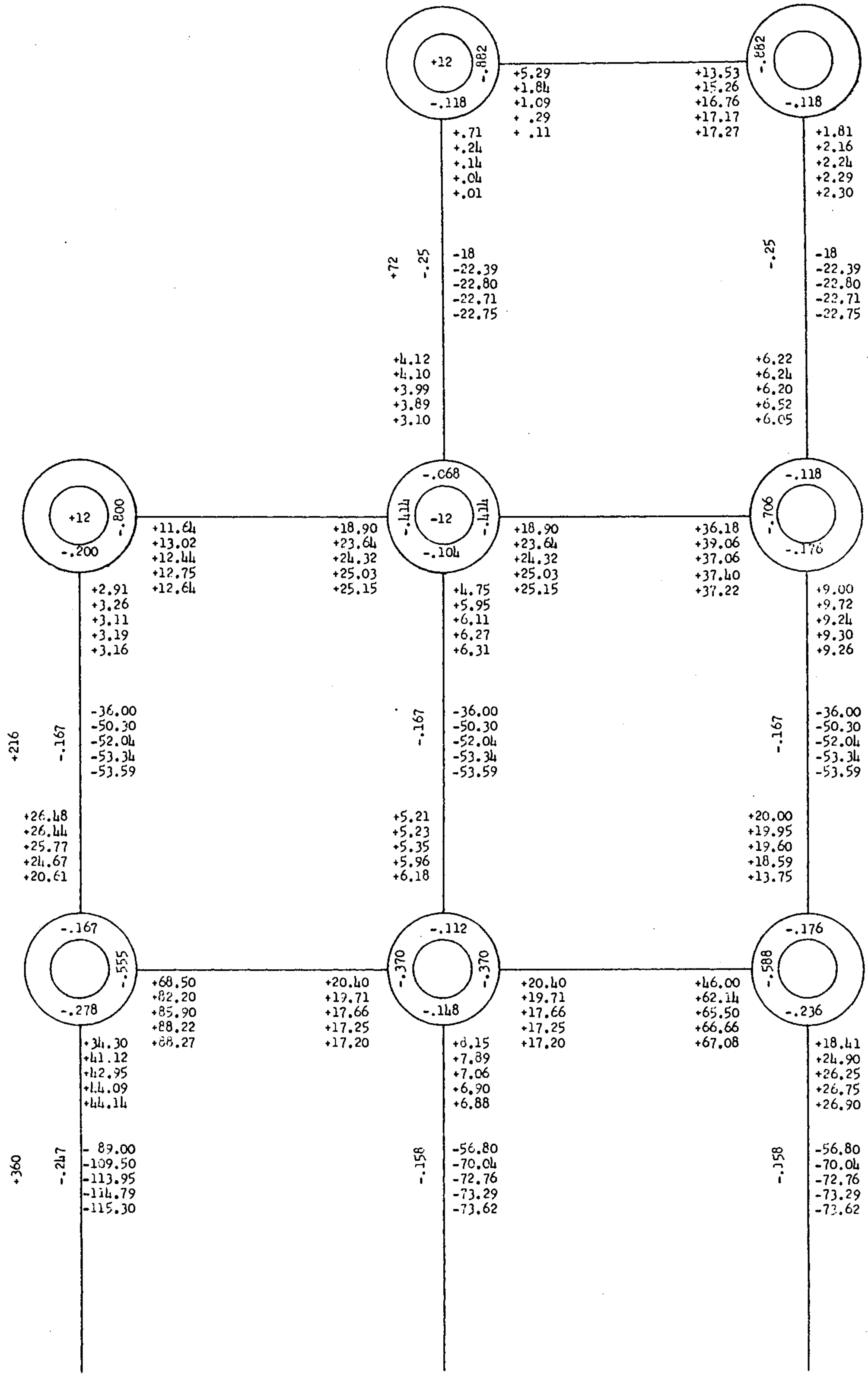
oint (1).

$$RM'_{12} = -.882 (+12.00 + \frac{17.27}{2} + \frac{4.12}{2} - 22.74) = + .04$$

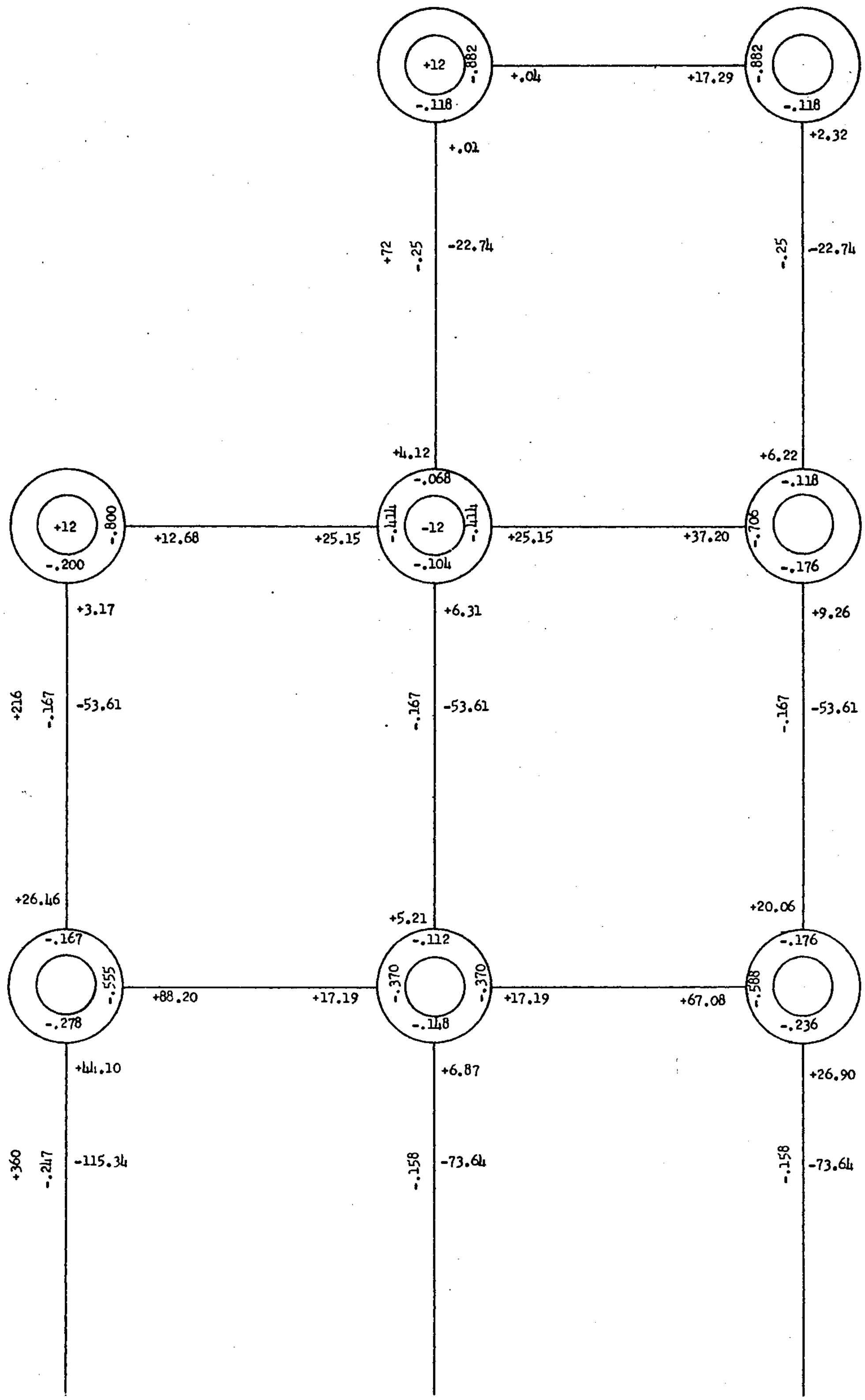
$$RM'_{14} = - .118(+12.00 + \frac{17.27}{2} + \frac{4.12}{2} - 22.74) = + .01.$$

mparison between the last two cycles indicates that the desired degre accuracy is obtained; therefore, the operation is ended, and the final nts are tabulated (Table 4).

LE 2 KANI'S DISTRIBUTION



3LE 3 KANI'S DISTRIBUTION



.BLE 4 FINAL END MOMENTS

	RM'	RM''	FM^L	FM^Δ	M
	.04	8.645	.00	.00	8.68
	.01	2.06	12.00	- 22.74	- 8.67
	17.29	.02	.00	.00	17.31
	2.32	3.11	.00	- 22.74	-17.31
	12.68	12.575	.00	.00	25.25
	3.17	13.23	12.00	- 53.61	-25.21
	4.12	.005	-12.00	- 22.74	-30.62
	25.15	6.34	.00	.00	+31.49
	25.15	18.60	.00	.00	+43.75
	6.31	2.605	.00	- 53.61	-44.70
	6.22	1.16	.00	- 22.74	-15.36
	37.20	12.575	.00	.00	+49.77
	9.26	10.03	.00	- 53.61	-34.32
	26.46	1.585	-12.00	- 53.61	-37.57
	88.20	8.595	.00	.00	+96.80
	44.10	.00	-12.00	-115.34	-59.24
	5.21	3.155	.00	- 53.61	-45.25
	17.19	44.10	.00	.00	+61.29
	17.19	33.54	.00	.00	+50.73
	6.87	.00	.00	.00	-66.77
	20.06	4.63	.00	- 53.61	-28.92
	67.08	8.595	.00	.00	+75.68
	26.90	.00	.00	- 73.64	-46.74
	.00	22.05	-12.00	-115.34	-105.29
	.00	3.4305	.00	- 73.64	- 70.21
	.00	13.45	.00	- 73.64	- 60.19

Moment Distribution Method

Since the elastic constants and the condition of loading is the e as for Kani's Method, the tabulation of the distribution factors, ry-over factors, and fixed end moments due to wind load are not re- ted.

The fixed end moment due to translation, in general form, is

$$FM^{\Delta}_{jk} = \frac{6EI}{h_{jk}} \frac{\Delta_r}{h_{jk}} = 1.5\ K_{jk} \frac{\Delta_r}{h_{jk}} .$$

s, the fixed end moments, in terms of X_1, X_2, X_3, are

$$FM^{\Delta}_{14} = FM^{\Delta}_{41} = FM^{\Delta}_{25} = FM^{\Delta}_{52} = -.025\Delta_1 = -100\ X_1$$

$$FM^{\Delta}_{14} = FM^{\Delta}_{41} = FM^{\Delta}_{25} = FM^{\Delta}_{52} = +.025\Delta_2 = +100\ X_2$$

$$FM^{\Delta}_{36} = FM^{\Delta}_{63} = FM^{\Delta}_{47} = FM^{\Delta}_{74} = FM^{\Delta}_{58} = FM^{\Delta}_{85} = -.0375\Delta_2 = -150\ X_2$$

$$FM^{\Delta}_{36} = FM^{\Delta}_{63} = FM^{\Delta}_{47} = FM^{\Delta}_{74} = FM^{\Delta}_{58} = FM^{\Delta}_{85} = +.0375\ \Delta_3 = +150\ X_3$$

$$FM^{\Delta}_{69} = FM^{\Delta}_{96} = -.0625\ \Delta_3 = -250\ X_3$$

$$FM^{\Delta}_{710} = FM^{\Delta}_{107} = FM^{\Delta}_{811} = FM^{\Delta}_{118} = -.050\ \Delta_3 = -160\ X_3$$

Since the horizontal forces in any story are in equilibrium, three ›ar equations are written

$$\overrightarrow{V_{14}} + \overrightarrow{V_{25}} = 0$$

$$\overrightarrow{V_{36}} + \overrightarrow{V_{47}} + \overrightarrow{V_{58}} + 12 = 0$$

$$\overrightarrow{V_{69}} + \overrightarrow{V_{710}} + \overrightarrow{V_{811}} + 24 = 0 .$$

TABLE 5 DISTRIBUTION OF WIND LOAD MOMENTS

STA.	14	12	21	25
-D's	-.118	-.882	-.882	-.118
C's	↓ .5	.5 →	← .5	.5 ↓
FM's	+12.00	0.00	0.00	0.00
	- 1.41	-10.59	0.00	0.00
	+ 0.41	0.00	-5.30	0.00
	- 0.05	- 0.36	+4.68	+0.62
	+ 0.19	+ 2.34	-0.18	-0.15
	- 0.30	- 2.24	+0.29	+0.04
	+ 0.06	+ 0.15	-1.12	-0.08
	- 0.02	- 0.19	+1.06	+0.14
	+ 0.04	+ 0.53	-0.09	-0.02
	- 0.07	- 0.50	+0.10	+0.01
M's	+10.86	-10.86	-0.56	+0.56

STA.	36	34	43	47	41	45	54	52	58
-D's	-.200	-.800	-.414	-.104	-.068	-.414	-.706	-.118	-.176
C's	↓ .5	.5 →	← .5	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	↓ .5
FM's	+12.00	.00	.00	.00	-12.00	.00	.00	.00	.00
	- 2.40	-9.60	+4.96	+1.25	+ 0.82	+ 4.96	0.00	0.00	0.00
	0.00	+2.48	-4.80	0.00	- 0.70	0.00	+2.48	0.00	0.00
	- 0.49	-1.99	+2.28	+0.57	+ 0.37	+ 2.28	-1.75	-0.29	-0.44
	+ 0.10	+1.14	-1.00	-0.03	- 0.02	- 0.87	+1.14	+0.31	0.00
	- 0.25	-0.99	+0.80	+0.20	+ 0.13	+ 0.80	-1.03	-0.17	-0.25
	+ 0.03	+0.40	-0.50	-0.03	- 0.15	- 0.51	+0.40	+0.02	+0.03
	- 0.09	-0.34	+0.49	+0.12	+ 0.08	+ 0.49	-0.32	-0.05	-0.08
	+ 0.02	+0.24	-0.17	-0.01	- 0.01	- 0.16	+0.24	+0.07	+0.02
	- 0.05	-0.21	+0.14	+0.04	+ 0.02	+ 0.14	-0.23	-0.04	-0.06
M's	+ 8.87	-8.87	+2.20	+2.11	-11.46	+ 7.14	+0.93	-0.15	-0.78

STA.	69	63	67	76	74	710	78	87	811	85
-D's	-.278	-.167	-.555	-.370	-.112	-.148	-.370	-.588	-.236	-.176
C's	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	↓ .5	.5 →	← .5	.5 ↓	↑ .5
FM's	+12.00	-12.00	.00	.00	.00	.00	.00	.00	.00	.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	- 1.20	0.00	0.00	+0.62	0.00	0.00	0.00	0.00	0.00
	+ 0.33	+ 0.20	+0.67	-0.23	-0.07	- 0.09	-0.23	0.00	0.00	0.00
	0.00	- 0.25	-0.12	+0.33	+0.28	0.00	0.00	-0.12	0.00	-0.22
	+ 0.10	+ 0.06	+0.21	-0.23	-0.07	- 0.09	-0.23	+0.19	+0.09	+0.06
	0.00	- 0.12	-0.11	+0.10	+0.10	0.00	+0.10	-0.11	0.00	-0.12
	+ 0.06	+ 0.04	+0.12	-0.11	-0.03	- 0.04	-0.11	+0.13	+0.06	+0.04
	0.00	- 0.04	-0.05	+0.06	+0.06	0.00	+0.06	-0.05	0.00	-0.04
	+ 0.03	+ 0.01	+0.05	-0.06	-0.02	- 0.03	-0.06	+0.06	+0.03	+0.01
M's	+12.52	-13.30	+0.77	-0.14	+0.87	- 0.25	-0.47	+0.10	+0.18	-0.29

STA.	96	107	118
FM's	-12.00	.00	.00
	+ 0.26	- 0.12	+0.09
M's	-11.74	- 0.12	+0.09

TABLE 6 DISTRIBUTION OF MOMENTS DUE TO Δ_1

STA.	14	12	21	25
-D's	-.118	-.882	-.882	-.118
C's	↓ .5	.5 →	← .5	.5 ↓
FM's	-100.0	0.0	0.0	-100.0
	+ 11.8	+88.2	+88.2	+ 11.8
	+ 3.3	+44.1	+44.1	+ 5.9
	- 5.6	-41.8	-44.1	- 5.9
	- 1.4	-22.0	-20.9	- 1.5
	+ 2.7	+20.7	+19.8	+ 2.6
	+ 0.7	+ 9.9	+10.3	+ 0.7
	- 1.2	- 9.4	- 9.7	- 1.3
	- 0.3	- 4.8	- 4.7	- 0.3
	+ 0.6	+ 4.5	+ 4.4	+ 0.6
M's	- 89.4	+89.4	+87.4	- 87.4

STA.	36	34	43	47	41	45	54	52	58
-D's	-.200	-.800	-.414	-.104	-.068	-.414	-.706	-.118	-.176
C's	↓ .5	.5 →	← .5	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	↓ .5
FM's	0.0	0.0	0.0	0.0	-100.0	0.0	0.0	-100.0	0.0
	0.0	0.0	+41.4	+10.4	+ 6.7	+41.4	+70.6	+ 11.8	+17.6
	0.0	+20.7	0.0	0.0	+ 5.9	+35.3	+20.7	+ 5.9	0.0
	-4.1	-16.6	-17.0	- 4.3	- 2.8	-17.0	-18.8	- 3.1	- 4.7
	0.0	- 8.5	- 8.3	- 0.3	- 2.8	- 9.4	- 8.5	- 3.0	- 0.7
	+1.7	+ 6.8	+ 8.6	+ 2.2	+ 1.4	+ 8.6	+ 8.6	+ 1.4	+ 2.1
	+0.2	+ 4.3	+ 3.4	+ 0.2	+ 1.3	- 4.3	+ 4.3	+ 1.3	+ 0.2
	-0.9	- 3.6	- 3.8	- 1.0	- 0.6	- 3.8	- 4.1	- 0.7	- 1.0
	-0.1	- 1.9	- 1.8	- 0.1	- 0.6	- 2.0	- 1.9	- 0.6	- 0.1
	+0.4	+ 1.6	+ 1.9	+ 0.5	+ 0.3	+ 1.9	+ 1.8	+ 0.3	+ 0.5
M's	-2.8	+ 2.8	+24.4	+ 7.6	- 91.2	+59.3	+72.7	- 86.7	+13.9

STA.	69	63	67	76	74	710	78	87	811	85
-D's	-.278	-.167	-.555	-.370	-.112	-.148	-.370	-.588	-.236	-.176
C's	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	↓ .5	.5 →	← .5	.5 ↓	↑ .5
FM's	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	+ 5.2	0.0	0.0	0.0	0.0	+ 8.8
	0.0	0.0	0.0	- 1.9	- 0.6	- 0.8	- 1.9	- 5.2	- 2.1	- 1.5
	0.0	-2.0	- 0.9	0.0	- 2.2	0.0	- 2.6	- 0.9	0.0	- 2.3
	+0.8	+0.5	+ 1.6	+ 1.8	+ 0.5	+ 0.7	+ 1.8	+ 1.8	+ 0.7	+ 0.5
	0.0	+0.8	+ 0.9	+ 0.8	+ 1.1	0.0	+ 0.9	+ 0.9	0.0	+ 1.0
	-0.5	-0.3	- 0.9	- 1.0	- 0.3	- 0.4	- 1.0	- 1.1	- 0.5	- 0.3
	0.0	-0.4	- 0.5	- 0.4	- 0.5	0.0	- 0.5	- 0.5	0.0	- 0.5
	+0.3	+0.1	+ 0.5	+ 0.5	+ 0.1	+ 0.2	+ 0.5	+ 0.6	+ 0.2	+ 0.2
M's	+0.6	-1.3	+ 0.7	- 0.2	+ 3.3	- 0.3	- 2.8	- 4.4	- 1.7	+ 6.0

STA.	96	107	118
FM's	0.0	0.0	0.0
	+0.3	- 0.1	- 0.8
	+0.3	- 0.1	- 0.8

TABLE 7 DISTRIBUTION OF MOMENTS DUE TO Δ_2

STA.	14	12	21	25
-D's	-.118	-.882	-.882	-.118
C's	↓ .5	.5 →	← .5	.5 ↓
FM's	+100.0	0.0	0.0	+100.0
	- 11.8	-88.2	-88.2	- 11.8
	+ 1.6	-44.1	-44.1	+ 2.9
	+ 5.0	+37.5	+36.7	+ 4.8
	- 2.7	+18.2	+18.7	- 1.0
	- 1.8	-13.7	-15.6	- 2.1
	+ 0.6	- 7.8	- 6.8	+ 1.0
	+ 0.8	+ 6.4	+ 5.1	+ 0.7
	- 0.5	+ 2.5	+ 3.2	- 0.2
	- 0.4	- 1.6	- 2.6	- 0.4
M's	+ 90.8	-90.8	-93.9	+ 93.9

STA.	36	34	43	47	41	45	54	52	58
-D's	-.200	-.800	-.414	-.104	-.068	-.414	-.706	-.118	-.176
C's	↓ .5	.5 →	← .5	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	.5 ↓
FM's	-150.0	0.0	0.0	-150.0	+100.0	0.0	0.0	+100.0	- 150.0
	+ 30.0	+120.0	+20.7	+ 5.2	+ 3.3	+20.7	+35.3	+ 5.9	+ 8.8
	+ 12.5	+ 10.3	+60.0	+ 8.3	- 5.9	+17.7	+10.3	- 5.9	+ 13.2
	- 4.5	- 18.3	-33.2	- 8.3	- 5.4	-33.2	-12.4	- 2.1	- 3.1
	- 3.5	- 16.6	- 9.1	- 4.9	+ 2.5	- 6.2	-16.6	+ 2.4	- 2.8
	+ 4.0	+ 16.1	+ 7.3	+ 1.9	+ 1.2	+ 7.3	+12.0	+ 2.0	+ 3.0
	+ 1.5	+ 3.7	+ 8.0	+ 1.4	- 0.9	+ 6.0	+ 3.6	- 1.0	+ 1.5
	- 2.0	- 4.2	- 6.0	- 1.5	- 1.0	- 6.0	- 2.9	- 0.5	- 0.7
	- 0.5	- 3.0	- 2.1	- 0.6	+ 0.4	- 1.5	- 3.0	+ 0.3	- 0.5
	+ 0.7	+ 2.8	+ 1.6	+ 0.4	+ 0.2	+ 1.6	+ 2.9	+ 0.4	+ 0.6
M's	-110.8	+110.8	+47.2	-148.1	+ 94.4	+ 6.4	+2[illegible].5	+101.5	- 130.0

STA.	69	63	67	76	74	710	78	87	811	85
-D's	-.278	-.167	-.555	-.370	-.112	-.148	-.370	-.588	-.236	-.176
C's	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	↓ .5	.5 →	← .5	.5 ↓	↑ .5
FM's	0.0	-150.0	0.0	0.0	-150.0	0.0	0.0	0.0	0.0	- 150.0
	+41.7	+ 25.0	+ 83.3	+55.5	+ 16.6	+ 22.2	+55.5	-88.2	+ 35.4	+ 26.4
	0.0	+ 15.0	+ 27.7	+41.7	+ 2.6	0.0	-44.1	+27.7	0.0	+ 4.[illegible]
	-11.9	- 7.1	- 23.7	-32.7	- 9.8	- 13.1	-32.7	-18.9	- 7.6	- 5.[illegible]
	0.0	- 2.2	- 16.3	-11.8	- 4.1	0.0	- 4.4	-16.3	0.0	- 1.[illegible]
	+ 5.2	+ 3.1	+ 10.2	+ 9.4	+ 2.8	+ 3.7	+ 9.4	+10.4	+ 4.2	+ 3.[illegible]
	0.0	+ 2.0	+ 4.7	+ 5.1	+ 1.0	0.0	+ 5.2	+ 4.7	0.0	+ 1.[illegible]
	-1.9	- 1.1	- 3.7	- 4.2	- 1.2	- 1.7	- 4.2	- 3.6	- 1.5	- 1.[illegible]
	0.0	- 0.5	- 2.1	- 1.8	- 0.7	0.0	- 1.8	- 2.1	0.0	- 0.[illegible]
	+ 0.7	+ 0.4	+ 1.4	+ 1.6	+ 0.5	+ 0.6	+ 1.6	+ 1.4	+ 0.6	+ 0.[illegible]
M's	+33.8	-115.4	+ 91.5	+62.8	-142.3	+ 11.7	+67.7	+91.5	+ 31.1	- 122.[illegible]

STA.	96	107	118
FM's	0.0	0.0	0.0
	+16.9	+ 5.8	+ 15.5
	+16.9	+ 5.8	+ 15.5

TABLE 8

DISTRIBUTION OF MOMENTS DUE TO Δ_3

STA.	14	12	21	25
-D's	-.118	-.882	-.882	-.118
C's	↓ .5	.5 →	← .5	.5 ↓
FM's	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0
	- 5.0	0.0	0.0	- 8.8
	+ 0.6	+ 4.4	+ 7.8	+ 1.0
	+ 3.7	+ 3.9	+ 2.2	+ 1.7
	- 0.9	- 6.7	- 3.4	- 0.5
	- 0.6	- 1.7	- 3.3	- 1.4
	+ 0.3	+ 2.0	+ 4.2	+ 0.5
	+ 0.6	+ 2.1	+ 1.0	+ 0.2
	- 0.3	- 2.4	- 1.1	- 0.1
	- 1.6	+ 1.6	+ 7.4	- 7.4

STA.	36	34	43	47	41	45	54	52	58
-D's	-.200	-.800	-.414	-.104	-.068	-.414	-.706	-.118	-.176
C's	↓ .5	.5 →	← .5	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	.5 ↓
FM's	+150.0	0.0	0.0	+150.0	0.0	0.0	0.0	0.0	+150.0
	- 30.0	-120.0	-62.1	- 15.6	- 10.1	-62.1	-105.9	- 17.7	- 26.4
	+ 8.3	- 31.0	-60.0	+ 0.5	0.0	-52.9	- 31.0	0.0	+ 0.9
	+ 4.5	+ 18.2	+46.6	+ 11.7	+ 7.5	+46.6	+ 21.3	+ 3.5	+ 5.3
	+ 1.1	+ 23.3	+ 9.1	- 1.2	+ 0.3	+10.7	+ 23.3	+ 0.5	+ 1.0
	- 4.9	- 19.5	- 7.8	- 2.0	- 1.2	- 7.8	- 17.5	- 2.9	- 4.4
	+ 0.1	- 3.9	- 9.7	- 0.7	- 0.4	- 8.7	- 3.9	- 0.2	+ 0.1
	+ 0.8	+ 3.0	+ 8.1	+ 2.0	+ 1.3	+ 8.1	+ 2.8	+ 0.5	+ 0.7
	+ 0.4	+ 4.0	+ 1.5	0.0	+ 1.0	+ 1.9	+ 4.0	+ 0.2	+ 0.4
	- 0.9	- 3.5	- 1.8	- 0.5	- 0.3	- 1.8	- 3.2	- 0.5	- 0.8
M's	+127.4	-129.4	-76.1	+144.2	- 1.9	-66.0	-110.1	- 16.6	+126.8

STA.	69	63	67	76	74	710	78	87	811	85
-D's	-.278	-.167	-.555	-.370	-.112	-.148	-.370	-.588	-.236	-.176
C's	.5 ↓	↑ .5	.5 →	← .5	.5 ↑	↓ .5	.5 →	← .5	.5 ↓	↑ .5
FM's	-250.0	+150.0	0.0	0.0	+150.0	-160.0	0.0	0.0	-160.0	+150.0
	- 27.8	+ 16.7	+ 55.5	+ 3.7	+ 1.1	+ 1.5	+ 3.7	+ 5.9	+ 2.3	+ 1.8
	0.0	- 15.0	+ 1.8	+27.7	- 7.8	0.0	+ 2.9	+ 1.8	0.0	- 13.2
	+ 3.7	+ 2.2	+ 7.3	- 8.4	- 2.5	- 3.4	- 8.4	+ 6.7	+ 2.7	+ 2.0
	0.0	+ 2.2	- 4.2	+ 3.6	+ 5.8	0.0	+ 3.3	- 4.2	0.0	+ 2.6
	+ 0.6	+ 0.3	+ 1.1	- 4.7	- 1.4	- 1.9	- 4.7	+ 0.9	+ 0.4	+ 0.3
	0.0	- 2.4	- 2.3	+ 0.5	- 1.0	0.0	+ 0.4	- 2.3	0.0	- 2.2
	+ 1.3	+ 0.8	+ 2.6	0.0	0.0	0.0	0.0	+ 2.7	+ 1.0	+ 0.8
	0.0	+ 0.4	0.0	+ 1.3	+ 1.0	0.0	+ 1.3	0.0	0.0	+ 0.3
	- 0.1	- 0.1	- 0.2	- 1.3	- 0.4	- 0.5	- 1.3	- 0.2	- 0.1	0.0
M's	-216.7	+155.1	+ 61.6	+22.4	+144.8	-164.3	- 2.8	+ 11.3	-153.7	+ 142.4

STA.	96	107	118
FM's	-250	-160.0	-160.0
	+ 16.6	- 2.1	+ 3.1
M's	-233.4	-162.1	-156.9

anding these shear equations, by using the results of Tables 5, 6, and 8, the following matrix equation is obtained:

$$\begin{bmatrix} +354.7 & -380.6 & +27.5 \\ +26.7 & -769.3 & +842.7 \\ +1.5 & -102.0 & +959.7 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} +71.79 \\ -213.42 \\ +360.70 \end{bmatrix}.$$

Solving the above matrix equation, the result is

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} +1.047 \\ +0.822 \\ +0.462 \end{bmatrix}.$$

ng these values, the final moments are obtained and tabulated in le 9.

TABLE 9 FINAL END MOMENTS

M_{12}		+89.4	- 90.8	+ 1.6	-10.86		X_1		+ 8.79
M_{14}		-89.4	+ 90.8	- 1.6	+10.86		X_2		- 8.79
M_{21}		+87.4	- 93.9	+ 7.4	- 0.56		X_3		+ 17.24
M_{25}		-87.4	+ 93.9	- 7.4	+ 0.56		1.0		- 17.24
M_{39}		+ 2.8	+110.8	-129.4	- 8.87				+ 25.10
M_{36}		- 2.8	-110.8	+129.4	+ 8.87				- 25.10
M_{41}		-91.2	+ 94.4	- 1.9	-11.46				- 30.36
M_{43}		+24.4	+ 47.2	- 76.1	+ 2.20				+ 31.19
M_{45}		+59.3	+ 6.4	- 66.0	+ 7.14				+ 43.92
M_{47}		+ 7.6	-148.1	+144.2	+ 2.11				- 44.95
M_{52}	=	-86.7	+101.5	- 16.6	- 0.15			=	- 15.19
M_{54}		+72.7	+ 28.6	-110.1	+ 0.93				+ 49.69
M_{58}		+13.9	-130.0	+126.8	- 0.78				- 34.52
M_{63}		- 1.3	-115.4	+155.1	-13.30				- 37.66
M_{67}		+ 0.7	+ 81.5	+ 61.6	+ 0.77				+ 96.93
M_{69}		+ 0.6	+ 33.8	-216.7	+12.52				- 59.25
M_{74}		+ 3.3	-142.3	+144.8	+ 0.87				- 45.46
M_{76}		- 0.2	+ 62.8	+ 22.4	- 0.14				+ 61.40
M_{78}		- 2.8	+ 67.7	- 2.8	- 0.47				+ 50.71
M_{710}		- 0.3	+ 11.7	-164.3	- 0.25				- 66.75
M_{85}		+ 6.0	-122.7	+142.4	- 0.29				- 28.85
M_{87}		- 4.4	+ 91.5	+ 11.3	+ 0.10				+ 75.99
M_{811}		- 1.7	+ 31.1	-153.7	+ 0.18				- 47.14
M_{96}		+ 0.3	+ 16.9	-233.4	-11.74				-105.53
M_{107}		- 0.1	+ 5.8	-162.1	- 0.12				- 70.46
M_{118}		- 0.8	+ 15.5	-156.9	+ 0.09				- 60.53

Carry-over Joint Moment Method

Since all necessary constants are tabulated in Sections 3-2 and , they are not repeated. Also, since all members are of constant ss-section, the joint carry-over factors are one-half of the corres- ling distribution factors.

In order to establish equilibrium of horizontal forces, the three ar equations are

$$\overrightarrow{V_{14}} + \overrightarrow{V_{25}} = 0$$

$$\overrightarrow{V_{36}} + \overrightarrow{V_{47}} + \overrightarrow{V_{58}} + 12 = 0$$

$$\overrightarrow{V_{69}} + \overrightarrow{V_{710}} + \overrightarrow{V_{811}} + 24 = 0.$$

anding these equations, by using the results of Tables 11, 13, 15, 17 , the following matrix equation is obtained:

$$\begin{bmatrix} +354.5 & -381.2 & +28.2 \\ +26.6 & -769.9 & +842.8 \\ +1.5 & -101.7 & +959.1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} +71.78 \\ -213.44 \\ +360.72 \end{bmatrix}.$$

results from solving this matrix equation are

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} +1.046 \\ +0.818 \\ +0.461 \end{bmatrix}.$$

ing these results, the final moments are obtained and tabulated in Tab

TABLE 10 CARRY-OVER OF MOMENTS DUE TO WIND LOAD

JOINT	1		2	
- C.O	14	12	21	25
	-.059 ↓	-.441 →	-.441 ←	-.059 ↓
m	- 12.00		0.00	
			+ 5.30 + 0.00 (+ 5.30)	
	- 2.34 - .60 (- 2.94)		+ 1.30 + .23 (+ 1.53)	
	- .67 - .10 (- .77)		+ .34 + .04 (+ .38)	
	- .17 - .02 (- .19)		+ .08 + .01 (+ .09)	
	- .02 + .00 (- .02)			
JM	-15.92		+ 7.30	

JOINT	3		4				5		
- C.O	36	34	43	47	41	45	54	52	58
	- .100 ↓	- .400 →	-.207 ←	- .052 ↓	- .034 ↑	- .207 →	- .353 ←	-.059 ↑	- .088 ↓
m	- 12.00		+ 12.00				0.00		
			+ 4.80 + 0.00 + 0.71 + 0.00 (+ 17.51)						
	- 0.10 - 3.62 (- 3.72)		+ 1.49 + 0.07 + 0.17 + 1.40 (+ 3.13)				- 3.62 - .32 + 0.00 (- 3.94)		
	-.05 - .65 (- .70)		+ .28 + .03 + .04 + .28 (+ .63)				- .65 - .09 - .05 (-.79)		
	-.01 - .13 (- .14)		+ .05 + .01 + .01 + .05 (+ .12)				- .13 - .02 - .01 (- .16)		
	0.00 - .02 (- .02)						- .02 + .00 + .00 (- .02)		
JM	- 16.58		+ 21.39				- 4.91		

JOINT	6			7				8		
- C.O	69	63	67	76	74	710	78	87	811	85
	- .139 ↓	-.083 ↑	- .278 →	- .185 ←	- .056 ↑	- .074 ↓	- .185 →	- .294 ←	- .118 ↓	- .088 ↑
m	0.00			0.00				0.00		
	0.00 + 1.20 + 0.00 (+ 1.20)							0.00 + 0.00 + 0.00 (0.00)		
	0.00 + 0.37 + 0.23 (+ 0.60)			- .33 - .91 + 0.00 + 0.00 (- 1.24)				+ .23 + .00 + .35 (+ .58)		
	0.00 + 0.07 + 0.09 (+ 0.16)			- .17 - .16 + .00 - .17 (- .50)				+ .09 + .00 + .06 (+ .15)		
	0.00 + 0.01 + 0.02 (+ 0.03)			- .04 - .03 - .00 - .04 (- .11)				+ .02 + .00 + .01 (+ .03)		
				.00 - .01 + .00 + .00 (- .01)						
JM	+ 1.99			- 1.86				+ .76		

JOINT	9	10	11
- C.O	96	107	118
	0.00 ↑	0.00 ↑	0.00 ↑
m	+ 12.00	.00	.00
	- .27	+ .12	- .09
JM	+ 11.73	+ .12	- .09

TABLE 11 MOMENTS DUE TO WIND LOAD

STA.	14	12	21	25
FM's	+12.00	0.0	0.0	0.0
JM	-15.92		+7.30	
D's	.118	.882	.882	.118
r's	↓ .059	→ .441	← .441	↓ .059
M's	+10.85	-10.85	-0.58	+0.58

STA.	36	34	43	47	41	45	54	52	58
FM's	+12.00	0.0	0.0	0.0	-12.00	0.0	0.0	0.0	0.0
JM	-16.58		+21.39				-4.91		
D's	.200	.800	.414	.104	.068	.414	.706	.118	.176
r's	↓ .100	→ .400	← .207	↓ .052	↑ .034	→ .207	← .353	↑ .059	↓ .088
M's	+ 8.84	- 8.83	+2.24	+2.12	-11.48	+7.12	+ .94	- .16	- .79

STA.	69	63	67	76	74	710	78	87	811	85
FM's	+12.00	-12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JM	+1.99			- 1.86				+0.76		
D's	.278	.167	.555	.370	.112	.148	.370	.588	.236	.176
r's	↓ .139	↑ .083	→ .278	← .185	↑ .056	↓ .074	→ .185	← .294	↓ .118	↑ .088
M's	+12.55	-13.33	+0.77	-0.14	+0.90	-0.28	-0.47	+0.11	+ .19	+ 0.30

STA.	96	107	118
FM's	-12.00	0.00	0.00
M's	-11.73	- .14	+ .09

TABLE 12 CARRY-OVER OF MOMENTS DUE TO Δ_1

JOINT	1		2	
-C.O	14	12	21	25
	-.059 ↓	-.441 →	-.441 ←	-.059 ↓
m	+100.0		+100.0	
			- 44.1 - 5.9 (+ 50.0)	
	- 2.0 - 22.1 (- 24.1)		+ 10.6 + 0.8 (+ 11.4)	
	- 0.4 - 5.0 (- 5.4)		+ 2.4 + 0.2 (+ 2.6)	
	- 0.1 - 1.1 (- 1.2)		+ 0.5 + 0.1 (+ 0.6)	
	0.0 - 0.2 (- 0.2)		+ 64.6 (JM)	
JM	+ 69.1			

JOINT	3		4				5		
-C.O	36	34	43	47	41	45	54	52	58
	- .100 ↓	- .400 →	- .207 ←	- .052 ↓	- .034 ↑	- .207 →	- .353 ←	- .059 ↑	- .088 ↓
m	0.0		+ 100.0				+ 100.0		
			0.0 + 0.0 - 5.9 - 35.3 (+ 58.8)						
	0.0 - 12.2 (- 12.2)		+ 4.9 + 0.0 + 1.4 + 5.0 (+ 11.3)				- 12.2 - 2.9 + 0.8 (- 14.3)		
	- 0.1 - 2.3 (- 2.4)		+ 1.0 + 0.1 + 0.3 + 1.1 (+ 2.5)				- 2.3 - 0.7 - 0.1 (- 3.1)		
	0.0 - 0.5 (- 0.5)		+ 0.2 + 0.0 + 0.2 + 0.2 (+ 0.6)				- 0.5 - 0.1 + 0.0 (- 0.6)		
	0.0 - 0.1 (- 0.1)		+ 73.2 (JM)				- 0.1 + 0.0 + 0.0 (- 0.1)		
JM	-15.2						+ 81.9		

JOINT	6			7				8		
- C.O	69	63	67	76	74	710	78	87	811	85
	-.139 ↓	-.083 ↑	-.278 →	-.185 ←	-.056 ↑	-.074 ↓	-.185 →	-.294 ←	-.118 ↓	- .088 ↑
m	0.0			0.0				0.0		
	0.0 + 0.0 + 0.0 (0.0)							0.0 + 0.0 - 8.8 (- 8.8)		
	0.0 + 1.2 + 0.1 (+1.3)			0.0 - 3.1 + 0.0 + 2.6 (- 0.5)				+0.1 + 0.0 + 1.2 (+ 1.3)		
	0.0 + 0.2 + 0.2 (+0.4)			-0.4 - 0.5 + 0.0 - 0.4 (- 1.3)				+0.2 + 0.0 + 0.3 (+ 0.5)		
	0.0 + 0.0 + 0.0 (0.0)			-0.1 - 0.1 + 0.0 + 0.1 (- 0.3)				0.0 + 0.0 + 0.0 (0.0)		
JM	+1.7			0.0 + 0.0 + 0.0 + 0.0 (0.0)						
				- 2.1				- 7.0		

JOINT	9	10	11
- C.O	96	107	118
	0.00 ↑	0.00 ↑	0.00 ↑
m	0.0	0.0	0.0
	+ 0.2	-0.1	-0.8
JM	+ 0.2	-0.1	-0.8

TABLE 13 MOMENTS DUE TO Δ_1

STA.	14	12	21	25
FM's	-100.0	0.0	0.0	-100.0
JM	+69.1		+64.6	
D's	.118	.882	.882	.118
r's	↓ .059	→ .441	← .441	↓ .059
M's	- 89.5	+85.9	+87.6	-87.6

STA.	36	34	43	47	41	45	54	52	58
FM's	0.0	0.0	0.0	0.0	-100.0	0.0	0.0	-100.0	0.0
JM	-15.2		+73.9				+81.9		
D's	.200	.800	.414	.104	.068	.414	.706	.118	.176
r's	↓ .100	→ .400	← .207	↓ .052	↑ .034	→ .207	← .353	↑ .059	↓ .088
M's	- 3.1	+ 3.1	+24.2	+ 7.5	- 90.9	+59.2	+72.9	-86.5	+13.8

STA.	69	63	67	76	74	710	78	87	811	85
FM's	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JM	+ 1.7			- 2.1				- 7.0		
D's	.278	.167	.555	.370	.112	.148	.370	.588	.236	.176
r's	↓ .139	↑ .083	→ .278	← .185	↑ .056	↓ .074	→ .185	← .294	↓ .118	↑ .088
M's	+0.5	- 1.2	+0.7	-0.4	+3.6	-0.3	-2.9	-4.4	- 1.6	+ 6.0

STA.	96	107	118
FM's	0.0	0.0	0.0
M's	+0.2	- 0.1	- 0.8

TABLE 14 CARRY-OVER OF MOMENTS DUE TO Δ_2

JOINT	1		2	
- C.O	14	12	21	25
	-.059 ↓	-.441 →	← -.441	-.059 ↓
m	- 100.0		- 100.0	
			+ 44.1 - 2.9 (- 58.8)	
	+ 1.0 + 26.0 (+ 27.0)		- 11.9 + 0.0 (- 11.9)	
	- 0.1 + 5.3 (+ 5.2)		- 2.3 + 0.1 (- 2.2)	
	0.0 + 0.9 (+ 0.9)		- 0.4 + 0.0 (- 0.4)	
	0.0 + 0.2 (+ 0.2)		- 73.3	
JM	- 66.7			

JOINT	3		4				5		
- C.O	36	34	43	47	41	45	54	52	58
	-.100 ↓	-.100 →	← -.207	-.052 ↓	- .034 ↑	-.207 →	← -.353	-.059 ↑	-.088 ↓
m	+ 150.0		+ 50.0				+ 50.0		
			- 60.0 - 8.4 + 5.9 - 17.7 (- 30.2)						
	- 8.9 + 6.2 (- 2.7)		+ 1.1 + 3.5 - 1.6 + 0.2 (+ 3.2)				+ 6.2 + 3.5 - 10.4 (- 0.7)		
	- 1.0 - 0.7 (- 1.7)		+ 0.7 + 0.4 - 0.3 + 0.3 (+ 1.1)				- 0.7 + 0.7 - 1.0 (- 1.0)		
	- 0.1 - 0.2 (- 0.3)		+ 0.1 + 0.0 + 0.0 + 0.0 (+ 0.1)				- 0.2 + 0.1 - 0.1 (- 0.2)		
	+ 0.0 + 0.0 (0.0)		- 25.8				0.0 + 0.0 + 0.0 (0.0)		
JM	+ 145.3						48.1		

JOINT	6			7				8		
- C.O	69	63	67	76	74	710	78	87	811	85
	-.139 ↓	- .083 ↑	- .278 →	← -.185	- .056 ↑	- .074 ↓	- .185 →	← -.294	- .118 ↓	-.088 ↑
m	+ 150.0			+ 150.0				+ 150.0		
	0.0 - 15.0 - 27.8 (+107.2)							- 27.8 + 0.0 - 4.4 (+ 117.8)		
	0.0 + 0.3 + 11.6 (+ 11.6)			- 29.8 + 1.6 + 0.0 - 34.6 (- 62.8)				+ 11.6 + 0.0 + 0.0 (+ 11.6)		
	0.0 + 0.2 + 1.3 (+ 1.5)			- 3.4 - 0.2 + 0.0 - 3.4 (- 6.9)				+ 1.3 + 0.0 + 0.1 (+ 1.4)		
	0.0 + 0.0 + 0.1 (+ 0.1)			- 0.4 + 0.0 + 0.0 - 0.4 (- 0.8)				+ 0.1 + 0.0 + 0.0 (+ 0.1)		
				0.0 + 0.0 + 0.0 + 0.0 (0.0)						
JM	+120.7			+ 79.5				+130.9		

JOINT	9	10	11
- C.O	96	107	118
	0.00 ↑	.00 ↑	.00 ↑
m	0.0	0.0	0.0
	+16.8	+ 5.9	+ 15.4
JM	+16.8	+ 5.9	+ 15.4

TABLE 15 MOMENTS DUE TO Δ_2

STA.	14	12	21	25
FM's	+100.0	0.0	0.0	+100.0
JM	-66.7		-73.3	
D's	.118	.882	.882	.118
r's	↓ .059	→ .441	← .441	↓ .059
M's	+ 91.2	-91.2	-94.1	+ 94.1

STA.	36	34	43	47	41	45	54	52	58
FM's	-150.0	0.0	0.0	-150.0	+100.0	0.0	0.0	+100.0	-150.0
JM	+145.3		-25.8				+48.1		
D's	.200	.800	.414	.104	.068	.414	.706	.118	.176
r's	↓ .100	→ .400	← .207	↓ .052	↑ .034	→ .207	← .353	↑ .059	↓ .088
M's	-110.9	+110.9	+47.5	-148.2	+94.4	+6.3	+28.6	+101.5	-130.1

STA.	69	63	67	76	74	710	78	87	811	85
FM's	0.0	-150.0	0.0	0.0	-150.0	0.0	0.0	0.0	0.0	-150.0
JM	+120.7			+79.5				+130.9		
D's	.278	.167	.555	.370	.112	.148	.370	.588	.236	.176
r's	↓ .139	↑ .083	→ .278	← .185	↑ .056	↓ .074	→ .185	← .294	↓ .118	↑ .088
M's	+33.7	-115.5	+81.7	+62.9	-142.5	+11.8	+67.8	+91.6	+30.9	-122.7

STA.	96	107	118
FM's	0.0	0.0	0.0
M's	+16.8	+5.9	+15.4

TABLE 16 CARRY-OVER OF MOMENTS DUE TO Δ_3

JOINT	1		2	
- C.O	14	12	21	25
	- .059 ↓	-.441 →	← - .441	-.059 ↓
m	0.0		0.0	
			0.0 + 8.8 (+ 8.8)	
	+ 1.3 - 3.9 (- 2.6)		+1.1 - 0.3 (+ 0.8)	
	0.0 - 0.3 (- 0.3)		+0.1 + 0.0 (+ 0.1)	
	0.0 + 0.0 (0.0)		+ 9.7	
JM	- 2.9			

JOINT	3		4				5		
- C.O	36	34	43	47	41	45	54	52	58
	- .100 ↓	- .400 →	← - .207	- .052 ↓	- .034 ↑	-.207 →	← -.353	- .059 ↑	- .088 ↓
m's	- 150.0		- 150.0				- 150.0		
			+ 60.0 - 0.5 + 0.0 + 53.0 (- 37.5)				+ 7.8 - 0.5 - 1.9 (+ 5.4)		
	- 9.4 + 7.8 (- 1.6)		+ 0.6 + 2.0 + 0.1 - 1.9 (+ 0.8)				- 0.1 + 0.0 - 0.5 (- 0.6)		
	- 0.5 - 0.1 (- 0.6)		+ 0.2 + 0.2 + 0.0 + 0.2 (+ 0.6)				- 0.1 + 0.0 - 0.1 (- 0.2)		
	0.0 - 0.1 (- 0.1)		-36.1						
JM's	- 152.3						- 145.4		

OINT	6			7				8		
C.O	69	63	67	76	74	710	78	87	811	85
	- .139 ↓	- .083 ↑	- .278 →	← - .185	-.056 ↑	-.074 ↓	-.185 →	← - .294	- .118 ↓	- .088 ↑
	+100.0			+10.0				+10.0		
	0.0 - 1.8 + 15.0 (+113.2)							- 1.8 + 0.0 + 13.2 (+ 21.4)		
	0.0 + 6.6 + 0.1 (+ 6.7)			- 31.5 + 1.9 + 0.0 - 6.3 (-35.9)				+ 6.6 + 0.0 - 0.5 (+ 6.1)		
	0.0 + 0.7 + 0.0 (+ 0.7)			- 1.8 + 0.0 + 0.0 - 1.8 (- 3.6)				+ 0.7 + 0.0 + 0.0 (+ 0.7)		
				- 0.2 + 0.0 + 0.0 - 0.2 (- 0.4)						
M	+120.6			-29.9				+28.2		

OINT	9	10	11
C.O	96	107	118
	.00 ↑	.00 ↑	.00 ↑
	+ 250.0	+160.0	+160.0
	- 16.8	+ 2.4	- 3.3
M	+ 233.2	+162.4	+156.7

TABLE 17 MOMENTS DUE TO Δ_3

STA.	14	12	21	25
FM's	0.0	0.0	0.0	0.0
JM	-2.9		9.7	
D's	.118	.882	.882	.118
r's	↓.059	.441→	←.441	↓.059
M's	-1.6	+1.6	+7.4	-7.4

STA.	36	34	43	47	41	45	54	52	58
FM's	+150.0	0.0	0.0	+150.0	0.0	0.0	0.0	0.0	+150.0
JM	-152.3		-36.1				-145.4		
D's	.200	.800	.414	.104	.068	.414	.706	.118	.176
r's	↓.100	.400→	←.207	↓.052	↑.034	.207→	←.353	↑.059	↓.088
M's	+129.4	-129.4	-75.7	144.6	- 2.6	-66.3	-110.1	-16.6	+126.8

STA.	69	63	67	76	74	710	78	87	811	85
FM's	-250.0	+150.0	0.0	0.0	+150.0	-160.0	0.0	0.0	-160.0	+150.0
JM	+120.6			-29.9				+28.2		
D's	.278	.167	.555	.370	.112	.148	.370	.588	.236	.176
r's	↓.139	↑.083	.278→	←.185	↑.056	↓.074	.185→	←.294	↓.118	↑.088
M's	-216.5	+155.0	+ 61.5	+22.4	+144.8	-164.4	- 2.8	+11.1	-153.3	+142.2

STA.	96	107	118
FM's	-250.0	-160.0	-160.0
M's	-233.2	-162.4	-156.7

ABLE 18 FINAL END MOMENTS

M_{12}		+89.5	- 91.2	+ 1.6	-10.85		X_1		+ 8.79
M_{14}		-89.5	+ 91.2	- 1.6	+10.85		X_2		- 8.79
M_{21}		+87.6	- 94.1	+ 7.4	- 0.58		X_3		+ 17.44
M_{25}		-87.6	+ 94.1	- 7.4	+ 0.58		1.0		- 17.44
M_{34}		+ 3.1	+110.9	-129.4	- 8.83				+ 25.26
M_{36}		- 3.1	-110.9	+129.4	+ 8.83				- 25.26
M_{41}		-90.9	+ 94.4	- 2.6	-11.48				- 30.38
M_{43}		+24.2	+ 47.5	- 75.7	+ 2.24				+ 31.41
M_{45}		+59.2	+ 6.3	- 66.3	+ 7.12				+ 43.57
M_{47}		+ 7.5	-148.2	+144.6	+ 2.12				- 45.03
M_{52}		-86.5	+101.5	- 16.6	- 0.16				- 15.12
M_{54}	=	+72.9	+ 28.6	-110.1	+ 0.94			=	+ 49.54
M_{58}		+13.8	-130.1	+126.8	- 0.79				- 34.62
M_{63}		- 1.2	-115.5	+155.0	-13.33				- 37.63
M_{67}		+ 0.7	+ 81.7	+ 61.5	+ 0.77				+ 96.85
M_{69}		+ 0.5	+ 33.7	-216.5	+12.55				- 59.23
M_{74}		+ 3.6	-142.5	+144.8	+ 0.90				- 45.34
M_{76}		- 0.4	+ 62.9	+ 22.4	- 0.14				+ 61.23
M_{78}		- 2.9	+ 67.8	- 2.8	- 0.47				+ 50.70
M_{710}		- 0.3	+ 11.8	-164.4	- 0.27				- 66.93
M_{85}		+ 6.0	-122.7	+142.2	- 0.30				- 28.74
M_{87}		- 4.4	+ 91.6	+ 11.1	+ 0.11				+ 75.73
M_{811}		- 1.6	+ 30.9	-153.3	+ 0.19				- 46.87
M_{96}		+ 0.2	+ 16.8	-233.2	-11.73				-105.53
M_{107}		- 0.1	+ 5.9	-162.4	- 0.14				- 70.42
M_{811}		- 0.8	+ 15.4	-156.7	+ 0.09				- 60.55

PART IV

SUMMARY AND CONCLUSIONS

Summary

A method for analyzing multistory building frames, developed by (3), has been presented in this report. The necessary equations are ved physically, and presented in a convenient form for iteration. The vidual members of the frame may be of constant or variable section, the frames may have nontranslating or translating joints.

A numerical example has been worked by Kani's method, illustrating general procedure of application. This example has also been worked he methods of moment distribution and carry-over joint moments for a arison of procedures and results.

Conclusions

Certain advantages of Kani's method have been observed in working the ple. The primary advantages are:

(1) Amount of numerical labor is reduced.

(2) Possible computation errors do not affect the final results.

(3) No shear equations are required.

(4) In analyzing for different types of loading, the results of a previous analysis can be used as starting values for a new analysis.

(5) For checking the results, only the numerical values from the last cycle of iteration need to be considered.

of these advantages exist to a greater or lesser degree, depending the method being compared.

From the results of this comparison, it is believed that Kani's od has certain advantages over other numerical methods for analyzing multistory building frames.

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