



### เอกสารอ้างอิง

1. American Institute of Steel Construction, " Specification for the Design, Fabrication and Erection of Structural Steel for Building," Part II, AISC, New York, 1978.
2. Wang, C.K., "General Computer Program for Limit Analysis," Journal of the Structural Division, ASCE, Vol. 89, No. ST6, Proc. Paper 3719, Dec., 1963, pp. 101-117.
3. Harrison, H.B., Computer Methods in Structural Analysis, Prentice-Hall, New Jersey, 1973.
4. Korn, A., and Galambos, T.V., "Behavior of Elastic-Plastic Frames," Journal of the Structural Division, ASCE, Vol. 94, No. ST5, May, 1968, pp. 1119-1142.
5. Kassimali, A., "Large Deformation Analysis of Elastic-Plastic Frames," Journal of Structural Engineering, ASCE, Vol. 109, No. 8, August, 1983, pp. 1869-1886.
6. Gharpuray, V., and Aristizabal-Ochoa, J.D., "Simplified Second-Order Elastic-Plastic Analysis of Frames," Journal of Computing in Civil Engineering, ASCE, Vol. 3, No. 1, January, 1989, pp. 47-59.
7. วิโรจน์ เตริยมเจริญพร, "การคำนวณออกแบบอย่างเหมาะสมที่สุดโดยวิธีพลาสติกสำหรับโครงเหล็กข้อแฉ่ง," วิทยานิพนธ์วิศวกรรมศาสตรมหาบัณฑิต, ภาควิชาวิศวกรรมโยธา จุฬาลงกรณ์มหาวิทยาลัย, 2532.

8. Ghali, A., and Neville, A.M., Structural Analysis - a Unified Classical and Matrix Approach. 2nd ed., Chapman & Hall, London, 1978.
9. American Institute of Steel Construction, " Manual of Steel Construction 7th Edition," New York: AISC, 1978.
10. Gaylord, E.H., and Gaylord, C.N.,Design of Steel Structures 2nd Edition, 1972.
11. Salmon, C.G., and Johnson, J.E., Steel Structural Design & Behavior, Harper and Row Co.Ltd., New York, 2nd ed., 1980.
12. Meek, J.L., Matrix Structural Analysis, Mcgraw-Hill, 1971.
13. ทักษิณ เทพชาตรี, พฤติกรรมและการออกแบบโครงสร้างเหล็ก, วิศวกรรมสถานแห่งประเทศไทย, 2529.
14. ทักษิณ เทพชาตรี, การออกแบบโครงสร้างเหล็กโดยวิธีพลาสติก, ภาควิชาวิศวกรรมโยธา จุฬาลงกรณ์มหาวิทยาลัย.
15. ปณิธาน ลักคุณะประสิทธิ์, การวิเคราะห์โครงสร้าง, วิศวกรรมสถานแห่งประเทศไทย, 2527.

ภาคผนวก ก.

รายการตารางประกอบ

ตารางที่ 3.1 ค่าตัวประกอบน้ำหนักบรรทุกที่จุดวิบัติของ โครงสร้างในตัวอย่างที่ 1

	ค่าตัวประกอบน้ำหนักบรรทุกที่จุดวิบัติ ของโครงสร้าง	เปอร์เซ็นต์ความแตกต่าง
Wang (2)	2.067	+ 61.11
Korn & Galumbos (4)	1.283	-
งานวิจัยนี้	1.243	- 3.12

ตารางที่ 3.2 คุณสมบัติของชั้นส่วนของโครงสร้างในตัวอย่างที่ 2

ชั้น	ชั้นส่วนเสา	$I_x$ (in <sup>4</sup> )	A (in <sup>2</sup> )	$r_x$ (in)	$M_p$ (t-in)
1	6 WF 15.5	30.1	4.56	2.57	169.275
2	8 WF 31	110	9.12	3.47	463.600
3	8 WF 31	110	9.12	3.47	463.600
4	8 WF 35	126	10.3	3.50	529.175
5	10 WF 49	273	14.4	4.35	919.575
6	12 WF 79	663	23.2	5.34	1814.750
7	14 WF 87	967	25.6	6.15	2302.750
8	14 WF 95	1060	27.9	6.17	2531.500



ตารางที่ 3.3 คุณสมบัติของชั้นส่วนของโครงสร้างในตัวอย่างที่ 2

ชั้น	ชั้นส่วนคาน	$I_x$ (in <sup>4</sup> )	A (in <sup>2</sup> )	$r_x$ (in)	$M_p$ (t-in)
1	8 WF 17	56.6	5.01	3.36	242.475
2	8 WF 20	69.4	5.89	3.43	291.275
3	10 WF 21	107	6.20	4.15	367.525
4	12 WF 27	204	7.95	5.07	579.500
5	14 WF 30	290	8.83	5.74	719.800
6	14 WF 34	340	10.0	5.83	832.650
7	14 WF 34	340	10.0	5.83	832.650
8	14 WF 38	386	11.2	5.88	939.400

ตารางที่ 3.4 ค่าตัวประกอบน้ำหนักบรรทุกที่จุดวิบัติของโครงสร้างในตัวอย่างที่ 2

	ค่าตัวประกอบน้ำหนักบรรทุกที่จุดวิบัติ ของโครงสร้าง	เปอร์เซ็นต์ความแตกต่าง
Wang (2)	1.649	+ 16.87
Korn & Galumbos (4)	1.411	-
งานวิจัยนี้	1.268	- 10.13

ตารางที่ 3.5 คุณสมบัติของชิ้นส่วนของโครงสร้างในตัวอย่างที่ 3

ชิ้นส่วน	ขนาด	$I_x$ (cm <sup>4</sup> )	A (cm <sup>2</sup> )	$r_x$ (cm)	$M_p$ (kg-cm)	$K_x$
1	WF 300*56.8	11300	72.38	12.5	2147500	2.0
2	WF 300*56.8	11300	72.38	12.5	2147500	1.0
3	WF 300*56.8	11300	72.38	12.5	2147500	1.0
4	WF 300*56.8	11300	72.38	12.5	2147500	1.2
5	WF 300*56.8	11300	72.38	12.5	2147500	1.2
6	WF 300*56.8	11300	72.38	12.5	2147500	1.0
7	WF 300*56.8	11300	72.38	12.5	2147500	1.0
8	WF 300*56.8	11300	72.38	12.5	2147500	2.0

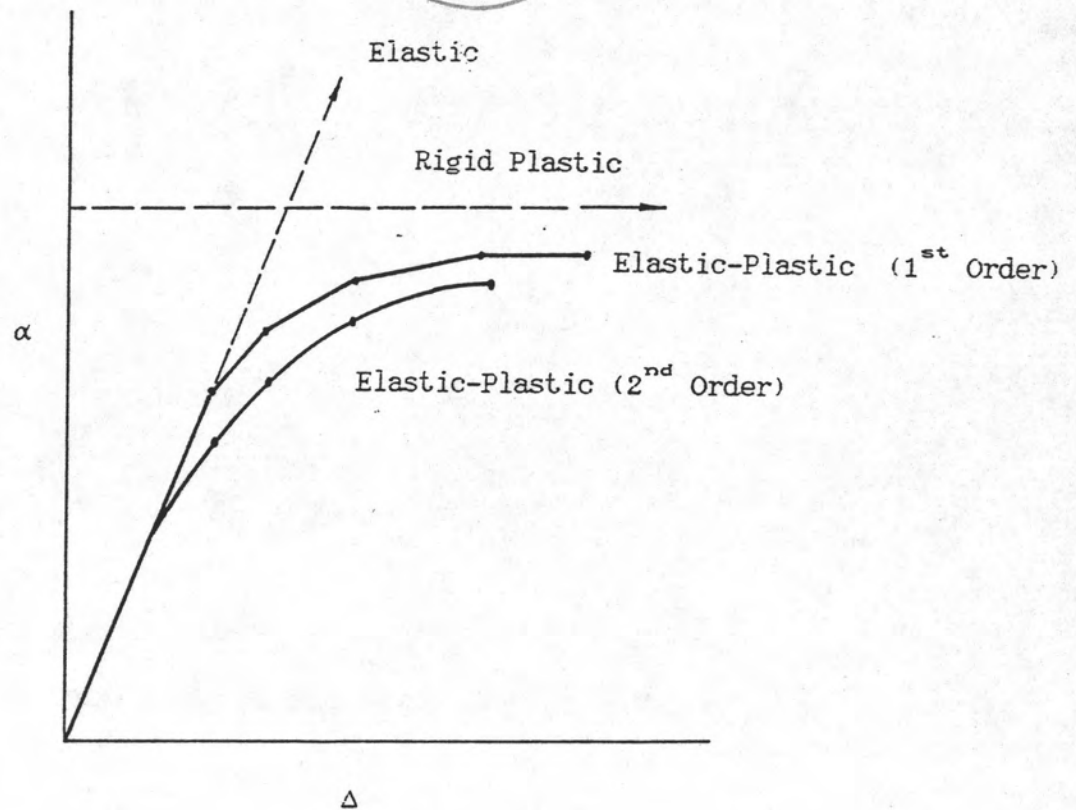


ตารางที่ 3.6 ค่าตัวประกอบน้ำหนักบรรทุกที่จุดวิบัติของโครงสร้างในตัวอย่างที่ 3

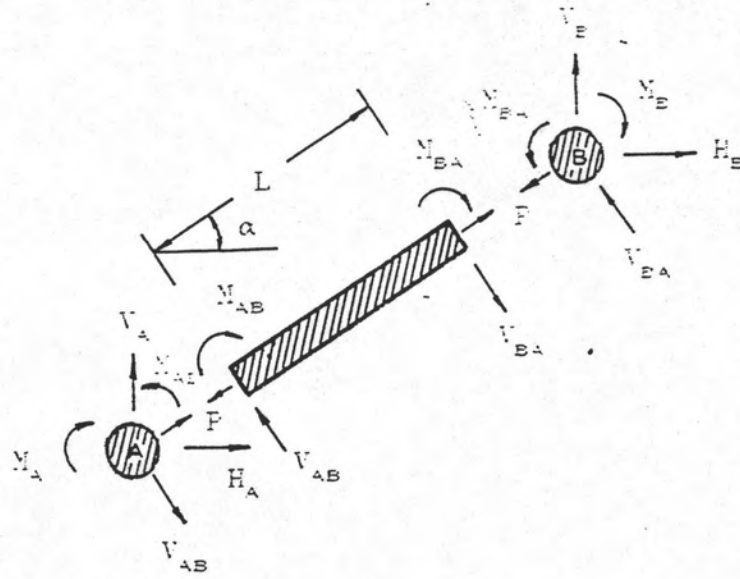
	ค่าตัวประกอบน้ำหนักบรรทุกที่จุดวิบัติ ของโครงสร้าง	เปอร์เซ็นต์ความแตกต่าง
วิโรจน์ (7)	1.300	-
งานวิจัยนี้	1.243	- 4.38

ภาคผนวก ข.

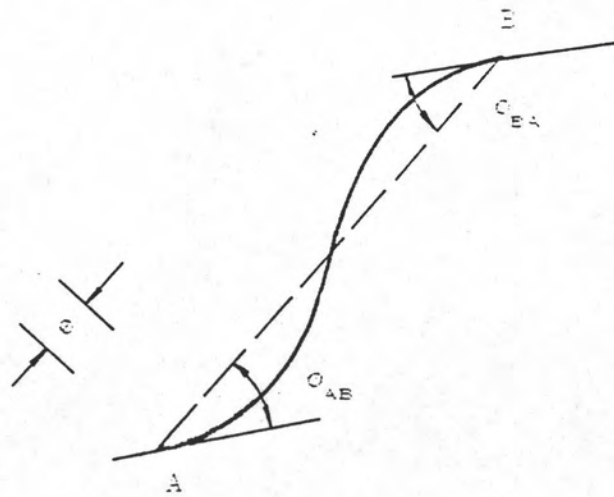
รายการรูปประกอบ



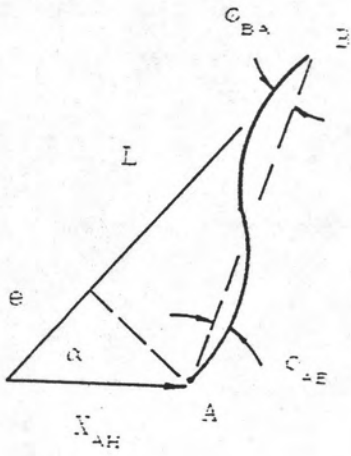
รูปที่ 1.1 รูปแบบการจำลองทางคณิตศาสตร์ของพฤติกรรมทางโครงสร้าง



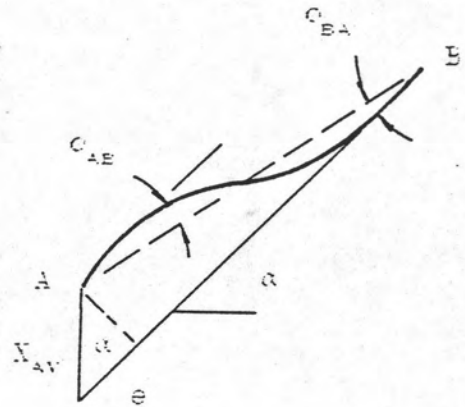
รูปที่ 2.1 สมดุลย์ของแรงภายในและแรงภายนอก



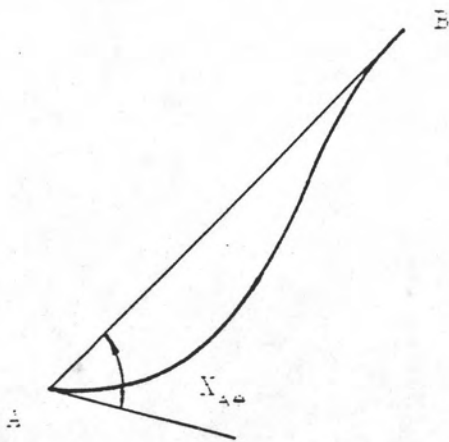
รูปที่ 2.2 การเปลี่ยนแปลงรูปร่างของชิ้นส่วนย่อยในระบบพิกัดเฉพาะที่ .



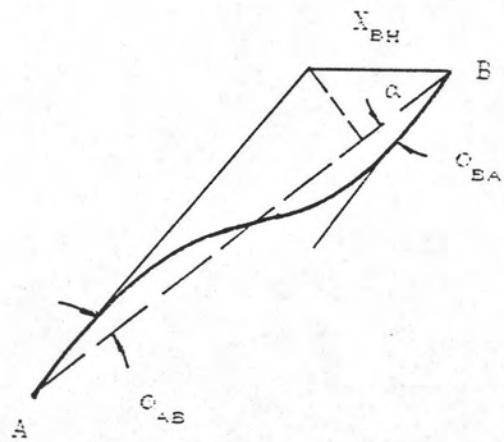
П.



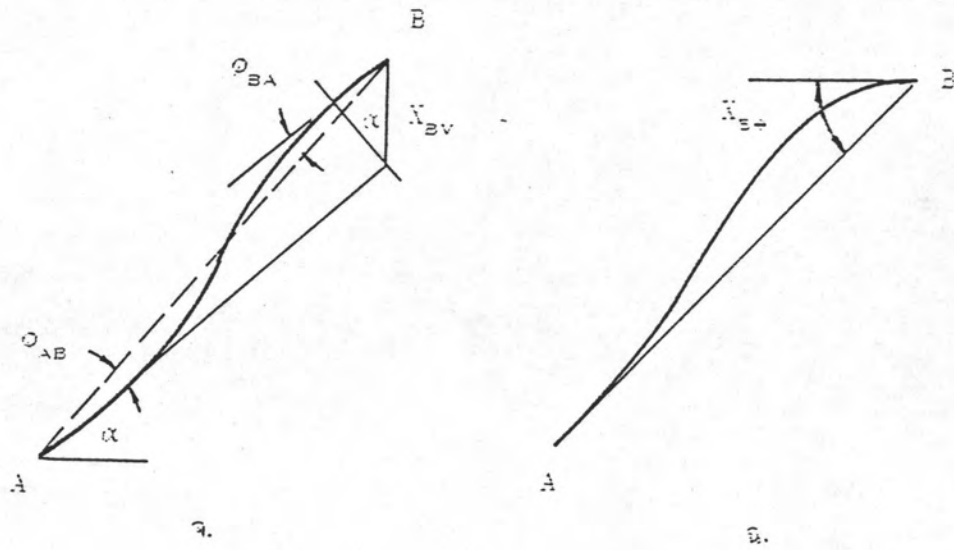
И.



А.

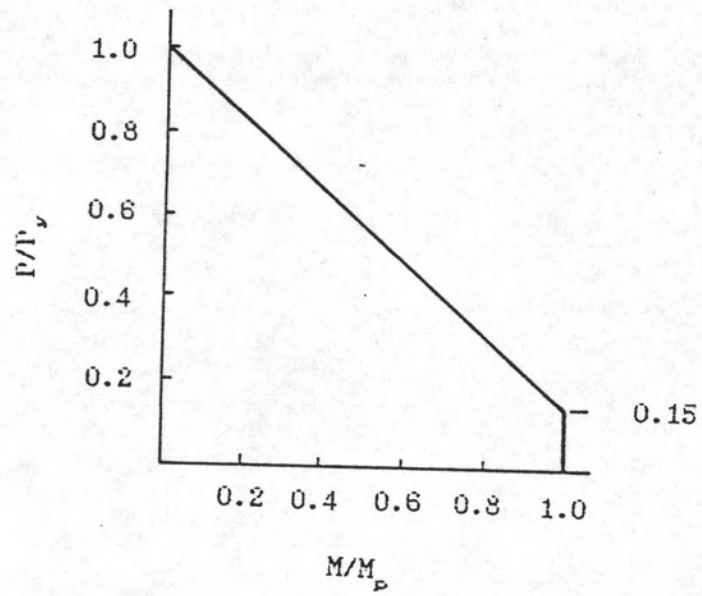


В.

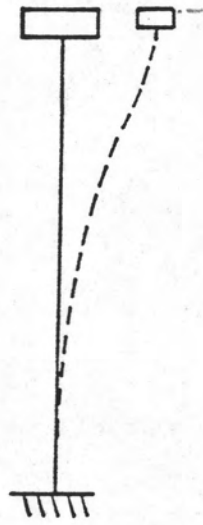


รูปที่ 2.3 ความสอดคล้องของการเปลี่ยนแปลงรูปร่างของชิ้นส่วนและข้อต่อ

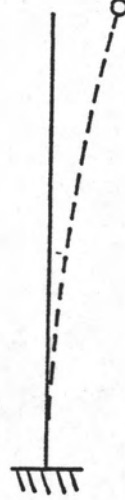
- ก. การเปลี่ยนแปลงรูปร่างของชิ้นส่วนสอดคล้องกับ  $X_{AH}$
- ข. การเปลี่ยนแปลงรูปร่างของชิ้นส่วนสอดคล้องกับ  $X_{AV}$
- ค. การเปลี่ยนแปลงรูปร่างของชิ้นส่วนสอดคล้องกับ  $X_{A\theta}$
- ง. การเปลี่ยนแปลงรูปร่างของชิ้นส่วนสอดคล้องกับ  $X_{BH}$
- จ. การเปลี่ยนแปลงรูปร่างของชิ้นส่วนสอดคล้องกับ  $X_{BV}$
- ฉ. การเปลี่ยนแปลงรูปร่างของชิ้นส่วนสอดคล้องกับ  $X_{B\theta}$



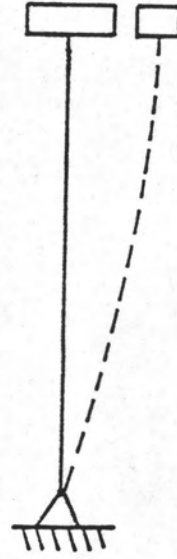
รูปที่ 2.4 ความสัมพันธ์ระหว่างแรงในแนวแกนกับแรงดัดสำหรับเหล็กหน้าตัด H



ก.



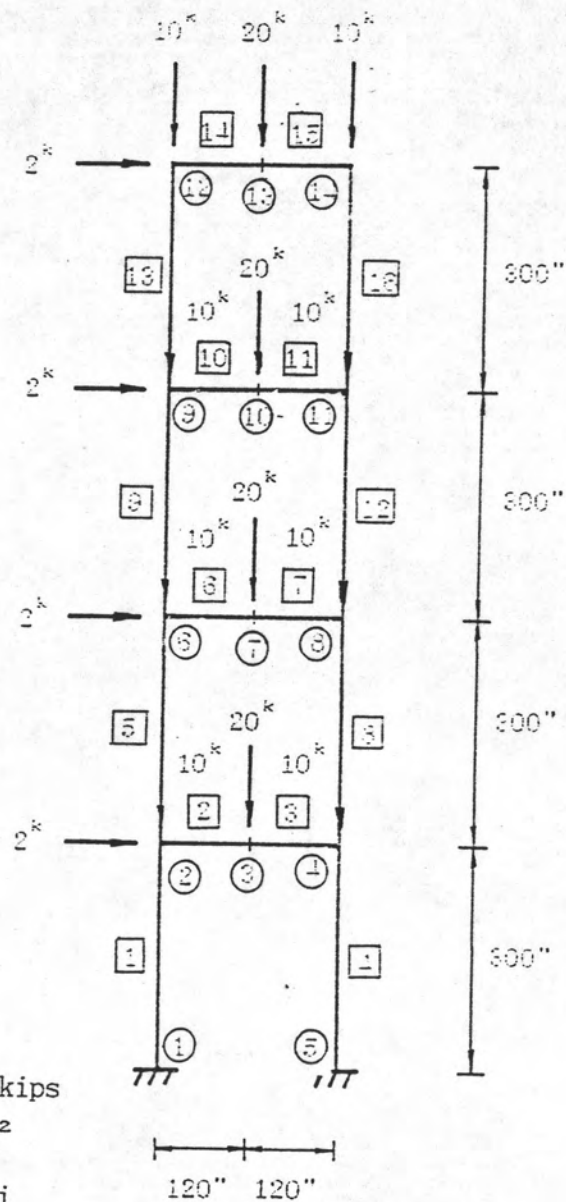
ข.



ค.

รูปที่ 2.5 ลักษณะการโค้งงอของเสา .

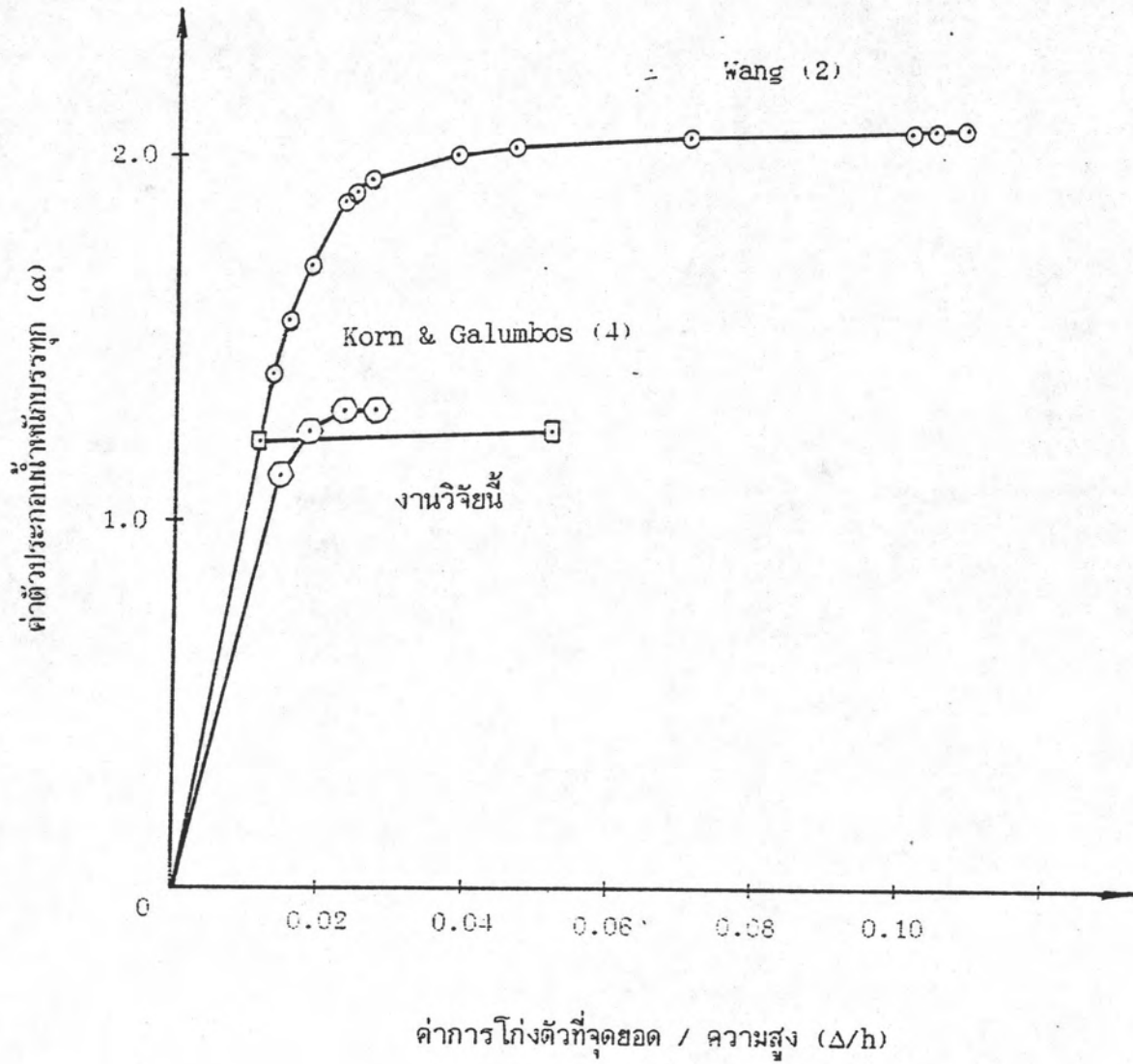




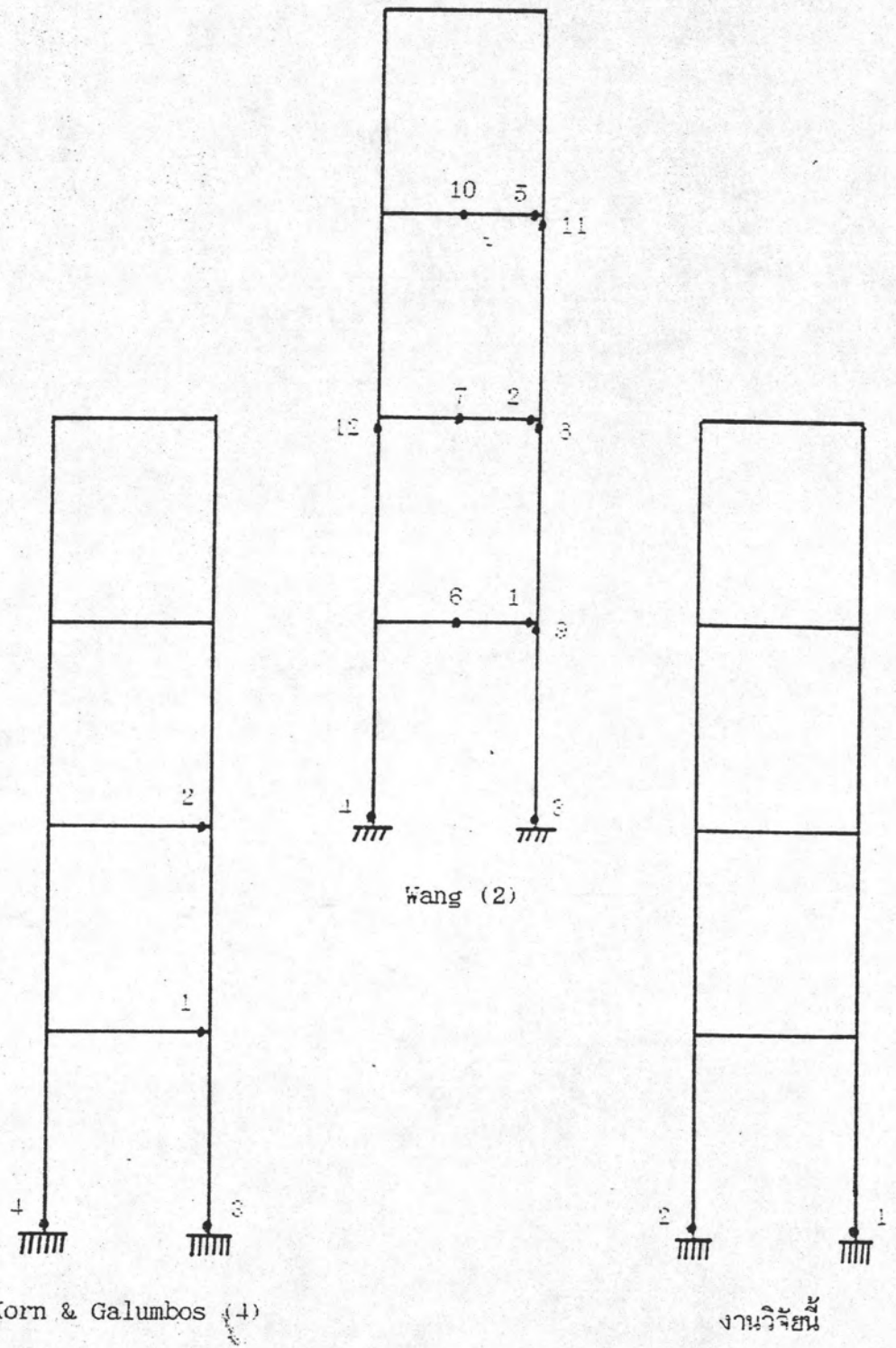
$I = 144 \text{ in}^4$   
 $M_p = 1920 \text{ in-kips}$   
 $A = 11.75 \text{ in}^2$   
 $E = 30000 \text{ ksi}$   
 $F_y = 36 \text{ ksi}$   
 $r = 3.50 \text{ in}$

○ = ข้อต่อ  
 □ = ชิ้นส่วน

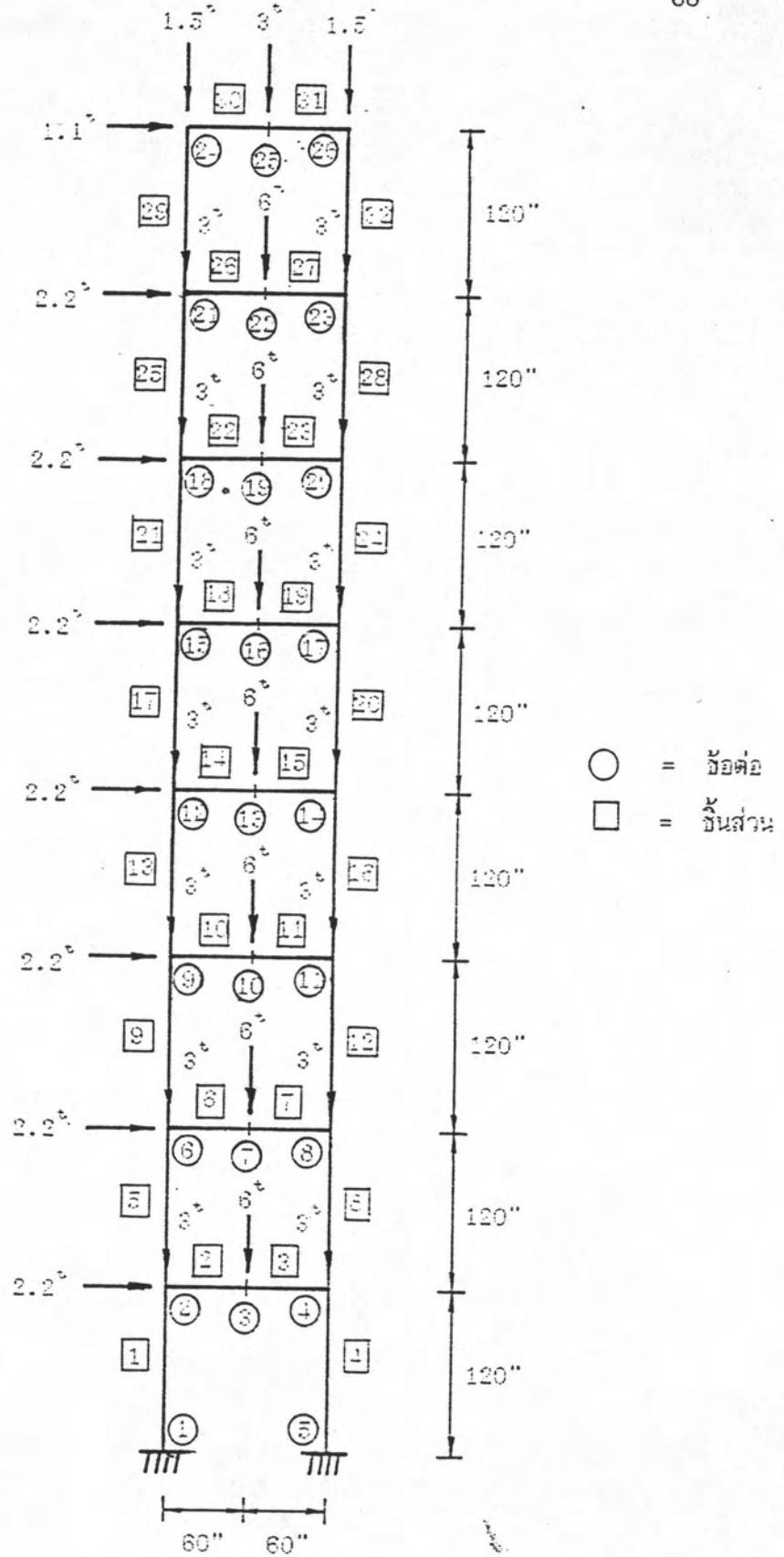
รูปที่ 3.1 ลักษณะของโครงสร้างในตัวอย่างที่ 1



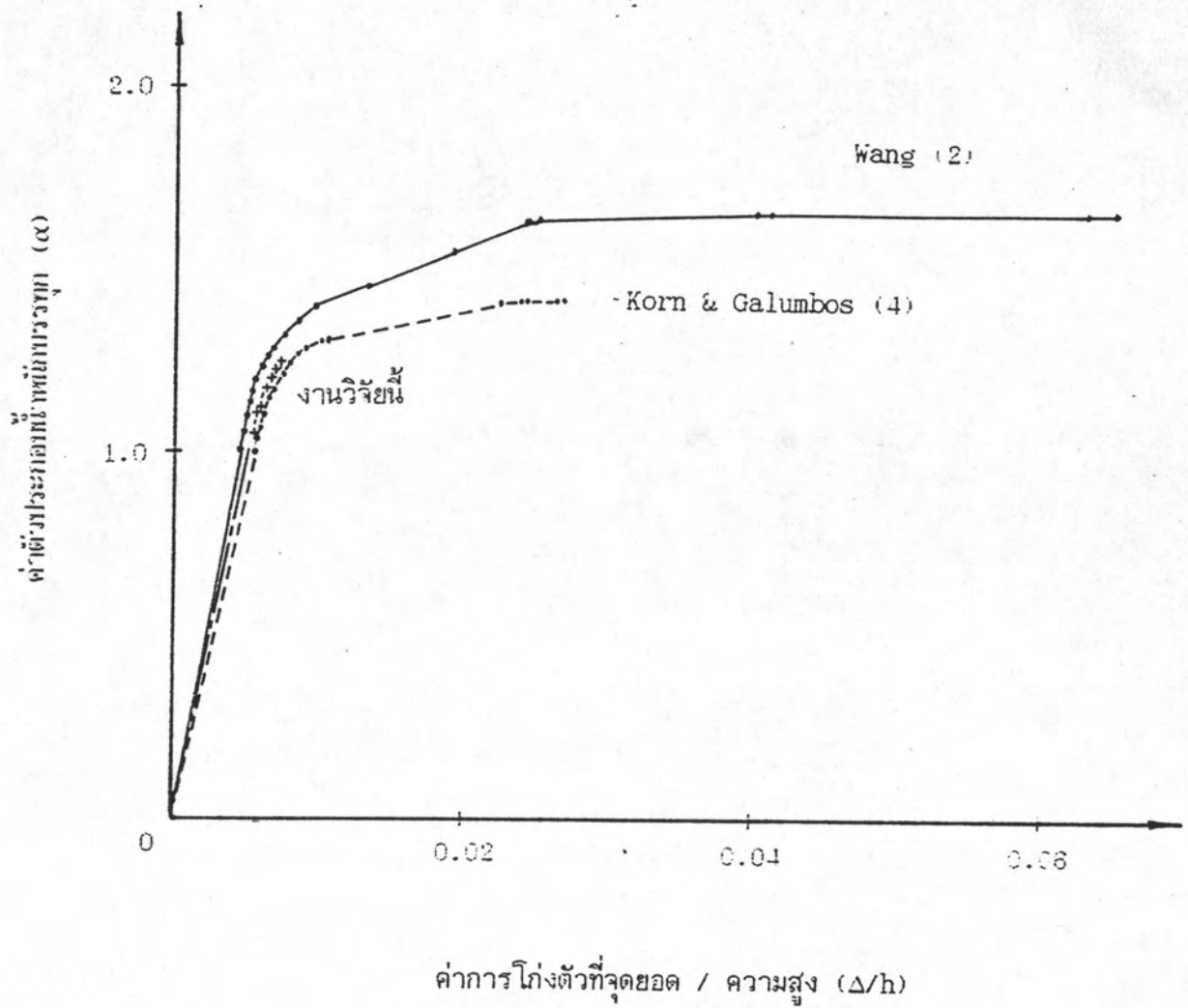
รูปที่ 3.2 ความสัมพันธ์ระหว่างแรงกระทำกับการเปลี่ยนตำแหน่งตั้งแต่จุดหมุนพลาสติก  
จุดแรกจนถึงจุดสุดท้ายของโครงสร้างในตัวอย่างที่ 1



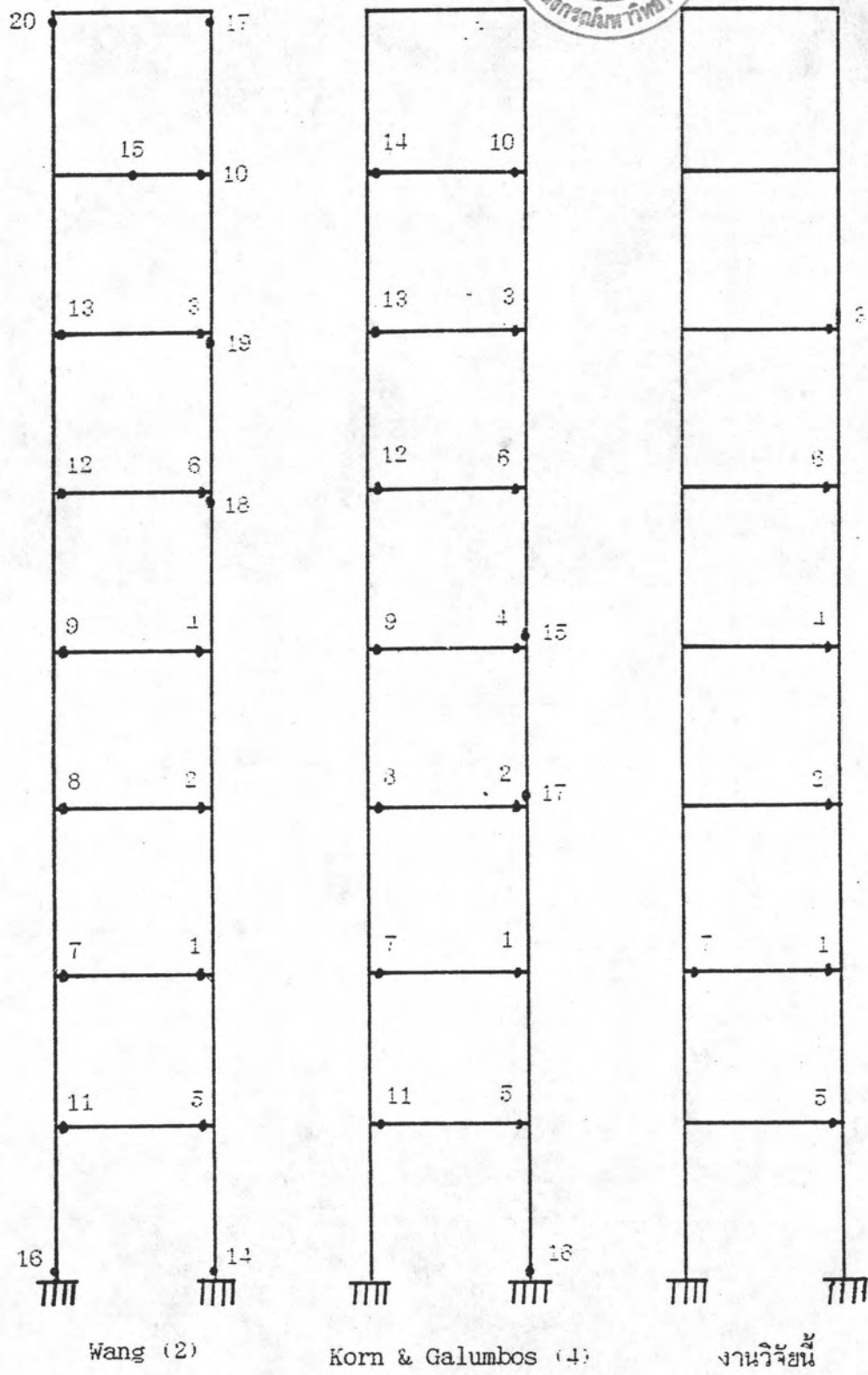
รูปที่ 3.3 ตำแหน่งและลำดับของการเกิดจุดหมุนพลาสติกของโครงสร้าง  
ในตัวอย่างที่ 1



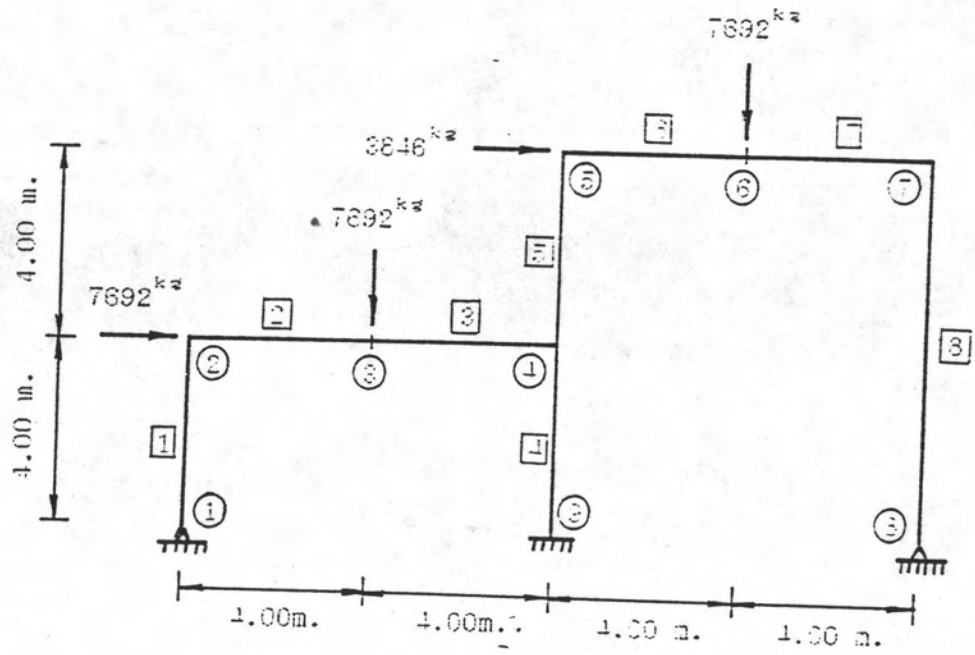
รูปที่ 3.4 ลักษณะของโครงสร้างในตัวอย่างที่ 2



รูปที่ 3.5 ความสัมพันธ์ระหว่างแรงกระทำกับการเปลี่ยนตำแหน่งตั้งแต่จุดหมุนพลาสติกจุดแรกจนถึงจุดสุดท้ายของโครงสร้างในตัวอย่างที่ 2

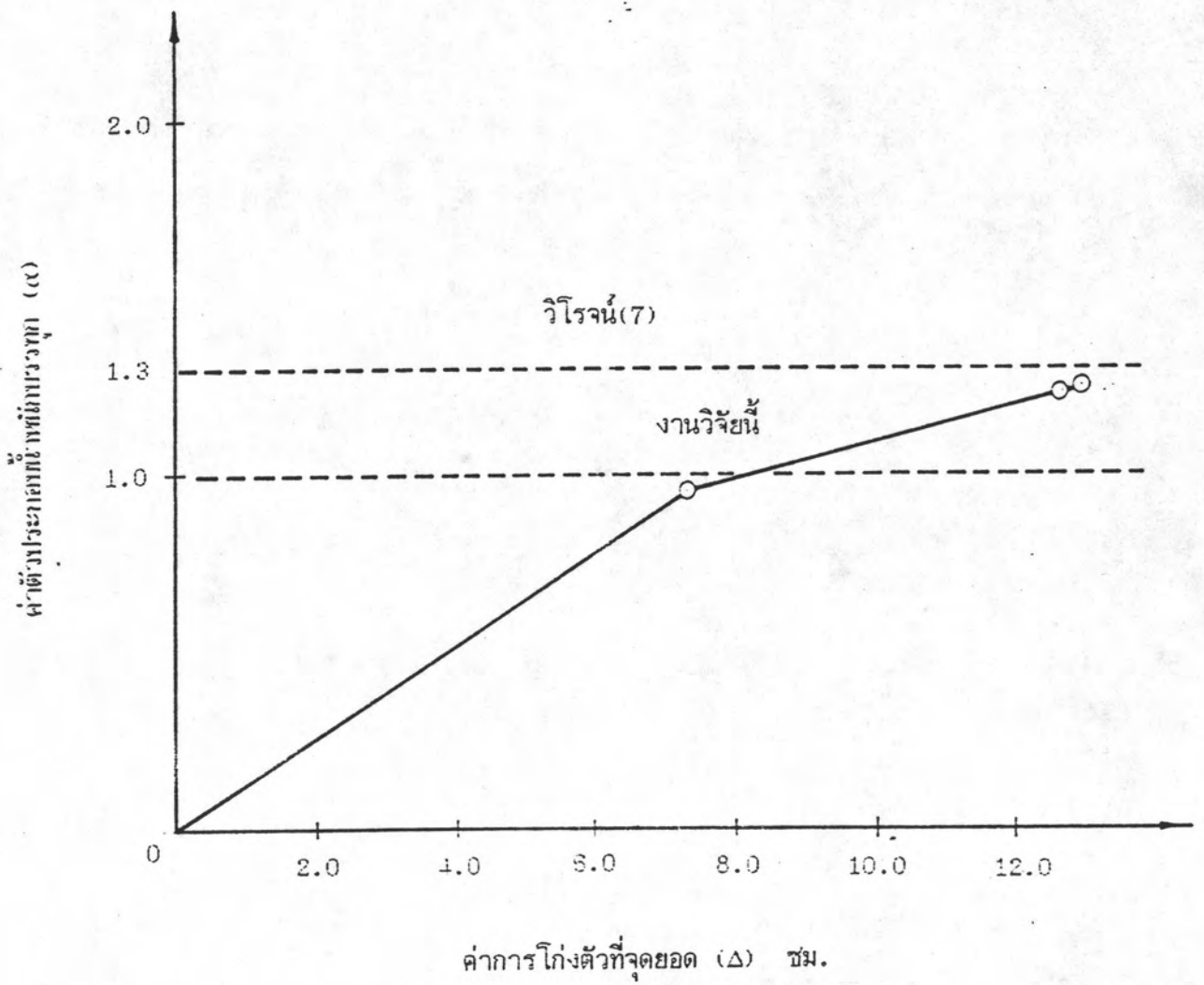


รูปที่ 3.6 ตำแหน่งและลำดับของการเกิดจุดหมุนพลาสติกของโครงสร้าง  
ในตัวอย่างที่ 2



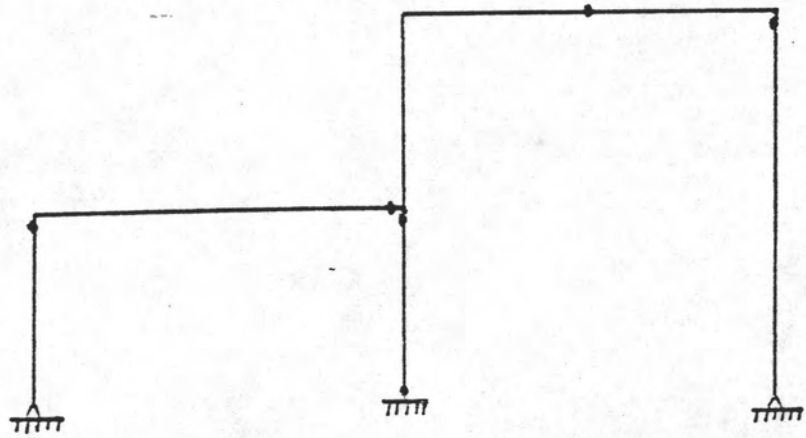
- = ข้อต่อ
- = ชิ้นส่วน

รูปที่ 3.7 ลักษณะของโครงสร้างในตัวอย่างที่ 3

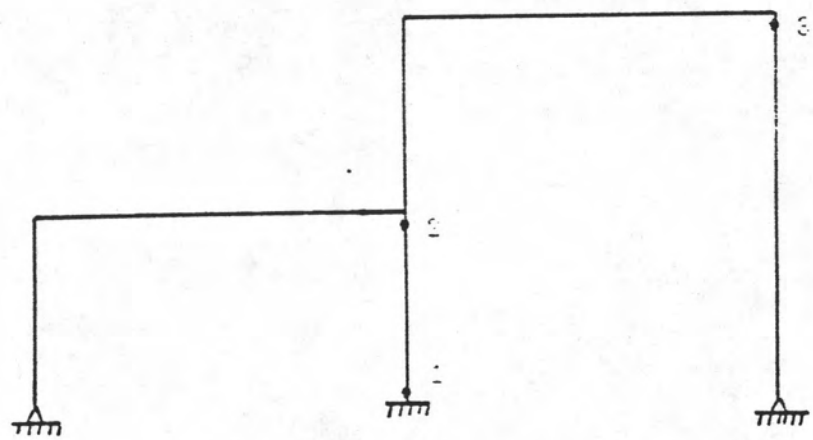


รูปที่ 3.8 ความสัมพันธ์ระหว่างแรงกระทำกับการเปลี่ยนตำแหน่งตั้งแต่จุดหมุนพลาสติกจุดแรกจนถึงจุดสุดท้ายของโครงสร้างในตัวอย่างที่ 3





วิโรจน์ (๗)

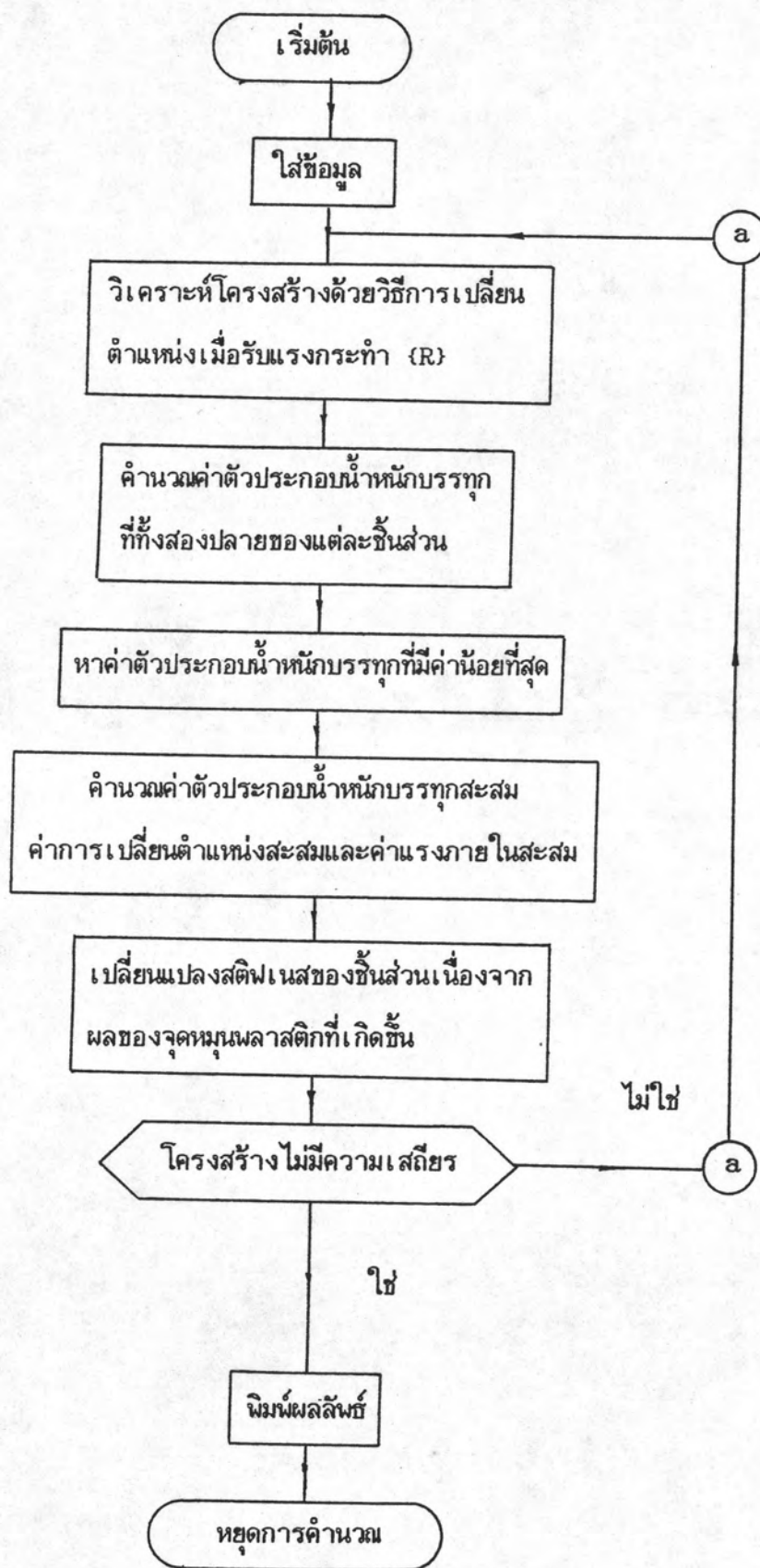


งานวิโรจน์

รูปที่ 3.9 ตำแหน่งและลำดับของการเกิดจุดหมุนพลาสติกของโครงสร้าง  
ในตัวอย่างที่ 3

ภาคผนวก ค.

แผนภาพขั้นตอนการทำงานของโปรแกรม



ภาคผนวก ง.

ผลลัพธ์จากโปรแกรมในตัวอย่างที่ 1

Plastic Hinge 1 Formed In Member 4 Near Joint 5

When Load Factor = 1.2181441591E+00

Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	4.0947119581E+00	-6.3263085749E-02	1.4547708946E-02
3	4.0946399001E+00	-7.3911209244E-01	-4.9435365724E-03
4	4.0945678422E+00	-1.0261186358E-01	6.2101567888E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	8.8374556447E+00	-1.1361604255E-01	1.2044580278E-02
7	8.8369120898E+00	-7.6103050073E-01	-3.8795511875E-03
8	8.8363685350E+00	-1.7666511877E-01	5.0498513774E-03
9	1.2198623730E+01	-1.4958021383E-01	8.2524678721E-03
10	1.2198545050E+01	-7.6354517662E-01	-2.2393050876E-03
11	1.2198466370E+01	-2.2363842215E-01	2.5562076859E-03
12	1.4006920226E+01	-1.6871315324E-01	9.3489275768E-03
13	1.4005547099E+01	-1.0295668356E+00	-7.2345632194E-04
14	1.4004173972E+01	-2.4597422007E-01	-4.5235756183E-03

Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-7.6030302626E+02	-3.4132900861E+02	1And2
2	5.2240724303E+02	-8.8096243432E+02	2And3
3	8.8096243432E+02	1.6840283563E+03	3And4
4	-8.2153050752E+02	-1.0003830230E+03	4And5
5	-1.8107823443E+02	-2.5316834007E+02	2And6
6	2.8974584983E+02	-8.5679161569E+02	6And7
7	8.5679161570E+02	1.4997086004E+03	7And8
8	-8.6249784881E+02	-8.9591464465E+02	4And8
9	-3.6577509771E+01	-1.4579034706E+02	6And9
10	-7.8011525733E+01	-8.3341917883E+02	9And10
11	8.3341917883E+02	1.1786960985E+03	10And11
12	-6.0379395572E+02	-6.7561089404E+02	8And11
13	2.2380187279E+02	2.5537991228E+02	9And12

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
14	-2.5537991229E+02	-9.8059155300E+02	12And13
15	9.8059155300E+02	7.0698296366E+02	13And14
16	-5.0308520449E+02	-7.0698296365E+02	11And14

## Cumulative Tension

Member	Tension
1	-7.4334125755E+01
2	-2.1167011638E-01
3	-2.1167009823E-01
4	-1.2056893970E+02
5	-5.9164724236E+01
6	-1.5966924494E+00
7	-1.5966923404E+00
8	-8.7012574855E+01
9	-4.2257901264E+01
10	-2.3112265230E-01
11	-2.3112239818E-01
12	-5.5193631465E+01
13	-2.2481203802E+01
14	-4.0335605712E+00
15	-4.0335605712E+00
16	-2.6244562564E+01

Plastic Hinge 2 Formed In Member 1 Near Joint 1

When Load Factor = 1.2430615623E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	1.0427854673E+01	-6.6656093768E-02	5.6076522032E-02
3	1.0427573911E+01	-6.1885767036E+00	4.3037172070E-02
4	1.0427293149E+01	-1.1352596952E+01	5.3923311149E-02
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
6	2.8917668387E+01	-1.1826232836E-01	5.9515093520E-02
7	2.8917412258E+01	-6.4393341081E+00	4.3026934615E-02
8	2.8917156128E+01	-1.1427941686E+01	5.1119151951E-02
9	4.6361351878E+01	-1.5498590901E-01	5.5122258036E-02
10	4.6361213990E+01	-6.3965569554E+00	4.4584152115E-02
11	4.6361076102E+01	-1.1475852084E+01	4.9562787869E-02
12	6.2258532233E+01	-1.7451271627E-01	5.6431032725E-02
13	6.2257139592E+01	-6.6779454066E+00	4.6118743834E-02
14	6.2255746951E+01	-1.1498642266E+01	4.2197230677E-02

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-1.3882183112E+03	2.2678552330E+02	1And2
2	1.5423846403E+02	-7.8459473329E+02	2And3
3	7.8459473324E+02	1.5683967470E+03	3And4
4	-8.2153050752E+02	-1.0003830230E+03	4And5
5	-3.8102398733E+02	-2.8199312848E+02	2And6
6	2.9018355551E+02	-8.9696388567E+02	6And7
7	8.9696388559E+02	1.4796035338E+03	7And8
8	-7.4686623951E+02	-8.2762602441E+02	4And8
9	-8.1904270850E+00	-1.3470408902E+02	6And9
10	-8.7163774075E+01	-8.4590740042E+02	9And10
11	8.4590740037E+02	1.2043691747E+03	10And11
12	-6.5197750943E+02	-6.9680079500E+02	8And11
13	2.2186786305E+02	2.5956057407E+02	9And12
14	-2.5956057409E+02	-1.0020453743E+03	12And13
15	1.0020453742E+03	7.1969642693E+02	13And14
16	-5.0756837976E+02	-7.1969642689E+02	11And14

## Cumulative Tension

Member	Tension
1	-7.8320910177E+01
2	-8.2473755058E-01

## Cumulative Tension

Member	Tension
3	-8.2473748490E-01
4	-1.2056893970E+02
5	-6.0637325644E+01
6	-7.5238073165E-01
7	-7.5238024253E-01
8	-8.8530061762E+01
9	-4.3150207270E+01
10	-4.0504592514E-01
11	-4.0504538586E-01
12	-5.6294717696E+01
13	-2.2943998527E+01
14	-4.0908832216E+00
15	-4.0908828413E+00
16	-2.6778463985E+01

DEFORMATION LARGER THAN 1.000000000E+06 IN CYCLE NO.3



ภาคผนวก จ.

ผลลัพธ์จากโปรแกรมในตัวอย่างที่ 2

Plastic Hinge 1 Formed In Member 7 Near Joint 8

When Load Factor = 1.0507404658E+00

Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	2.7833864759E-01	3.9840237293E-03	3.2089864682E-03
3	2.7801053218E-01	-2.9508562877E-02	-1.0711732839E-03
4	2.7768241678E-01	-3.5271581021E-02	3.0384869050E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	7.9073476144E-01	6.3824652152E-03	4.0527441393E-03
7	7.9017464870E-01	-4.5498571381E-02	-1.0689541244E-03
8	7.8961453596E-01	-6.7222098105E-02	3.9033005244E-03
9	1.3750735281E+00	6.6064663187E-03	4.1277033496E-03
10	1.3744927680E+00	-6.1169724460E-02	-7.2467953033E-04
11	1.3739120079E+00	-9.5038488096E-02	3.8532624924E-03
12	2.0693185842E+00	3.5866514997E-03	4.3703426443E-03
13	2.0686613555E+00	-8.6710913539E-02	-3.8114717832E-04
14	2.0680041268E+00	-1.2839045863E-01	3.7531015754E-03
15	2.9371225228E+00	-3.3246057558E-03	4.9802043767E-03
16	2.9364791749E+00	-1.1873851773E-01	-2.6602104409E-04
17	2.9358358271E+00	-1.6102910389E-01	3.9691047064E-03
18	3.8084746417E+00	-1.1818496230E-02	5.7055883065E-03
19	3.8078085668E+00	-1.5414990408E-01	-4.4119301072E-04
20	3.8071424919E+00	-1.8444028829E-01	4.6902733393E-03
21	4.5705976098E+00	-1.8342089934E-02	5.5376793265E-03
22	4.5693440029E+00	-1.9918447652E-01	-5.8321265797E-05
23	4.5680903960E+00	-1.9705973951E-01	3.6314882154E-03
24	5.2157083267E+00	-2.3338031157E-02	4.2489331939E-03
25	5.2147885282E+00	-2.0125794496E-01	9.5445340553E-04
26	5.2138687297E+00	-2.0482582823E-01	1.0076430378E-03

Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-8.6113050937E+02	-1.2413328385E+02	1And2

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
2	6.1423168922E+02	-1.0169636532E+02	2And3
3	1.0169636532E+02	7.8910552626E+02	3And4
4	-1.9868155798E+02	-8.9652071717E+02	4And5
5	-4.9009840536E+02	-3.1331711064E+02	2And6
6	6.5452572911E+02	-1.0007114840E+02	6And7
7	1.0007114841E+02	8.3265000000E+02	7And8
8	-5.9042396829E+02	-4.0923110147E+02	4And8
9	-3.4120861850E+02	-3.3044072793E+02	6And9
10	6.1024253082E+02	-1.0467521349E+02	9And10
11	1.0467521350E+02	7.7915867152E+02	10And11
12	-4.2341889855E+02	-4.3060686185E+02	8And11
13	-2.7980180292E+02	-2.6544968864E+02	9And12
14	4.8314558888E+02	-1.1395829884E+02	12And13
15	1.1395829884E+02	6.3349555888E+02	13And14
16	-3.4855180968E+02	-3.5447632792E+02	11And14
17	-2.1769590025E+02	-2.0104667496E+02	12And15
18	3.4685438256E+02	-1.1691194463E+02	15And16
19	1.1691194463E+02	4.9129706098E+02	16And17
20	-2.7901923097E+02	-2.7312234549E+02	14And17
21	-1.4580770761E+02	-1.2851939062E+02	15And18
22	1.7866992583E+02	-1.0633583458E+02	18And19
23	1.0633583458E+02	3.4426482434E+02	19And20
24	-2.1817471550E+02	-2.0098686308E+02	17And20
25	-5.0150535225E+01	-5.4152365913E+01	18And21
26	5.9392369052E+01	-1.0889802209E+02	21And22
27	1.0889802209E+02	2.1986289256E+02	22And23
28	-1.4327796126E+02	-1.6851234005E+02	20And23
29	-5.2400031454E+00	-1.3644775839E+01	21And24
30	1.3644775842E+01	-6.7157831768E+01	24And25
31	6.7157831768E+01	6.8462396148E+01	25And26
32	-5.1350552514E+01	-6.8462396147E+01	23And26

## Cumulative Tension

Member	Tension
1	1.2041711722E+01
2	-7.9622671316E-01
3	-7.9622671022E-01
4	-1.0660835364E+02
5	6.6516777209E+00
6	-1.2135775964E+00
7	-1.2135775925E+00
8	-8.8609434046E+01
9	5.6298944012E-01
10	-1.2583135311E+00
11	-1.2583135311E+00
12	-6.9911860177E+01
13	-4.7109111176E+00
14	-1.2573880309E+00
15	-1.2573880192E+00
16	-5.2029074031E+01
17	-7.7118112209E+00
18	-1.1081666824E+00
19	-1.1081666590E+00
20	-3.6419288339E+01
21	-8.3919637889E+00
22	-8.9476067190E-01
23	-8.9476065624E-01
24	-2.3130250183E+01
25	-6.4453105789E+00
26	-1.5998112940E+00
27	-1.5998112862E+00
28	-1.2468017805E+01
29	-2.4679949642E+00
30	-9.9844128715E-01
31	-9.9844127150E-01

## Cumulative Tension

Member	Tension
32	-3.8364478306E+00

Plastic Hinge 2 Formed In Member 11 Near Joint 11

When Load Factor = 1.1106472190E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	2.9686179939E-01	4.1839737338E-03	3.4435128588E-03
3	2.9643778854E-01	-3.1449647962E-02	-1.1543982466E-03
4	2.9601377769E-01	-3.7255354940E-02	3.2460465614E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	8.5282280139E-01	6.6240827236E-03	4.4437054473E-03
7	8.5226268865E-01	-5.6569375221E-02	-1.0716262288E-03
8	8.5121174143E-01	-7.0932416960E-02	4.3538810415E-03
9	1.4844480060E+00	6.9327160201E-03	4.4148300069E-03
10	1.4838733021E+00	-6.4918170654E-02	-7.8880301461E-04
11	1.4832985983E+00	-1.0040658730E-01	4.1073472176E-03
12	2.2212028706E+00	3.7527751396E-03	4.6225224173E-03
13	2.2205029970E+00	-9.1595771916E-02	-4.0632291106E-04
14	2.2198031234E+00	-1.3567212708E-01	3.9740143377E-03
15	3.1387680314E+00	-3.5514783759E-03	5.2643640898E-03
16	3.1380886950E+00	-1.2551886253E-01	-2.8205382899E-04
17	3.1374093586E+00	-1.7017266806E-01	4.1949107102E-03
18	4.0597586331E+00	-1.2529553252E-02	6.0302567085E-03
19	4.0590544429E+00	-1.6293641818E-01	-4.6699961310E-04
20	4.0583502528E+00	-1.9491869902E-01	4.9571990321E-03
21	4.8652631067E+00	-1.9425071879E-02	5.8528177824E-03
22	4.8639380511E+00	-2.1054140747E-01	-6.2273171766E-05
23	4.8626129955E+00	-2.0825764389E-01	3.8379035053E-03
24	5.5470804536E+00	-2.4705849645E-02	4.4905562899E-03
25	5.5461082114E+00	-2.1273226957E-01	1.0082494907E-03



Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
26	5.5451359692E+00	-2.1646650846E-01	1.0644786879E-03

Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-9.1362137825E+02	-1.2276125835E+02	1And2
2	6.6086163219E+02	-1.0821563204E+02	2And3
3	1.0821563204E+02	8.4426336693E+02	3And4
4	-2.0859505303E+02	-9.5410374663E+02	4And5
5	-5.3810037384E+02	-3.2854335667E+02	2And6
6	6.8600046724E+02	-1.2659173303E+02	6And7
7	1.2659173303E+02	8.3265000000E+02	7And8
8	-6.3566831391E+02	-4.0355852643E+02	4And8
9	-3.5745711060E+02	-3.6160506761E+02	6And9
10	6.5538473273E+02	-1.1128386577E+02	9And10
11	1.1128386578E+02	8.3265000000E+02	10And11
12	-4.2909147359E+02	-4.6450605739E+02	8And11
13	-2.9377966515E+02	-2.8149465908E+02	9And12
14	5.1162601773E+02	-1.2033221187E+02	12And13
15	1.2033221187E+02	6.7079459280E+02	13And14
16	-3.6814394262E+02	-3.7603058247E+02	11And14
17	-2.3013135866E+02	-2.1260908101E+02	12And15
18	3.6671017462E+02	-1.2359316939E+02	15And16
19	1.2359316939E+02	5.1935683466E+02	16And17
20	-2.9476401033E+02	-2.8873353936E+02	14And17
21	-1.5410109363E+02	-1.3584731955E+02	15And18
22	1.8885934151E+02	-1.1239677660E+02	18And19
23	1.1239677660E+02	3.6389878712E+02	19And20
24	-2.3062329530E+02	-2.1245542363E+02	17And20
25	-5.3012021975E+01	-5.7240983045E+01	18And21
26	6.2779455083E+01	-1.1510704688E+02	21And22
27	1.1510704688E+02	2.3239836015E+02	22And23
28	-1.5144336349E+02	-1.7811990688E+02	20And23

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
29	-5.5384720443E+00	-1.4422687411E+01	21And24
30	1.4422687414E+01	-7.0986690681E+01	24And25
31	7.0986690682E+01	7.2365805458E+01	25And26
32	-5.4278453274E+01	-7.2365805458E+01	23And26

## Cumulative Tension

Member	Tension
1	1.2646060610E+01
2	-1.0289329961E+00
3	-1.0289329930E+00
4	-1.1260431031E+02
5	6.7672355982E+00
6	-1.2135775964E+00
7	-1.2135775925E+00
8	-9.3397718668E+01
9	7.7569835189E-01
10	-1.2451917269E+00
11	-1.2451917251E+00
12	-7.4078414796E+01
13	-4.9607077736E+00
14	-1.3389748167E+00
15	-1.3389748041E+00
16	-5.5014242045E+01
17	-8.1503295477E+00
18	-1.1701569587E+00
19	-1.1701569343E+00
20	-3.8496853644E+01
21	-8.8703379780E+00
22	-9.4596210071E-01
23	-9.4596208416E-01
24	-2.4449078588E+01
25	-6.8127724030E+00

## Cumulative Tension

Member	Tension
26	-1.6909917875E+00
27	-1.6909917783E+00
28	-1.3178877538E+01
29	-2.6087042163E+00
30	-1.0553688755E+00
31	-1.0553688567E+00
32	-4.0551790973E+00

Plastic Hinge 3 Formed In Member 23 Near Joint 20

When Load Factor = 1.1217080085E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	3.0059122387E-01	4.2177756890E-03	3.4941138287E-03
3	3.0013528435E-01	-3.1879419780E-02	-1.1723023131E-03
4	2.9967934484E-01	-3.7618510431E-02	3.2869097298E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	8.6669406553E-01	6.6546855473E-03	4.5393211450E-03
7	8.6613395279E-01	-5.9145869994E-02	-1.0753111318E-03
8	8.6402434920E-01	-7.1603458026E-02	4.4580855596E-03
9	1.5116021079E+00	6.9582554042E-03	4.5140960705E-03
10	1.5110274040E+00	-6.7669464870E-02	-7.9031613022E-04
11	1.5109283569E+00	-1.0136302068E-01	4.2393269608E-03
12	2.2608584344E+00	3.7669105435E-03	4.6837152727E-03
13	2.2601653456E+00	-9.2691103450E-02	-4.1547690373E-04
14	2.2594722567E+00	-1.3700002995E-01	4.0165393671E-03
15	3.1881483485E+00	-3.6083335690E-03	5.3161423556E-03
16	3.1874600824E+00	-1.2673555289E-01	-2.8563109764E-04
17	3.1867718162E+00	-1.7184590879E-01	4.2382607958E-03
18	4.1183211958E+00	-1.2675677000E-02	6.0902894816E-03
19	4.1176104319E+00	-1.6456588541E-01	-4.7205969555E-04



## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
20	4.1168996681E+00	-1.9683852513E-01	5.0060917070E-03
21	4.9318131291E+00	-1.9639849975E-02	5.9107020197E-03
22	4.9304748013E+00	-2.1263609222E-01	-6.3259389153E-05
23	4.9291364736E+00	-2.1031032802E-01	3.8758594389E-03
24	5.6203792474E+00	-2.4973216172E-02	4.5349407079E-03
25	5.6193973303E+00	-2.1485135940E-01	1.0179342489E-03
26	5.6184154133E+00	-2.1860094573E-01	1.0747087742E-03

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-9.2341313439E+02	-1.2093165839E+02	1And2
2	6.7091756783E+02	-1.0961830550E+02	2And3
3	1.0961830551E+02	8.5549583988E+02	3And4
4	-2.1087170241E+02	-9.6576530368E+02	4And5
5	-5.4998590943E+02	-3.3099755654E+02	2And6
6	6.9442669817E+02	-1.3279579062E+02	6And7
7	1.3279579062E+02	8.3265000000E+02	7And8
8	-6.4462413749E+02	-3.9924328154E+02	4And8
9	-3.6342914165E+02	-3.6705272361E+02	6And9
10	6.6395619292E+02	-1.1756053799E+02	9And10
11	1.1756053800E+02	8.3265000000E+02	10And11
12	-4.3340671848E+02	-4.6483139120E+02	8And11
13	-2.9690346935E+02	-2.8687049354E+02	9And12
14	5.1888431971E+02	-1.2191416380E+02	12And13
15	1.2191416380E+02	6.7887087516E+02	13And14
16	-3.6781860881E+02	-3.8099649498E+02	11And14
17	-2.3201382618E+02	-2.1474856681E+02	12And15
18	3.7042187003E+02	-1.2477490324E+02	15And16
19	1.2477490324E+02	5.2468694662E+02	16And17
20	-2.9787438019E+02	-2.9182138519E+02	14And17
21	-1.5567330323E+02	-1.3722279673E+02	15And18
22	1.9075287688E+02	-1.1352137997E+02	18And19

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
23	1.1352137997E+02	3.6752500000E+02	19And20
24	-2.3286556144E+02	-2.1456559139E+02	17And20
25	-5.3530080165E+01	-5.7810248003E+01	18And21
26	6.3404587200E+01	-1.1625234557E+02	21And22
27	1.1625234557E+02	2.3471477913E+02	22And23
28	-1.5295940861E+02	-1.7989661100E+02	20And23
29	-5.5943392030E+00	-1.4566595891E+01	21And24
30	1.4566595894E+01	-7.1693849189E+01	24And25
31	7.1693849189E+01	7.3086339047E+01	25And26
32	-5.4818168128E+01	-7.3086339046E+01	23And26

## Cumulative Tension

Member	Tension
1	1.2748227020E+01
2	-1.1064132272E+00
3	-1.1064132240E+00
4	-1.1370194778E+02
5	6.7583633402E+00
6	-1.2135775964E+00
7	-1.2135775925E+00
8	-9.4251587996E+01
9	7.6297224031E-01
10	-1.2451917269E+00
11	-1.2451917251E+00
12	-7.4795700796E+01
13	-4.9784979827E+00
14	-1.3259945089E+00
15	-1.3259944961E+00
16	-5.5593734472E+01
17	-8.2295432222E+00
18	-1.1855384741E+00
19	-1.1855384496E+00

## Cumulative Tension

Member	Tension
20	-3.8882193132E+01
21	-8.5585353098E+00
22	-9.5479280700E-01
23	-9.5479278995E-01
24	-2.4692704943E+01
25	-6.8806028995E+00
26	-1.7079292948E+00
27	-1.7079292853E+00
28	-1.3310141253E+01
29	-2.6346829011E+00
30	-1.0658709463E+00
31	-1.0658709272E+00
32	-4.0955651500E+00

Plastic Hinge 4 Formed In Member 15 Near Joint 14  
 When Load Factor = 1.1768808744E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	3.1919220524E-01	4.3864173285E-03	3.7467492941E-03
3	3.1857586899E-01	-3.4031631953E-02	-1.2615840253E-03
4	3.1795953273E-01	-3.9430016564E-02	3.4904085018E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	9.3595633937E-01	6.8074829074E-03	5.0170045528E-03
7	9.3539622663E-01	-7.2014361446E-02	-1.0937814992E-03
8	9.2782512346E-01	-7.4950856733E-02	4.9766721752E-03
9	1.6472186230E+00	7.0856512553E-03	5.0097915842E-03
10	1.6466439192E+00	-8.1405515686E-02	-7.9793144663E-04
11	1.6485226209E+00	-1.0613385441E-01	4.8972629912E-03
12	2.4587406648E+00	3.8368694504E-03	4.9860180520E-03
13	2.4580908454E+00	-9.8012118620E-02	-4.6206169300E-04

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
14	2.4574410260E+00	-1.4362325671E-01	4.2352350283E-03
15	3.4365625737E+00	-3.8984058810E-03	5.6356899665E-03
16	3.4357760408E+00	-1.3371709206E-01	-3.1906331406E-04
17	3.4349895078E+00	-1.8018581265E-01	4.4549336282E-03
18	4.4415619496E+00	-1.3486974175E-02	6.6850852290E-03
19	4.4408511857E+00	-1.8522168611E-01	-4.3823580338E-04
20	4.4346559241E+00	-2.0633249358E-01	5.7718724389E-03
21	5.3215328539E+00	-2.0727728424E-02	6.2948388633E-03
22	5.3201544962E+00	-2.2351936059E-01	-1.0904846337E-04
23	5.3187761385E+00	-2.2053288886E-01	4.1316130121E-03
24	6.0490329549E+00	-2.6315222662E-02	4.7592416473E-03
25	6.0480012054E+00	-2.2531504135E-01	1.0628047166E-03
26	6.0469694559E+00	-2.2923949431E-01	1.1357530687E-03

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-9.7219182389E+02	-1.1168840267E+02	1And2
2	7.2108862374E+02	-1.1663859616E+02	2And3
3	1.1663859617E+02	9.1148854620E+02	3And4
4	-2.2235667857E+02	-1.0239871645E+03	4And5
5	-6.0940022107E+02	-3.4326057346E+02	2And6
6	7.3653928061E+02	-1.6378319771E+02	6And7
7	1.6378319771E+02	8.3265000000E+02	7And8
8	-6.8913186765E+02	-3.7773485701E+02	4And8
9	-3.9327870719E+02	-3.9431485014E+02	6And9
10	7.0677175721E+02	-1.4889943600E+02	9And10
11	1.4889943601E+02	8.3265000000E+02	10And11
12	-4.5491514301E+02	-4.6632227230E+02	8And11
13	-3.1245690711E+02	-3.1386311154E+02	9And12
14	5.5513564259E+02	-1.2950637869E+02	12And13
15	1.2950637869E+02	7.1980000000E+02	13And14
16	-3.6632772771E+02	-4.0548668172E+02	11And14

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
17	-2.4127253107E+02	-2.2353648780E+02	12And15
18	3.9438619623E+02	-1.3201399378E+02	15And16
19	1.3201399378E+02	5.5403532347E+02	16And17
20	-3.1431331829E+02	-3.0831554651E+02	14And17
21	-1.7084970844E+02	-1.4583912135E+02	15And18
22	2.0147239631E+02	-1.2881225555E+02	18And19
23	1.2881225555E+02	3.6752500000E+02	19And20
24	-2.4571977696E+02	-2.1433273531E+02	17And20
25	-5.5633274983E+01	-6.4934146696E+01	18And21
26	7.0403106480E+01	-1.2218313172E+02	21And22
27	1.2218313172E+02	2.4971395783E+02	22And23
28	-1.5319226470E+02	-1.9228511437E+02	20And23
29	-5.4689597911E+00	-1.5483612968E+01	21And24
30	1.5483612971E+01	-7.5177663484E+01	24And25
31	7.5177663484E+01	7.6966843399E+01	25And26
32	-5.7428843468E+01	-7.6966843399E+01	23And26

## Cumulative Tension

Member	Tension
1	1.3257946375E+01
2	-1.4956426552E+00
3	-1.4956426519E+00
4	-1.1917722506E+02
5	6.7144218724E+00
6	-1.2135775964E+00
7	-1.2135775925E+00
8	-9.8511130070E+01
9	6.9912978090E-01
10	-1.2451917265E+00
11	-1.2451917251E+00
12	-7.8373267487E+01
13	-5.0680996156E+00

## Cumulative Tension

Member	Tension
14	-1.2432128959E+00
15	-1.2432128823E+00
16	-5.8483467599E+01
17	-8.6312780573E+00
18	-1.3548029762E+00
19	-1.3548029504E+00
20	-4.0797718665E+01
21	-9.4735054748E+00
22	-9.5479280700E-01
23	-9.5479278995E-01
24	-2.5832920756E+01
25	-7.1538651976E+00
26	-1.7590141307E+00
27	-1.7590141179E+00
28	-1.4029990542E+01
29	-2.7602221536E+00
30	-1.1199641142E+00
31	-1.1199640926E+00
32	-4.3010630929E+00

Plastic Hinge 5 Formed In Member 3 Near Joint 4

When Load Factor = 1.2040451667E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	3.2857472395E-01	4.4673654513E-03	3.8802851206E-03
3	3.2785238298E-01	-3.5267145496E-02	-1.3072381168E-03
4	3.2713004200E-01	-4.0319826987E-02	3.5880269685E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	9.7301706320E-01	6.8733497536E-03	5.2820347256E-03
7	9.7245695046E-01	-7.9025133425E-02	-1.1067813304E-03

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
8	9.5884942734E-01	-7.6589581600E-02	5.2318599951E-03
9	1.7222256131E+00	7.1199870396E-03	5.3023361305E-03
10	1.7216509092E+00	-8.9270101741E-02	-8.0827428629E-04
11	1.7189600826E+00	-1.0845438109E-01	5.2822995307E-03
12	2.5769112416E+00	3.7833738518E-03	5.2714698349E-03
13	2.5762614221E+00	-1.0614403240E-01	-4.6363420026E-04
14	2.5808645168E+00	-1.4679625443E-01	4.6928350763E-03
15	3.5980343192E+00	-4.0838677724E-03	5.8531271881E-03
16	3.5972455233E+00	-1.3832439367E-01	-3.4714477107E-04
17	3.5964567274E+00	-1.8424930885E-01	4.5437239499E-03
18	4.6431697158E+00	-1.3926715019E-02	6.9797164773E-03
19	4.6424589519E+00	-1.9544680311E-01	-4.2256130826E-04
20	4.6307313902E+00	-2.1096653751E-01	6.1660041380E-03
21	5.5551075829E+00	-2.1302018612E-02	6.4764240437E-03
22	5.5537054240E+00	-2.2861065349E-01	-1.3323864258E-04
23	5.5523032651E+00	-2.2552727946E-01	4.2677935692E-03
24	6.3018244940E+00	-2.7014430419E-02	4.8714589936E-03
25	6.3007691942E+00	-2.3053466649E-01	1.0841740327E-03
26	6.2997138945E+00	-2.3443889802E-01	1.1630682560E-03

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-9.9539439065E+02	-1.0422224130E+02	1And2
2	7.4711439344E+02	-1.2058532672E+02	2And3
3	1.2058532673E+02	9.3940000000E+02	3And4
4	-2.3017127029E+02	-1.0542214641E+03	4And5
5	-6.4289215214E+02	-3.4920224739E+02	2And6
6	7.6058829039E+02	-1.8069727520E+02	6And7
7	1.8069727520E+02	8.3265000000E+02	7And8
8	-7.0922872973E+02	-3.6481831346E+02	4And8
9	-4.1138604303E+02	-4.0846974622E+02	6And9
10	7.3326231427E+02	-1.6703428714E+02	9And10

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
11	1.6703428714E+02	8.3265000000E+02	10And11
12	-4.6783168657E+02	-4.6058604727E+02	8And11
13	-3.2479256809E+02	-3.2661830949E+02	9And12
14	5.7592218472E+02	-1.4478922236E+02	12And13
15	1.4478922236E+02	7.1980000000E+02	13And14
16	-3.7206395274E+02	-4.0693077522E+02	11And14
17	-2.4930387525E+02	-2.3342462951E+02	12And15
18	4.1080216463E+02	-1.3730187657E+02	15And16
19	1.3730187657E+02	5.6965467150E+02	16And17
20	-3.1286922479E+02	-3.1693995854E+02	14And17
21	-1.7737753513E+02	-1.5052715707E+02	15And18
22	2.0683554443E+02	-1.3638340222E+02	18And19
23	1.3638340222E+02	3.6752500000E+02	19And20
24	-2.5271471297E+02	-2.1405036849E+02	17And20
25	-5.6308387380E+01	-6.8303523710E+01	18And21
26	7.3805304066E+01	-1.2496928512E+02	21And22
27	1.2496928512E+02	2.5732299384E+02	22And23
28	-1.5347463152E+02	-1.9871531674E+02	20And23
29	-5.5017803633E+00	-1.5968827432E+01	21And24
30	1.5968827435E+01	-7.6920648373E+01	24And25
31	7.6920648373E+01	7.8855660690E+01	25And26
32	-5.8607677105E+01	-7.8855660690E+01	23And26

## Cumulative Tension

Member	Tension
1	1.3502612077E+01
2	-1.7528807617E+00
3	-1.7528807583E+00
4	-1.2186667707E+02
5	6.6725964648E+00
6	-1.2135775965E+00
7	-1.2135775925E+00



## Cumulative Tension

Member	Tension
8	-1.0058811946E+02
9	6.1988171215E-01
10	-1.2451917267E+00
11	-1.2451917251E+00
12	-8.0086862707E+01
13	-5.2051165730E+00
14	-1.2432128959E+00
15	-1.2432128823E+00
16	-5.9813322423E+01
17	-8.7785304455E+00
18	-1.3587008890E+00
19	-1.3587008624E+00
20	-4.1791366551E+01
21	-9.7247330797E+00
22	-9.5479280700E-01
23	-9.5479278995E-01
24	-2.6396621918E+01
25	-7.2867999500E+00
26	-1.7893884519E+00
27	-1.7893884375E+00
28	-1.4386013050E+01
29	-2.8219314324E+00
30	-1.1455278735E+00
31	-1.1455278503E+00
32	-4.4023395677E+00

Plastic Hinge 6 Formed In Member 19 Near Joint 17

When Load Factor = 1.2210871037E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00

## Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
2	3.3991197440E-01	4.4811156160E-03	4.0263124584E-03
3	3.3918963343E-01	-3.9027120340E-02	-1.3181839451E-03
4	3.3445059042E-01	-4.0841029370E-02	3.7039890205E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	1.0070784545E+00	6.8925030421E-03	5.4748456559E-03
7	1.0065183418E+00	-8.4028916497E-02	-1.1186701702E-03
8	9.8572369748E-01	-7.7595491585E-02	5.4351646457E-03
9	1.7824013545E+00	7.1259020005E-03	5.4970130108E-03
10	1.7818266506E+00	-9.4460683172E-02	-8.1644908513E-04
11	1.7749739628E+00	-1.0989457310E-01	5.5549870033E-03
12	2.6652451984E+00	3.7379961031E-03	5.4554829860E-03
13	2.6645953790E+00	-1.1136108294E-01	-4.6545861803E-04
14	2.6726671008E+00	-1.4877506695E-01	4.9931464641E-03
15	3.7142030697E+00	-4.2103196561E-03	5.9916315990E-03
16	3.7134145787E+00	-1.4125785395E-01	-3.6534385975E-04
17	3.7126260878E+00	-1.8678850624E-01	4.5986531693E-03
18	4.7846244437E+00	-1.4212603170E-02	7.1644882861E-03
19	4.7839136798E+00	-2.0186387451E-01	-4.1290665402E-04
20	4.7686113320E+00	-2.1386376636E-01	6.4137645050E-03
21	5.7165727697E+00	-2.1672257325E-02	6.5899272189E-03
22	5.7151555289E+00	-2.3179495956E-01	-1.4861815384E-04
23	5.7137382882E+00	-2.2865063839E-01	4.3534644496E-03
24	6.4753304468E+00	-2.7463030502E-02	4.9417836414E-03
25	6.4742604086E+00	-2.3381176696E-01	1.0974116561E-03
26	6.4731903704E+00	-2.3769088266E-01	1.1799623424E-03

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-1.0269514917E+03	-1.0224173044E+02	1And2
2	7.6257361318E+02	-1.3138248525E+02	2And3
3	1.3138248525E+02	9.3940000000E+02	3And4
4	-2.1893818327E+02	-1.0696209950E+03	4And5

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
5	-6.6033188274E+02	-3.5684003565E+02	2And6
6	7.7864932426E+02	-1.9279534080E+02	6And7
7	1.9279534080E+02	8.3265000000E+02	7And8
8	-7.2046181675E+02	-3.5775167033E+02	4And8
9	-4.2180928865E+02	-4.1862494813E+02	6And9
10	7.5114182453E+02	-1.7904159093E+02	9And10
11	1.7904159093E+02	8.3265000000E+02	10And11
12	-4.7489832970E+02	-4.5768584803E+02	8And11
13	-3.3251687644E+02	-3.3497337741E+02	9And12
14	5.8944621083E+02	-1.5461878407E+02	12And13
15	1.5461878407E+02	7.1980000000E+02	13And14
16	-3.7496415198E+02	-4.0819701987E+02	11And14
17	-2.5447283343E+02	-2.3983597630E+02	12And15
18	4.2127396793E+02	-1.4068266263E+02	15And16
19	1.4068266263E+02	5.7950000000E+02	16And17
20	-3.1160298014E+02	-3.2237264708E+02	14And17
21	-1.8143799164E+02	-1.5348490727E+02	15And18
22	2.1020357782E+02	-1.4113496757E+02	18And19
23	1.4113496757E+02	3.6752500000E+02	19And20
24	-2.5712735292E+02	-2.1386719943E+02	17And20
25	-5.6718670568E+01	-7.0412376000E+01	18And21
26	7.5938209256E+01	-1.2671231192E+02	21And22
27	1.2671231192E+02	2.6210494275E+02	22And23
28	-1.5365780058E+02	-2.0276161857E+02	20And23
29	-5.5258332630E+00	-1.6274476294E+01	21And24
30	1.6274476297E+01	-7.8015153930E+01	24And25
31	7.8015153930E+01	8.0039847099E+01	25And26
32	-5.9343324189E+01	-8.0039847098E+01	23And26

## Cumulative Tension

Member	Tension
1	1.3544171949E+01

## Cumulative Tension

Member	Tension
2	-1.7528807617E+00
3	-1.7528807583E+00
4	-1.2344201127E+02
5	6.6875811284E+00
6	-1.2135775965E+00
7	-1.2135775925E+00
8	-1.0193237521E+02
9	5.8660938208E-01
10	-1.2451917268E+00
11	-1.2451917251E+00
12	-8.1178358219E+01
13	-5.2851331999E+00
14	-1.2432128954E+00
15	-1.2432128823E+00
16	-6.0653570394E+01
17	-8.8689956680E+00
18	-1.3581756639E+00
19	-1.3581756369E+00
20	-4.2416662683E+01
21	-9.8822561118E+00
22	-9.5479280700E-01
23	-9.5479278995E-01
24	-2.6750356996E+01
25	-7.3701383050E+00
26	-1.8086354317E+00
27	-1.8086354165E+00
28	-1.4609429561E+01
29	-2.8606419495E+00
30	-1.1615264875E+00
31	-1.1615264633E+00
32	-4.4658806726E+00



Plastic Hinge 7 Formed In Member 6 Near Joint 6

When Load Factor = 1.2675271472E+00

Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
2	3.7308327264E-01	4.5378527465E-03	4.4540017386E-03
3	3.7236093166E-01	-4.9935555496E-02	-1.3513703349E-03
4	3.4847129444E-01	-4.2280596581E-02	3.9293769675E-03
5	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00
6	1.1071246583E+00	6.9738658810E-03	6.0440402753E-03
7	1.1065645455E+00	-9.8638475547E-02	-1.1559928910E-03
8	1.0388884828E+00	-8.0365810728E-02	5.8530902770E-03
9	1.9601588669E+00	7.1662555269E-03	6.0797911410E-03
10	1.9595841630E+00	-1.0977234754E-01	-8.4480573421E-04
11	1.8911626328E+00	-1.1384339601E-01	6.1742047274E-03
12	2.9293368750E+00	3.6000067440E-03	6.0328888160E-03
13	2.9286870555E+00	-1.2729229371E-01	-4.8019419769E-04
14	2.8828360196E+00	-1.5415308694E-01	5.9080761822E-03
15	4.0772440403E+00	-4.6767962672E-03	6.6091868314E-03
16	4.0764555494E+00	-1.5925260033E-01	-3.7136442239E-04
17	4.0501056069E+00	-1.9358604361E-01	5.7358217064E-03
18	5.2460034585E+00	-1.5031004601E-02	7.8371129842E-03
19	5.2452926946E+00	-2.2317048347E-01	-4.0847412899E-04
20	5.2338579966E+00	-2.2171950169E-01	7.3261585695E-03
21	6.2538473060E+00	-2.2687766824E-02	7.0049113311E-03
22	6.2524330656E+00	-2.4243522466E-01	-2.1081945258E-04
23	6.2510188253E+00	-2.3715533931E-01	4.5617451037E-03
24	7.0480774464E+00	-2.8688006113E-02	5.1201292348E-03
25	7.0469600291E+00	-2.4224608404E-01	1.1318024022E-03
26	7.0458426118E+00	-2.4655016659E-01	1.2457691802E-03

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-1.1191840578E+03	-9.6248325135E+01	1And2
2	8.0839356599E+02	-1.6265166949E+02	2And3
3	1.6265166950E+02	9.3940000000E+02	3And4
4	-1.9591219520E+02	-1.0983591054E+03	4And5
5	-7.1214524086E+02	-3.7900566677E+02	2And6
6	8.3265000000E+02	-2.2815488650E+02	6And7
7	2.2815488650E+02	8.3265000000E+02	7And8
8	-7.4348780482E+02	-3.4043780459E+02	4And8
9	-4.5364433327E+02	-4.4850872142E+02	6And9
10	8.0559603541E+02	-2.1462790420E+02	9And10
11	2.1462790421E+02	8.3265000000E+02	10And11
12	-4.9221219543E+02	-4.4608410464E+02	8And11
13	-3.5708731403E+02	-3.5986158656E+02	9And12
14	6.3348169703E+02	-1.8499573501E+02	12And13
15	1.8499573501E+02	7.1980000000E+02	13And14
16	-3.8656589537E+02	-4.0230739882E+02	11And14
17	-2.7362011049E+02	-2.5788717467E+02	12And15
18	4.5245056289E+02	-1.6463016795E+02	15And16
19	1.6463016795E+02	5.7950000000E+02	16And17
20	-3.1749260119E+02	-3.2219514837E+02	14And17
21	-1.9456338824E+02	-1.6529781493E+02	15And18
22	2.2528533510E+02	-1.5703505405E+02	18And19
23	1.5703505405E+02	3.6752500000E+02	19And20
24	-2.5730485163E+02	-2.1940182306E+02	17And20
25	-5.9987520192E+01	-7.9821659589E+01	18And21
26	8.4555095763E+01	-1.3244598134E+02	21And22
27	1.3244598134E+02	2.7597290609E+02	22And23
28	-1.4812317694E+02	-2.1400836455E+02	20And23
29	-4.7334361820E+00	-1.7025356753E+01	21And24
30	1.7025356756E+01	-8.0795006026E+01	24And25
31	8.0795006026E+01	8.3590231202E+01	25And26

## Cumulative Moments

Member	Terminal Applied Moments		Near Joints
32	-6.1964541553E+01	-8.3590231201E+01	23And26

## Cumulative Tension

Member	Tension
1	1.3715659926E+01
2	-1.7528807616E+00
3	-1.7528807583E+00
4	-1.2779310317E+02
5	6.7558764263E+00
6	-1.2135775968E+00
7	-1.2135775925E+00
8	-1.0562299390E+02
9	4.8353931006E-01
10	-1.2451917282E+00
11	-1.2451917251E+00
12	-8.4140331019E+01
13	-5.5633481013E+00
14	-1.2432128941E+00
15	-1.2432128823E+00
16	-6.2883117843E+01
17	-9.2355326932E+00
18	-1.3581756633E+00
19	-1.3581756369E+00
20	-4.4000607486E+01
21	-1.0229957834E+01
22	-9.5479280700E-01
23	-9.5479278995E-01
24	-2.7795856580E+01
25	-7.5648810766E+00
26	-1.8048064410E+00
27	-1.8048064237E+00
28	-1.5250607573E+01

## Cumulative Tension

Member	Tension
29	-2.9641182087E+00
30	-1.2129565030E+00
31	-1.2129564767E+00
32	-4.6410446745E+00

ZERO DIVISION IN EQUATION SOLUTION



ภาคผนวก ฉ.

ผลลัพธ์จากโปรแกรมในตัวอย่างที่ 3



Plastic Hinge 1 Formed In Member 4 Near Joint 9

When Load Factor = 9.4920961850E-01

Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	9.6741953525E-03
2	3.3992885663E+00	-1.8541119181E-03	6.1462735423E-03
3	3.3828282166E+00	-7.3249717500E-01	-3.2848023014E-03
4	3.3663678670E+00	-2.2570267712E-02	7.1483068320E-03
5	7.3178884115E+00	-2.7780393508E-02	9.9546725913E-03
6	7.3144979004E+00	-2.0882160827E+00	-1.8773254438E-03
7	7.3111073893E+00	-2.8008256075E-02	-2.4436618468E-03
8	0.0000000000E+00	0.0000000000E+00	1.4930157278E-02
9	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00

Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-1.8104736681E-06	-4.1858792278E+05	1And2
2	4.1858792276E+05	-7.0040922610E+05	2And3
3	7.0040922610E+05	1.9382976248E+06	3And4
4	-1.2993533944E+06	-2.1475000000E+06	4And9
5	-6.3894423042E+05	-3.0596893307E+05	4And5
6	3.0596893304E+05	-1.0978976338E+06	5And6
7	1.0978976338E+06	1.0307018196E+06	6And7
8	-1.0307018196E+06	-7.2418946724E-06	7And8

Cumulative Tension

Member	Tension
1	-7.0455325832E+02
2	-6.2548505754E+03
3	-6.2548505718E+03
4	-8.5765888790E+03
5	-1.9798217519E+03
6	-1.2883772776E+03
7	-1.2883772667E+03
8	-5.3214986336E+03

Plastic Hinge 2 Formed In Member 4 Near Joint 4

When Load Factor = 1.2358491038E+00

Cumulative Déformation

Joint	X-Movement	Y-Movement	Rotaion
1	0.0000000000E+00	0.0000000000E+00	2.1795329692E-02
2	8.3230652803E+00	-4.7552434135E-03	1.8832330218E-02
3	8.3003616880E+00	-5.5402526899E+00	6.8145698858E-03
4	8.2776580956E+00	-8.1049691470E+00	1.4660994516E-02
5	1.2714189751E+01	-8.1072781414E+00	5.1502650617E-03
6	1.2707234851E+01	-6.4480037561E+00	-1.4432625240E-02
7	1.2700279951E+01	-4.5415044989E-02	-7.8837373234E-03
8	0.0000000000E+00	0.0000000000E+00	2.7754893569E-02
9	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00

Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-3.9973593895E-06	-3.5155988758E+05	1And2
2	3.5155988754E+05	-1.0743473759E+06	2And3
3	1.0743473759E+06	2.0053256582E+06	3And4
4	-2.1475000000E+06	-2.1475000000E+06	4And9
5	1.4217434172E+05	-9.8627370799E+05	4And5
6	9.8627370796E+05	-1.3372362264E+06	5And6
7	1.3372362264E+06	2.1142617777E+06	6And7
8	-2.1142617777E+06	-1.1615666115E-05	7And8

Cumulative Tension

Member	Tension
1	-1.8069687209E+03
2	-8.6272515796E+03
3	-8.6272515672E+03
4	-8.5765888790E+03
5	-8.7740630465E+02
6	-2.6428272235E+03
7	-2.6428272083E+03
8	-8.6287450102E+03

Plastic Hinge 3 Formed In Member 8 Near Joint 7

When Load Factor = 1.2429493356E+00

Cumulative Deformation

Joint	X-Movement	Y-Movement	Rotation
1	0.0000000000E+00	0.0000000000E+00	2.2601642974E-02
2	8.6274421134E+00	-4.8271061788E-03	1.9502529902E-02
3	8.6047010461E+00	-5.7416842332E+00	7.1204817199E-03
4	8.5819599788E+00	-8.3497704770E+00	1.4602618499E-02
5	1.2947096815E+01	-8.3520076086E+00	4.8676695563E-03
6	1.2940032578E+01	-6.5567274189E+00	-1.4799371873E-02
7	1.2932968340E+01	-4.5846221578E-02	-7.9663924685E-03
8	0.0000000000E+00	0.0000000000E+00	2.8232511872E-02
9	0.0000000000E+00	0.0000000000E+00	0.0000000000E+00

Cumulative Moments

Member	Terminal Applied Moments		Near Joints
1	-4.1057003284E-06	-3.6770976597E+05	1And2
2	3.6770976594E+05	-1.1014202509E+06	2And3
3	1.1014202509E+06	1.9891757797E+06	3And4
4	-2.1475000000E+06	-2.1475000000E+06	4And9
5	1.5832422021E+05	-9.9672747185E+05	4And5
6	9.9672747182E+05	-1.3367669937E+06	5And6
7	1.3367669937E+06	2.1475000000E+06	6And7
8	-2.1475000000E+06	-1.1615666115E-05	7And8

Cumulative Tension

Member	Tension
1	-1.8342762124E+03
2	-8.6414918661E+03
3	-8.6414918533E+03
4	-8.5765888790E+03
5	-8.5009881369E+02
6	-2.6843750011E+03
7	-2.6843749857E+03
8	-8.7106674843E+03

DEFORMATION LARGER THAN 1.0000000000E+06 IN CYCLE NO.4



## ประวัติผู้เขียน

นายศิริวุฒิ ศศิบุตร เกิดเมื่อวันที่ 6 กรกฎาคม พ.ศ. 2509 ที่กรุงเทพฯ สำเร็จ  
การศึกษาได้รับปริญญาวิทยาศาสตรบัณฑิตสาขาวิศวกรรมโยธา จากจุฬาลงกรณ์มหาวิทยาลัย  
เมื่อปีการศึกษา 2530 เข้าศึกษาหลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาวิศวกรรม  
โครงสร้าง ภาควิชาวิศวกรรมโยธา คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัยเมื่อปี  
การศึกษา 2531