

## หนังสืออ้างอิง

- 1 ตระกูล อ่วมรักษ์, “การวิเคราะห์โครงสร้าง 2” ฟิสิกส์เชิงเตอร์ การพิมพ์, 2529.
- 2 สมชาย ตั้งจิตเพิ่มคามดี “การวิเคราะห์ไม่เชิงเส้นทางเรขาคณิตของโครงข้อแข็งระนาบด้วยไมโครคอมพิวเตอร์”, วิทยานิพนธ์มหาบัณฑิต ภาควิศวกรรมโยธา จุฬาลงกรณ์มหาวิทยาลัย, 2531.
- 3 สัญญา เพชรเนียม “การวิเคราะห์โครงข้อแข็งด้วยวิธีอีลาสติค-พลาสติกโดยคำนึงถึงผล  $P-\Delta$ ”, วิทยานิพนธ์มหาบัณฑิต ภาควิศวกรรมโยธา จุฬาลงกรณ์มหาวิทยาลัย, 2535.
- 4 วินัย แก้วกุลชล “การวิเคราะห์อีลาสติค-พลาสติกอันดับที่สองของโครงข้อแข็ง”, วิทยานิพนธ์มหาบัณฑิต ภาควิศวกรรมโยธา จุฬาลงกรณ์มหาวิทยาลัย, 2538.
- 5 Bruinette, K. E. and Fenves, S.J. (1966). A general formation of the elastic-plastic analysis of space frame works.”International Conference on Space Structures., Depature of Civil Engineering, University of Surrey, U.K., Sep. pp92-108.
- 6 Chu, K. H., and Rampetsreiter, R. H. (1972). “Large Deflection Buckling of Space frames. ” J. Struct. Div., ASCE, 98(12), pp.2701-2722.
- 7 Connor, J. J., Logeer, R. D., and Chan, S. C. (1968). “Nonlinear Analysis of Elastic Framed Structures.” J. Struct. Div., ASCE, 94(6), pp.1525-1547.
- 8 Erwin Kreyszig “Advanced Engineering Mathematics” John Wiley & Sons, Inc.
- 9 Ghali A., Neville A.M., Cheung Y.K. (1978) “Structural Analysis” Chapman & Hall.
- 10 Jenning A. (1968) “Frame Analysis Including Change of Geometry. ” J. Struct. Div., ASCE, 94(3), pp.627-644.
- 11 Kassimali, A. (1990) “Large Deflection Analysis of Elastic Space Frames. ” J. Struct. Div., ASCE, 117(6), pp.2069-2087.
- 12 Oran, C., (1973) “Tangent Stiffness in Plane Frames. ” J. Struct. Div., ASCE, 99(5) pp. 973-985.
- 13 Oran, C., (1973) “Tangent Stiffness in Space Frames. ” J. Struct. Div., ASCE, 99(5) pp.987-1001.
- 14 Ram Chandra, (1990) “Elastic-Plastic Analysis of Steel Space Structures. ” J. Struct. Div., ASCE, 116(4), pp 939-953.
- 15 Reddy, J.N. “Finite Element Method” McGraw-Hill, (1993).

- 16 Sohal I ,Chen W.F., “ Plastic Design and Second-Order Analysis of Steel Frames ” Springer-Verlag ,(1995).
- 17 Timoshenko, S.P., and Gere, J.M., “Theory of Elastic Stability” \* Edition, Mc.Graw-Hill, N.Y., (1961).
- 18 Timoshenko, S.P., and Gere, J.M., “Theory of Elasticity” † Edition, Mc.Graw-Hill, N.Y., (1970).
- 19 Vinit Chovichien, “ Stability of Structures “, Unpublished , Chulalongkorn University, (1977).
- 20 Yang , Yeong-Bin , McGuire ,William (1986a) “Stiffness Matrix for Geometric Nonlinear Analysis,” *J. Struct. Eng. ASCE.*, 112(4), pp.853-877.
- 21 Yang , Yeong-Bin , McGuire , William (1986b) “ Joint Rotation and Geometric Nonlinear Analysis,” *J. Struct. Eng. ASCE.*, 112(4), pp.879-905.



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## วิธีการใช้ตัวอย่างโปรแกรม

ทิศของแกน การเคลื่อนที่ และแรงภายในที่วิเคราะห์โดยตัวอย่างโปรแกรมนี้จะใช้ตาม ในรูปที่ 2.1

เริ่มใช้โปรแกรม เมื่อเรียกโปรแกรมมาใช้จะปรากฏค่า 4 คำ

- 1 input data ใช้สำหรับการแก้ไขข้อมูลหรือเขียนข้อมูลใหม่
- 2 solution ใช้สำหรับการวิเคราะห์หาแรงภายในและค่าการเคลื่อนที่ของจุดต่อ
- 3 result ใช้สำหรับการอ่านผลการวิเคราะห์จากในหัวข้อ 2
- 4 exit ใช้สำหรับการออกจากโปรแกรม

1 Input data การป้อนข้อมูลจะแบ่งเป็น 4 หัวข้อหลัก

- 1.1 Load Exist File ใช้สำหรับการแก้ไขข้อมูล
- 1.2 Edit New File ใช้สำหรับเขียนข้อมูลใหม่
- 1.3 Data Output ใช้สำหรับการอ่านข้อมูลที่ป้อนลงไป
- 1.4 Quit ใช้สำหรับออกจากการป้อนข้อมูล

Load Exist File หรือ Edit New File

เมื่อเลือกใช้จะปรากฏคำว่า Input File Name ให้ใส่ชื่อที่ต้องการเขียนข้อมูลลงไปจากนั้น กด enter ( ระวังระหว่างที่ป้อนชื่ออย่าป้อนชื่อผิดเพราะจะทำให้ไม่สามารถวิเคราะห์ข้อมูลได้ ) จะปรากฏอักษร 5 คำ

- 1 Input Control Parameter ใช้ในการป้อนชื่อผู้ทำ ป้อนหน่วยแรงกระทำ
- 2 Input Node Data ใช้ในการป้อนข้อมูลโคออร์ดิเนตจุดต่อ เงื่อนไขการยึดรั้งของจุดต่อ
- 3 Input Element Data ใช้ในการป้อนข้อมูลเกี่ยวกับคุณสมบัติชิ้นส่วน
- 4 Input Load Data ใช้ในการป้อนน้ำหนักกระทำ

Data Output เมื่อเรียกใช้จะปรากฏอักษร 5 คำ

- 1 Text on Screen ดูข้อมูลจากหน้าจอคอมพิวเตอร์
- 2 Graphics On Screen ดูรูปของโครงสร้างจากคอมพิวเตอร์
- 3 Text on Printer ดูข้อมูลจากเครื่องพิมพ์
- 4 Graphics On Printer ดูรูปของโครงสร้างจากเครื่องพิมพ์
- 5 Quit ออกจากการดูข้อมูล

## 2 Solution จะมี 5 หัวข้อ

- 1 1st Order Elastic Analysis การวิเคราะห์โครงสร้างโดยวิธีอีลาสติกอันดับที่ 1
- 2 2nd Order Elastic Analysis การวิเคราะห์โครงสร้างโดยวิธีอีลาสติกอันดับที่ 2
- 3 1st Order Elastic-Plastic Analysis การวิเคราะห์โครงสร้างโดยวิธีอีลาสติก-พลาสติกอันดับที่ 1
- 4 2nd Order Elastic-Plastic Analysis การวิเคราะห์โครงสร้างโดยวิธีอีลาสติก-พลาสติกอันดับที่ 2
- 5 Quit ออกจากการวิเคราะห์

## 3 Result จะมี 5 หัวข้อ

- 1 Text on Screen ดูผลการวิเคราะห์จากหน้าจอคอมพิวเตอร์
- 2 Graphics On Screen ดูรูปโครงสร้างจากคอมพิวเตอร์
- 3 Text on Printer ดูผลการวิเคราะห์จากเครื่องพิมพ์
- 4 Graphics On Printer ดูรูปโครงสร้างจากเครื่องพิมพ์
- 5 Quit ออกจากการดูผลการวิเคราะห์

### การอ่านข้อมูล Text on Printer

หลังเลือกตัวเลือกนี้จะมีตัวเลือก 2 ตัว

- 1 Internal Member Force
- 2 Nodal Displacement

ถ้าเลือก 1 จะได้คำตอบคือแรงภายในชิ้นส่วน ดังจะแสดงต่อไปนี้

Project Name : Nue2

Internal Member Force

Load Factor = 1.412 : Hinge No = 1

Ele No = 1 Near\Ele No = 4:Near\

Ele: Axial : Shear-Y : Shear-Z : Torsion : Bending-Y : Bending-Z:

1	8.411e+03	-9.411e-03	-6.136e+02	3.119e-02	3.119e-02	3.119e-02
	7.411e+03	-6.411e-03	-4.136e+02	1.119e-02	1.119e-02	5.119e-02
2	6.411e+03	-5.411e-03	-6.136e+02	1.119e-02	3.119e-02	3.119e-02
	5.411e+03	-4.411e-03	-3.136e+02	3.119e-02	2.119e-02	4.119e-02
3	4.411e+03	-9.411e-03	-6.136e+02	2.119e-02	5.119e-02	2.119e-02
	3.411e+03	-9.411e-03	-2.136e+02	3.119e-02	3.119e-02	3.119e-02

Project Name : ชื่อของไฟล์ที่เราเก็บ

Internal Member Force บอกว่าเป็นข้อมูลแรงภายในของชิ้นส่วน

Load Factor = ตัวประกอบน้ำหนักบรรทุกประลัย

Hinge No = เกิดจุดหมุนครั้งที่เท่าไร

Ele No = 1 Near\Ele No = 4:Far\

Ele No = ชิ้นส่วนที่เกิดจุดหมุนคือชิ้นส่วนที่ 1 เกิดที่จุดเริ่มต้นของชิ้นส่วนที่ 1

Ele No = ชิ้นส่วนที่เกิดจุดหมุนคือชิ้นส่วนที่ 2 เกิดที่จุดปลายของชิ้นส่วนที่ 2

Ele ชิ้นส่วนที่กำลังจะบอกแรงภายใน

Axial แรงในแนวแกนของชิ้นส่วน

Shear-Y แรงเฉือนของชิ้นส่วนในทิศทาง Y

Shear-Z แรงเฉือนของชิ้นส่วนในทิศทาง Z

Torsion แรงบิดในชิ้นส่วน

Bending-Y โมเมนต์ในทิศทาง Y

Bending-Z โมเมนต์ในทิศทาง Z

Ele: Axial : Shear-Y : Shear-Z : Torsion : Bending-Y : Bending-Z:

1 8.411e+03 -9.411e-03 -6.136e+02 3.119e-02 3.119e-02 3.119e-02

7.411e+03 -6.411e-03 -4.136e+02 1.119e-02 1.119e-02 5.119e-02

2 6.411e+03 -5.411e-03 -6.136e+02 1.119e-02 3.119e-02 3.119e-02

5.411e+03 -4.411e-03 -3.136e+02 3.119e-02 2.119e-02 4.119e-02

3 4.411e+03 -9.411e-03 -6.136e+02 2.119e-02 5.119e-02 2.119e-02

3.411e+03 -9.411e-03 -2.136e+02 3.119e-02 3.119e-02 3.119e-02

การที่มีสองบรรทัดต่อหนึ่งชิ้นส่วนเพราะว่า

1 บรรทัดแรกเป็น แรงภายในที่ปลายแรก

2 บรรทัดที่สองเป็น แรงภายในที่ปลายสอง

เครื่องหมายหรือทิศทางจะตามรูปที่ 2.1

การอ่านข้อมูลการเคลื่อนที่ของจุดต่อ Nodal Displacement

Project Name Nue2

Nodal Displacement

Load Factor 1.412

Node	X-Disp	Y-Disp	Z-Disp	Theta=X	Theta_y	Theta-Z
1	1.182e00	5.345e-02	7.065e-03	2.560e-04	8.150e-04	0.000e+00
2	1.182e00	5.345e-02	7.065e-03	2.560e-04	8.150e-04	0.000e+00
3	1.182e00	5.345e-02	7.065e-03	2.560e-04	8.150e-04	0.000e+00

จะสามารถอ่านข้อมูลได้ดังนี้

Project Name Nue2 ชื่อไฟล์ที่เก็บข้อมูล Nue2

Nodal Displacement แสดงว่าเป็นการแสดงค่าการเคลื่อนที่

Load Factor 1.412 น้ำหนักบรรทุกทุกประลัย 1.412

Node เลขของจุดต่อที่จะแสดงค่าการเคลื่อนที่

X-Disp การเคลื่อนที่ในทิศทาง X

Y-Disp การเคลื่อนที่ในทิศทาง Y

Z-Disp การเคลื่อนที่ในทิศทาง Z

Theta=X มุมหมุนของจุดต่อในทิศทาง X

Theta\_y มุมหมุนของจุดต่อในทิศทาง Y

Theta-Z มุมหมุนของจุดต่อในทิศทาง Z

Node	X-Disp	Y-Disp	Z-Disp	Theta=X	Theta_y	Theta-Z
1	1.182e00	5.345e-02	7.065e-03	2.560e-04	8.150e-04	0.000e+00
2	1.182e00	5.345e-02	7.065e-03	2.560e-04	8.150e-04	0.000e+00
3	1.182e00	5.345e-02	7.065e-03	2.560e-04	8.150e-04	0.000e+00

การอ่านข้อมูลก็อ่านตามข้างบน

ศูนย์วิจัยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

ตัวอย่างโปรแกรมคอมพิวเตอร์  
ภาษาที่ใช้คือภาษาซี

```

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>
#include <conio.h>
#include <graphics.h>
#include <bios.h>
#include <dos.h>
#include <stdarg.h>
#include <alloc.h>

struct oo_or{int node_no;
            double x;
            double y;
            double z;
            int bou[6];
            double xo;
            double yo;
            double zo;
            };

struct oo_or *alloo_oo(int n);
struct ele_con{int ele_no;
              int node_1;
              int node_2;
              double Es;
              double G;
              double Ix;
              double Iy;
              double Iz;
              double B;
              double Tw;

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



```

        double D;
        double D1;
        double A;
        int hinge_1;
        int hinge_2;
        int moase;
    };

    struct ele_oon *alloo_ele(int n);

    struct load{int node_no;
        double x_load;
        double y_load;
        double z_load;
        double Mx;
        double My;
        double Mz;
    };

    struct load *alloo_ld(int n);
    int get_req(FILE *fp);
    void get_node(FILE *fp,int n,struct oo_or *pt);
    void get_ele(FILE *fp,int n, struct ele_oon *pt);
    void get_ld(FILE *fp,int n,struct load *pt);
    void win_graph(void);
    int mainwin(int menu_status);
    void inputdat(char *fn);
    int sol_menu(void);
    void solution(int mode,char *fn);/*solution mode*/
    void result(char *fn,int mode);
    void main(void)
    {
        int mode1,sol_mode,menu_status=0,re_mode;
        char fn[15];
        normvideo();
        /*win_graph();*/
        for(;;){

```

```

mode1=mainwin(menu_status);
switch(mode1){
case 0:inputdat(fn);
        break;
case 1:sol_mode=sol_menu();
        if(sol_mode!=4)solution(sol_mode,fn);
        break;
case 2:
        re_mode=0;
        result(fn,re_mode);
        break;
default:return;
}
menu_status=mode1;
}
}
void win_graph(void)
{
register int i,j,k;
int GraphDriver=DETECT;
int GraphMode,n_n,n_e;
double AspectRatio,fy;
strout palettetype palette;
initgraph(&GraphDriver,&GraphMode,"");
if(graphresult()!=grOk){
printf("Graphics System Error\n");
printf("\n%s\n",grapherrormsg(graphresult()));
exit(1);
}
settextstyle(GOTHIC_FONT,HORIZ_DIR,1);
getch();
getch();
closegraph();
}

```

```

void w_string(char *stp,int x,int y,int baokgroundool);
void border(int startx,int starty,int endx,int endy);
int get_response(int m,int x,int y,int oount,char *menu[],char *keys,int step,int dir_ohcek);
int mainwin(int menu_status)
{
int i,norm_baokgroundool=0,rev_baokgroundool=1;
int step=20,dir_ohcek=1;
char *st[]={
    "Input data",
    "Solution",
    "Result",
    "Exit",
};
char keys[]='isre';
clrscr();
window(2,4,78,25);
border(2,4,78,25);
gotoxy(1,1);
putch(255);
for(i=1;i<75;i++)putch(219);
putch(255);
/*initialize text attribute & baokground color*/
for(i=0;i<4;i++)w_string(st[i],5+i*step,1,norm_baokgroundool);
for(i=0;i<4;i++)if(i==menu_status)w_string(st[i],5+i*step,1,rev_baokgroundool);
i=get_response(menu_status,5,1,4,st,keys,step,dir_ohcek);
return(i);
}
void w_string(char *stp,int x,int y,int baokgroundool)
{
char c;
int i;
gotoxy(x,y);
textattr(RED/baokgroundool*16);
c=stp[0];

```

```

putch(o);
for(i=1;i<strlen(stp);i++){
    textattr(WHITE|baokgroundool*16);
    o=stp[i];
    putch(o);
}
normvideo();
}
void border(int startx,int starty,int endx,int endy)
{
    register int i;
    gotoxy(1,1);
    gotoxy(1,2);
    putch(213);
    for(i=1;i<endx-startx-1;i++)putch(205);
    putch(184);
    gotoxy(1,endy-starty);
    putch(192);
    for(i=1;i<endx-startx-1;i++)putch(196);
    putch(217);
    for(i=3;i<endy-starty;i++){
        gotoxy(1,i);
        putch(179);
        gotoxy(endx-startx,i);
        putch(179);
    }
    gotoxy(3,2);
    return;
}
int is_in(char *s,char o);
int get_response(int menu_status,int x,int y,int count,char *menu[],char *keys,int step,int dir_check)
{
    union inkey{
        char oh[2];

```

```

int i;
}o;
int arrow=0,arrowx_step=0,arrowy_step=0,key;
int norm_backgroundool=0,rev_backgroundool=1;
arrow=arrow+menu_status;
if(dir_check==1)arrowx_step=arrowx_step+step*menu_status;
if(dir_check==0)arrowy_step=arrowy_step+step*menu_status;
gotoxy(x,y);
for(;;){
while(!bioskey(1));
o.i=bioskey(0);
gotoxy(x+arrowx_step,y+arrowy_step);
w_string(menu[arrow],x+arrowx_step,y+arrowy_step,norm_backgroundool);
if(o.ch[0]){
key=is_in(keys,tolower(o.ch[0]));
if(key)return(key-1);
switch(o.ch[0]){
case '\x':return(arrow);
case '27':return (-1);
}
}else
{
switch(o.ch[1]){
case 72: /*Up Arrow */
if(dir_check==0){
arrow--;
arrowy_step=arrowy_step-step;
}
break;
case 80: /*Down Arrow */
if(dir_check==0){
arrow++;
arrowy_step=arrowy_step+step;
}
}
}
}

```

```

        break;
    case 75: /*Left Arrow */
        if(dir_cheek==1){
            arrow--;
            arrowx_step=arrowx_step-step;
        }
        break;
    case 77: /*Right Arrow */
        if(dir_cheek==1){
            arrow++;
            arrowx_step=arrowx_step+step;
        }
        break;
    }
} /*end if*/
if(arrow==count){
    arrow=0;
    if(dir_cheek==0)arrowy_step=0;
    if(dir_cheek==1)arrowx_step=0;
}
if(arrow<0){
    arrow=count-1;
    if(dir_cheek==0)arrowy_step=step*(count-1);
    if(dir_cheek==1)arrowx_step=step*(count-1);
}
gotoxy(x+arrowx_step,y+arrowy_step);
w_string(menu[arrow],x+arrowx_step,y+arrowy_step,rev_baokgroundool);
}
}
int is_in(char *s,char o)
{
    register i;
    for(i=0;*s;i++)if(*s++==o)return(i+1);
    return(0);
}

```

```

)
int input_submenu(char *fn,int l);
void input_data(char *fn,int i,int j);
void dat_out(char *fn);
void inputdat(char *fn)
{
int i,j,k,l,norm_backgroundool=0,rev_backgroundool=1;
int step=2,dir_okeok=0,menu_status=0,re_mode;
char *st[]={
    "Load Exist File",
    "Edit New File",
    "Data Output",
    "Quit",
};
char keys[]="req";
l=0;
for(;;){
if(l==0||j==4){
    window(5,5,28,15);
    border(5,5,28,15);
    /*initialize text attribute & background oolor*/
    for(k=0;k<4;k++)w_string(st[k],3,3+k*step,norm_backgroundool);
    for(k=0;k<4;k++)if(k==menu_status)w_string(st[k],3,3+k*step,rev_backgroundool);
    i=get_response(menu_status,3,3,4,st,keys,step,dir_okeok);
}
switch(i){
case 0:
    j=input_submenu(fn,l);
    input_data(fn,i,j);
    break;
case 1:
    j=input_submenu(fn,l);
    input_data(fn,i,j);
    break;

```

```

    case 2:
        re_mode=1;
        result(fn,re_mode);
        break;
    default:
        return;
}

menu_status=i;
l++;
}
}

void clear_screen(int x1,int x2,int y1,int y2);
int input_submenu(char *fn,int l)
{
    int i,j,norm_baokgroundool=0,rev_baokgroundool=1;
    int step=2,dir_cheok=0,menu_status=0;
    char *st[]={
        "Input Control Parameter",
        "Input Node Data",
        "Input Element Data",
        "Input Load data",
        "Quit"
    };
    char keys[]="req";
    window(30,10,60,23);
    border(30,10,60,23);
    if(l==0){
        gotoxy(3,3);
        oprintf("Input File Name:");
        oscanf("%s",fn);
    }
    /*initialize text attribute & baokground color*/
    for(i=0;i<5;i++)w_string(st[i],3,3+i*step,norm_baokgroundool);
    for(i=0;i<5;i++)if(i==menu_status)w_string(st[i],3,3+i*step,rev_baokgroundool);

```



```

i=get_response(mcnu_status,3,3,5,st,keys,step,dir_check);
return(i);
}
void input_dir(FILE *fp,int mode2);
void input_ooo(FILE *fp,int mode2);
void input_ele(FILE *fp,int mode2);
void input_ld(FILE *fp,int mode2);
void input_data(char *fn,int mode1,int mode2)
{
register int i,j;
FILE *fp;
char fn1[15];
window(3,4,77,22);
border(3,4,77,22);
for(i=2;i<74;i++){
    for(j=3;j<18;j++){
        gotoxy(i,j);
        printf(" ");
    }
}
gotoxy(3,16);
oprintf("Prof.Dr. VINIT CHOVIHCHEN ");
gotoxy(3,17);
oprintf("Mr. TISADEE SINGSILARAK");
stropy(fn1,fn);
switch(mode2){
    case 0:
        streat(fn1,".dir");
        if(mode1==0)fp=fopen(fn1,"r+");
        else if(mode1==1)fp=fopen(fn1,"w");
        input_dir(fp,mode2);
        break;
    case 1:
        streat(fn1,".ooo");

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

        if(mode1==0)fp=fopen(fn1,"r+");
        else if(mode1==1)fp=fopen(fn1,"w");
        input_ooo(fp,mode2);
        break;
    case 2:
        stroat(fn1,".ele");
        if(mode1==0)fp=fopen(fn1,"r+");
        else if(mode1==1)fp=fopen(fn1,"w");
        input_ele(fp,mode2);
        break;
    case 3:
        stroat(fn1,".lds");
        if(mode1==0)fp=fopen(fn1,"r+");
        else if(mode1==1)fp=fopen(fn1,"w");
        input_ld(fp,mode2);
        break;
    default:
        return;
}
fclose(fp);
return;
}
void input_dir(FILE *fp,int mode2)
{
    register int i,j,k;
    char s[8];
    gotoxy(3,3);
    printf("PROJECT TITLE :");
    gotoxy(3,4);
    printf("ENGINEER :");
    gotoxy(3,5);
    printf("Force Unit :");
    gotoxy(3,6);
    printf("Length Unit :");

```

```

gotoxy(3,7);
printf("DD/MM/YY :");
gotoxy(19,3);
scanf("%s",&s);
fprintf(fp,"%s\n",s);
gotoxy(14,4);
scanf("%s",&s);
fprintf(fp,"%s\n",s);
gotoxy(16,5);
scanf("%s",&s);
fprintf(fp,"%s\n",s);
gotoxy(17,6);
scanf("%s",&s);
fprintf(fp,"%s\n",s);
gotoxy(14,7);
scanf("%s",&s);
fprintf(fp,"%s\n",s);
getch();
return;
}
void input_coo(FILE *fp,int mode2)
{
register int i,j=0,k;
int n;
struct oo_or *pt;
window(3,4,77,22);
clrscr();
border(3,4,77,22);
gotoxy(3,3);
printf("No of Node: ");
gotoxy(3,4);
printf("NodeNo");putch(179);printf(" X-Coor ");putch(179);printf(" Y-Coor ");putch(179);printf(" Z-Coor
");putch(179);printf("Bou 1");putch(179);printf("Bou 2");putch(179);printf("Bou 3");putch(179);printf("
Bou 4");putch(179);printf("Bou 5");putch(179);printf("Bou 6");putch(179);printf("\n");

```

```

gotoxy(3,5);
for(i=0;i<70;i++)putch(196);
gotoxy(9,5);putch(197);
gotoxy(18,5);putch(197);
gotoxy(27,5);putch(197);
gotoxy(36,5);putch(197);
gotoxy(42,5);putch(197);
gotoxy(48,5);putch(197);
gotoxy(54,5);putch(197);
gotoxy(60,5);putch(197);
gotoxy(66,5);putch(197);
gotoxy(72,5);putch(180);
gotoxy(3,6);
for(i=0;i<10;i++){
    gotoxy(3,6+i);
    oprintf("    ");putch(179);oprintf("    ");putch(179);oprintf("    ");putch(179);oprintf("    ");
    putch(179);oprintf("    ");putch(179);oprintf("    ");putch(179);oprintf("    ");putch(179);oprintf("    ");
    putch(179);oprintf("    ");putch(179);oprintf("    ");putch(179);oprintf("\n");
}
gotoxy(3,13);
oprintf("Remark:-1> Bou 1 == Boudary Condition in X Direction");
gotoxy(3,14);
oprintf("    2> Bou 2 == Boudary Condition in Y Direction");
gotoxy(3,15);
oprintf("    3> Bou 3 == Boudary Condition in Z Direction");
gotoxy(3,16);
oprintf("Remark:-1> Bou 4 == Boudary Condition in X Rotation");
gotoxy(3,17);
oprintf("    2> Bou 5 == Boudary Condition in Y Rotation");
gotoxy(3,18);
oprintf("    3> Bou 6 == Boudary Condition in Z Rotation");
gotoxy(3,19);
oprintf("    4> Bou = 0 Look    ");
gotoxy(3,20);

```

```

oprintf("      5> Bou = 1 Free  ");
gotoxy(15,3);
scanf("%i",&n);
pt=alloc_oo(n);
for(i=0;i<n;i++){
    gotoxy(3,6+j);
    oprintf("%i",i+1);
    pt[i].node_no=i+1;
    gotoxy(10,6+j);
    scanf("%lf",&pt[i].x);
    gotoxy(20,6+j);
    scanf("%lf",&pt[i].y);
    gotoxy(29,6+j);
    scanf("%lf",&pt[i].z);
    pt[i].xc=pt[i].x;
    pt[i].yc=pt[i].y;
    pt[i].zc=pt[i].z;
    for(k=0;k<6;k++){
        gotoxy(38+6*k,6+j);
        scanf("%i",&pt[i].bou[k]);
    }
    j++;
    if((i%6)==0&& i!=0){
        j=0;
        for(k=0;k<7;k++){
            gotoxy(3,6+k);
            oprintf(" ");putoh(179);oprintf(" ");putoh(179);oprintf(" ");putoh(179);oprintf(" ");
            putoh(179);oprintf(" ");putoh(179);oprintf(" ");putoh(179);oprintf(" ");putoh(179);oprintf(" ");
            putoh(179);oprintf(" ");putoh(179);oprintf(" ");putoh(179);oprintf("\n\n");
        }
    }
}
fprintf(fp,"%i",n);
fprintf(fp,"\n");

```

```

for(i=0;i<n;i++){
    fprintf(fp,"%i\n",pt[i].node_no);
    fprintf(fp,"%lf\n",pt[i].x);
    fprintf(fp,"%lf\n",pt[i].y);
    fprintf(fp,"%lf\n",pt[i].z);
    for(k=0;k<6;k++){
        fprintf(fp,"%i\n",pt[i].bou[k]);
    }
    fprintf(fp,"%lf\n",pt[i].xo);
    fprintf(fp,"%lf\n",pt[i].yo);
    fprintf(fp,"%lf\n",pt[i].zo);
    fprintf(fp,"\n");
}
free(pt);
for(i=2;i<19;i++){
    for(k=1;k<75;k++){
        gotoxy(k,i);
        oprintf(" ");
    }
}
return;
}

void input_ele(FILE *fp,int mode2)
{
    register int i,k;
    int n;
    double fy,Es,G;
    struct ele_con *pt;
    /***** Add New Program *****/
    clrscr();
    gotoxy(3,6);
    oprintf("Yield Strength= ");scanf("%lf",&fy);
    gotoxy(3,8);
    oprintf("Modulus of Elasticity = ");scanf("%lf",&Es);

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

gotoxy(3,10);
printf("G = ");scanf("%lf",&G);
gotoxy(3,12);
printf("No of Element= ");scanf("%i",&n);
gotoxy(3,16);
printf("Remark:-> Hinge1 == Hinge Code on 'Near' members' end");
gotoxy(3,17);
printf("    2> Hinge2 == Hinge Code on 'Far' members' end");
gotoxy(2,18);
printf("    3> Hinge = 0   Inactive Hinge                ");
gotoxy(2,19);
printf("    4> Hinge = 1   Active Hinge                  ");
gotoxy(2,20);
printf("    5> Normal Case=1 Other Case =2            ");
gotoxy(2,21);
printf("    Press any key when you finished Read !!!! ");
flushall();
getch();
pt=aloo_ele(n);
/***** Loop Read Value from Keyboard *****/
for(i=0;i<n;i++){
    clrscr();
    gotoxy(40,2);
    printf("    Group Data %i",i+1);
    pt[i].ele_no=i+1;
    gotoxy(3,5);
    printf("Element Number : %i",i+1);
    gotoxy(3,6);
    printf("Node 1 = ");scanf("%i",&pt[i].node_1);
    gotoxy(3,7);
    printf("Node 2 = ");
    scanf("%i",&pt[i].node_2);
    gotoxy(3,8);
    printf("Ix    = ");

```

```

scanf("%lf",&pt[i].Ix);
gotoxy(3,9);
printf("Iy  = ");
scanf("%lf",&pt[i].Iy);
gotoxy(3,10);
printf("Iz  = ");
scanf("%lf",&pt[i].Iz);
gotoxy(3,11);
printf("B    = ");
scanf("%lf",&pt[i].B);
gotoxy(3,12);
printf("Tw   = ");
scanf("%lf",&pt[i].Tw);
gotoxy(3,13);
printf("D    = ",n+1);
scanf("%lf",&pt[i].D);
gotoxy(3,14);
printf("D1   = ");
scanf("%lf",&pt[i].D1);
gotoxy(3,15);
printf("A    = ");
scanf("%lf",&pt[i].A);
gotoxy(3,16);
printf("Hinge1 = ");
scanf("%i",&pt[i].hinge_1);
gotoxy(3,17);
printf("Hinge2 = ");
scanf("%i",&pt[i].hinge_2);
gotoxy(3,18);
printf("Case  = ");
scanf("%i",&pt[i].moase);
}

fprintf(fp,"%lf\n",fy);
fprintf(fp,"%lf\n",n);

```



ศูนย์วิทยทรัพยากร  
 วิทยาลัย  
 ราชภัฏวชิรวิทยาดง



```

for(i=0;i<n;i++){
    fprintf(fp,"%i\n",pt[i].ele_no);
    fprintf(fp,"%i\n",pt[i].node_1);
    fprintf(fp,"%i\n",pt[i].node_2);
    fprintf(fp,"%lf\n",Es);
    fprintf(fp,"%lf\n",G);
    fprintf(fp,"%lf\n",pt[i].Ix);
    fprintf(fp,"%lf\n",pt[i].Iy);
    fprintf(fp,"%lf\n",pt[i].Iz);
    fprintf(fp,"%lf\n",pt[i].B);
    fprintf(fp,"%lf\n",pt[i].Tw);
    fprintf(fp,"%lf\n",pt[i].D);
    fprintf(fp,"%lf\n",pt[i].D1);
    fprintf(fp,"%lf\n",pt[i].A);
    fprintf(fp,"%i\n",pt[i].hinge_1);
    fprintf(fp,"%i\n",pt[i].hinge_2);
    fprintf(fp,"%i",pt[i].moase);
    fprintf(fp,"\n");
}
free(pt);
return;
}

void input_ld(FILE *fp,int mode2)
{
    register int i,j=0,k;
    int n,node_no;
    struct load *pt;
    window(3,4,77,22);
    border(3,4,77,22);
    gotoxy(3,3);
    oprintf("No of Node/w Loading: ");
    gotoxy(3,4);

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

printf("NodeNo");putch(179);printf(" X-load ");putch(179);printf(" Y-load ");putch(179);printf(" Z-
load ");putch(179);printf(" Mx ");putch(179);printf(" My ");putch(179);printf(" Mz ");
putch(179);printf("\n\n");
gotoxy(3,5);
for(i=0;i<72;i++)putch(196);
gotoxy(9,5);putch(197);
gotoxy(20,5);putch(197);
gotoxy(31,5);putch(197);
gotoxy(42,5);putch(197);
gotoxy(53,5);putch(197);
gotoxy(64,5);putch(197);
gotoxy(75,5);putch(180);
for(i=0;i<10;i++){
    gotoxy(3,6+i);
    printf(" ");putch(179);printf(" ");putch(179);printf(" ");putch(179);printf(" ");
putch(179);printf(" ");putch(179);printf(" ");putch(179);printf(" ");putch(179);printf
("\n\n");
}
gotoxy(25,3);
scanf("%i",&n);
pt=alloo_ld(n);
for(i=0;i<n;i++){
    gotoxy(5,6+j);
    scanf("%i",&node_no);
    pt[i].node_no=node_no;
    gotoxy(10,6+j);
    scanf("%lf",&pt[i].x_load);
    gotoxy(21,6+j);
    scanf("%lf",&pt[i].y_load);
    gotoxy(32,6+j);
    scanf("%lf",&pt[i].z_load);
    gotoxy(43,6+j);
    scanf("%lf",&pt[i].Mx);
    gotoxy(54,6+j);

```

```

scanf("%lf",&pt[i].My);
gotoxy(65,6+j);
scanf("%lf",&pt[i].Mz);
j++;
if((i%6)==0&& i!=0){
j=0;
for(k=0;k<7;k++){
gotoxy(3,6+k);
printf(" ");putch(179);printf(" ");putch(179);printf(" ");putch(179);printf("
");putch(179);printf(" ");putch(179);printf(" ");putch(179);printf(" ");putch(179);
printf("\n");
}
}
}
fprintf(fp,"%i",n);
fprintf(fp,"\n");
for(i=0;i<n;i++){
fprintf(fp,"%i\n",pt[i].node_no);
fprintf(fp,"%lf\n",pt[i].x_load);
fprintf(fp,"%lf\n",pt[i].y_load);
fprintf(fp,"%lf\n",pt[i].z_load);
fprintf(fp,"%lf\n",pt[i].Mx);
fprintf(fp,"%lf\n",pt[i].My);
fprintf(fp,"%lf\n",pt[i].Mz);
fprintf(fp,"\n");
}
free(pt);
for(i=2;i<19;i++){
for(k=1;k<75;k++){
gotoxy(k,i);
printf(" ");
}
}
return;

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

}

int sol_menu(void)
{
register int i,norm_baokgroundool=0,rev_baokgroundool=1;
int step=2,dir_ohook=0;
ohar *st[]={
    "1st Order Elastio Analysis",
    "2nd Order Elastio Analysis",
    "1st Order Elastio-Plastio Analysis",
    "2nd Order Elastio-Plastio Analysis",
    "Quit",
};
ohar keys[]="";
window(25,5,65,17);
border(25,5,65,17);
/*initialize text attribute & baokground color*/
w_string(st[0],3,3,rev_baokgroundool);
w_string(st[1],3,5,norm_baokgroundool);
w_string(st[2],3,7,norm_baokgroundool);
w_string(st[3],3,9,norm_baokgroundool);
w_string(st[4],3,11,norm_baokgroundool);

i=get_response(0,3,3,5,st,keys,step,dir_ohook);
ohrsor();
return(i);
}

void on_soreen_file(ohar *fn);
void on_soreen_graph(ohar *fn);
void dat_out_file(ohar *fn,int sor);
void dat_out_soreen(ohar *fn,int sor);
void print_graph(int i);
void on_printer_file(ohar *fn);
void dat_printer_file(ohar *fn);
void result(ohar *fn,int mode)

```

```

{
register int i,j,norm_backgroundool=0,rev_backgroundool=1;
int step=2,dir_cheek=0,sor;
ohar *st[]={
    "Text On Screen ",
    "Graphies On screen ",
    "Text On Printer ",
    "Graphies On Printer ",
    "Quit",
};
ohar keys[]="";
if(mode==0){
    window(28,5,52,17);
    border(28,5,52,17);
}else{
    window(20,10,44,22);
    for(i=20;i<44;i++){
        for(j=10;j<22;j++){
            gotoxy(i-20,j-10);
            putoh(0);
        }
    }
    border(20,10,44,22);
}
/*initialize text attribute & baokground color*/
w_string(st[0],3,3,rev_backgroundool);
w_string(st[1],3,5,norm_backgroundool);
w_string(st[2],3,7,norm_backgroundool);
w_string(st[3],3,9,norm_backgroundool);
w_string(st[4],3,11,norm_backgroundool);
i=get_response(0,3,3,5,st,keys,step,dir_cheek);
switch(i){
    case 0:
        sor=0;

```

```

        if(mode==0)on_screen_file(fn);
        else dat_out_screen(fn,sor);
        break;

    case 1:on_screen_graph(fn);
        break;

    case 2:
        sor=1;
        if(mode==0)on_printer_file(fn);
        else dat_out_file(fn,sor);
        break;

    case 3:print_graph(1);
        break;
}
}
void on_screen_file(char *fn)
{
int no_node,no_ele,i,j,k,l,m,n,o;
int i1,i2,i3;
float a,lf;
char *b,o,f1[15],f2[15];
FILE *fp1,*fp2;

strcpy(f1,fn);
strcpy(f2,fn);
strcpy(f1,".str");
strcpy(f2,".lfd");
fp1=fopen(f1,"r");
fp2=fopen(f2,"r");

clrscr();

window(3,4,77,22);
border(3,4,77,22);
clear_soreen(2,74,3,18);
gotoxy(3,3);
printf("Select File:\n\n");

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

gotoxy(3,4);
printf("(1) Internal Member Force at Plastic Hinge Form\n\n");
gotoxy(3,5);
printf("(2) Displacement");
gotoxy(3,6);
scanf("%i",&i);
clear_screen(2,74,3,18);
switch(i){
  case 0:
  case 1:
    fscanf(fp1,"%i\n",&no_ele);
    do{
      fscanf(fp1,"%f\n",&lf);
      if(lf>0){
        fscanf(fp1,"%i\n",&k);
        gotoxy(3,3);
        printf("Project Name : %s\n",fn);
        gotoxy(3,4);
        printf("Load Factor=%9.3f :Hinge No=%i\n",lf,k);
        j=0;
        o=5;
        gotoxy(3,5);
        printf(" ");
        gotoxy(3,6);
        printf(" ");
        do{
          if(j>=3){
            o++;
            j=0;
          }
          gotoxy(3+20*j,o);
          fscanf(fp1,"%i\n",&k);
          fscanf(fp1,"%o\n",&o);
          if(k>0){

```

```

        if(c=='N')printf("Ele No=%i:End=Near\\",k);
        if(c=='B')printf("Ele No=%i:End=Both\\",k);
        if(c=='F')printf("Ele No=%i:End=Far\\",k);
    }
    ++j;
}while(k>0);
gotoxy(3,7);
printf("ELE : Fx : Fy : Fz : Mx : My : Mz ");
j=4;
n=1;
do
{
    gotoxy(3,2*j);
    printf("%3i",n);
    m=0;
    for(l=0;l<12;l++){
        fscanf(fp1,"%f\\",&a);
        if(l<6) {
            gotoxy(7+11*m,2*j);
        } else
        {
            gotoxy(7+11*(m-6),2*j+1);
        }
        printf("%11.4e",a);
        m++;
    }
    j++;
    if((n%5)==0&&(n!=0)){
        j=4;
        getch();getch();
        for(l=2*j;l<2*j+10;l++){
            gotoxy(3,l);
            printf("
\n");
        }
    }
}

```



```

        j=4;
    }
    n++;
    }while(n<=no_ele);
getch();
}
}
while(lf>0);
break;
case 2:
fscanf(fp2,"%i\n",&no_node);
do{
fscanf(fp2,"%f\n",&lf);
if(lf>=0){
gotoxy(3,3);
printf("Project Name : %s\n",fn);
gotoxy(3,4);
printf("Load Factor=%9.3f\n",lf);
gotoxy(3,5);
printf("Node: X-Disp : Y-Disp : Z-Disp : THETAx : THETAy : THETAz\n");
k=0;
for(i=0;i<no_node;i++){
gotoxy(3,6+k);
printf("%4i",1+i);
for(j=0;j<6;j++){
fscanf(fp2,"%f\n",&a);
gotoxy(7+(11*j),6+k);
printf("%11.4e",a);
}
k++;
if((i%10)==0&& i!=0){
k=0;
getch();
for(j=0;j<=10;j++){

```

```

        gotoxy(3,6+j);
        oprintf("
    );
    }
}
    getch();
}
}while(lf!=0);
break;
}
fclose(fp1);
fclose(fp2);
}
void print_graph(int i)
{
}
void on_printer_file(char *fn)
{
int no_node,no_ele,i,j,k,l,m,n,o,z;
float a,lf;
char *b,o,f1[15],f2[15];
FILE *fp1,*fp2;

strcpy(f1,fn);
strcpy(f2,fn);
stroat(f1,".str");
stroat(f2,".lfd");
fp1=fopen(f1,"r");
fp2=fopen(f2,"r");
clrscr();
window(3,4,77,22);
border(3,4,77,22);
clear_screen(2,74,3,18);
gotoxy(3,3);

```

ศูนย์วิทยทรัพยากร

จุฬาลงกรณ์มหาวิทยาลัย

```

printf("Select File:\n\n");
gotoxy(3,4);
printf("(1) Internal Member Force at Plastic Hinge Form\n\n");
gotoxy(3,5);
printf("(2) Displacement");
gotoxy(3,6);
scanf("%i",&i);
fprintf(stdpm," :- Project Name : %s\n",fn);
switch(i){
case 0:
case 1:
fprintf(stdpm," :- Internal Member Force\n");
fprintf(stdpm,"\n\n");
fscanf(fp1,"%i\n",&no_ele);
do{
fscanf(fp1,"%f\n",&lf);
if(lf>0){
fscanf(fp1,"%i\n",&k);
fprintf(stdpm,"\n\n");
fprintf(stdpm," Load Factor=%9.3f :Hinge No=%i\n",lf,k);
fprintf(stdpm," ");
z=0;
do{
if(j>=3){
o++;
j=0;
}
fscanf(fp1,"%i\n",&k);
fscanf(fp1,"%o\n",&o);
z++;
if(k>0){
if(z%5==0&&z!=0){fprintf(stdpm,"\n\n");
fprintf(stdpm," ");}
if(o=='N')fprintf(stdpm,"Ele No=%i:Near\n",k);

```

```

        if(c=='B')fprintf(stdpm,"Ele No=%i:Both\\",k);
        if(c=='F')fprintf(stdpm,"Ele No=%i:Far\\",k);
    }
    ++j;
}while(k>0);
fprintf(stdpm, "\\n\\n");
fprintf(stdpm, "   Ele : Axial : Shear-y : Shear-z : Torsion :Bending -y:Bending -z:\\n\\n");
j=4;
n=1;
do{
    fprintf(stdpm, "      %3i ",n);
    for(l=0;l<12;l++){
        fprintf(fp1,"%f\\n",&a);
        if(l==6){fprintf(stdpm, "\\n\\n");
            fprintf(stdpm, "      ");
        }
        fprintf(stdpm,"%10.3e ",a);
    }
    fprintf(stdpm, "\\n\\n");
    n++;
}while(n<=no_ele);
}
}while(lf>0);
break;
case 2:
    fprintf(stdpm, "      :- Nodal Displacement\\n\\n");
    fprintf(stdpm, "\\n\\n\\n\\n");
    fprintf(fp2,"%i\\n",&no_node);
    do{
        fprintf(fp2,"%f\\n",&lf);
        if(lf>=0){
            fprintf(stdpm, "   Load Factor=%9.3f      \\n\\n",lf);
            fprintf(stdpm, "   Node: X-Disp : Y-Disp : Z-Disp : THETA-x : THETA-y : THETA-z
\\n\\n");

```

```

        for(i=0;i<no_node;i++){
            fprintf(stdpm,"  %3i ",l+i);
            for(j=0;j<6;j++){
                fscanf(fp2,"%f\n",&a);
                fprintf(stdpm,"%10.3e ",a);
            }
            fprintf(stdpm,"\n\r");
        }
    }
}while(lf>=0);
break;
}
fclose(fp1);
fclose(fp2);
}
void write_node_sym(int x,int y);
void write_node_no(int no,int x,int y);
void write_ele_no(void);
void write_load(void);
void write_dim_lin(void);
void write_bc(int x,int y,int b1,int b2,int b3);
void on_screen_graph(char *fn)
{
    register int i,j,k;
    FILE *fp;
    char frame0[15],fname1[15];
    int GraphDriver=DETECT;
    int GraphMode,n_n,n_e;
    double AspectRatio,fy;
    double x_max,y_max,z_max,soale_x,soale_y,soale_z,soale;
    int x_start,y_start,x_end,y_end,z_start,z_end,xx,yy,zz;
    struct palettetype palette;
    struct oo_or*pt_oo;
    struct ele_con *pt_ele;

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

stropy(fname0,fn);
stropy(fname1,fn);
stroat(fname0,".coo");
fp=fopen(fname0,"r");
n_n=get_req(fp);
pt_co=alloo_co(n_n);
get_node(fp,n_n,pt_co);
folose(fp);
stroat(fname1,".ele");
fp=fopen(fname1,"r");
fscanf(fp,"%lf",&fy);
n_e=get_req(fp);
pt_ele=alloo_ele(n_e);
get_ele(fp,n_e,pt_ele);
folose(fp);
for(i=1;i<n_n;i++){
    j=i-1;
    x_max=max(pt_co[i].x,pt_co[j].x);
    y_max=max(pt_co[i].y,pt_co[j].y);
    z_max=max(pt_co[i].z,pt_co[j].z);
}
scale_x=(x_max+50)/640;
scale_y=(y_max+50)/480;
if(scale_x<=1&&scale_y<=1)scale=max(scale_x,scale_y);
if(scale_x<=1&&scale_y>1)scale=scale_y;
if(scale_x>1&&scale_y<=1)scale=scale_x;
if(scale_x>1&&scale_y>1)scale=max(scale_x,scale_y);
initgraph(&GraphDriver,&GraphMode,"");
if(graphresult()!=grOk){
    printf("Graphics System Error\n");
    printf("\n%s\n",grapherrormsg(graphresult()));
    exit(1);
}
printf("scale 1 : %f\n",scale);

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

for(i=0;i<n_e;i++){
x_start=*(640)/2+*/pt_co[pt_ele[i].node_1-1].x/soale;
y_start=470-pt_co[pt_ele[i].node_1-1].y/soale;
x_end=*(640)/2+*/pt_co[pt_ele[i].node_2-1].x/soale;
y_end=470-pt_co[pt_ele[i].node_2-1].y/soale;
line(x_start,y_start,x_end,y_end);
}
setcolor(RED);
for(i=0;i<n_n;i++){
xx=*(640)/2+*/pt_co[i].x/soale;
yy=470-pt_co[i].y/soale;
write_node_sym(xx,yy);
}
/*
for(i=0;i<n_n;i++){
setcolor(BLUE);
xx=640/2+pt_co[i].x/soale;
yy=470-pt_co[i].y/soale;
write_node_no(i,xx,yy);
} */
for(i=0;i<n_n;i++){
write_bc(pt_co[i].x,pt_co[i].y,pt_co[i].bou[0],pt_co[i].bou[1],pt_co[i].bou[2]);
}
getch();
getch();
closegraph();
olrsrc();
soale_x=(x_max+50)/640;
soale_z=(z_max+50)/480;
if(soale_x<=1&&soale_z<=1)soale=max(soale_x,soale_z);
if(soale_x<=1&&soale_z>1)soale=soale_z;
if(soale_x>1&&soale_z<=1)soale=soale_x;
if(soale_x>1&&soale_z>1)soale=max(soale_x,soale_z);
initgraph(&GraphDriver,&GraphMode,"");

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

if(graphresult()!=grOk){
    printf("Graphics System Error\n");
    printf("\n%s\n",grapherrmsg(graphresult()));
    exit(1);
}
printf("scale 1 : %f\n",scale);
for(i=0;i<n_e;i++){
    x_start=*(640)/2+*/pt_co[pt_ele[i].node_1-1].x/scale;
    z_start=470-pt_co[pt_ele[i].node_1-1].z/scale;
    x_end=*(640)/2+*/pt_co[pt_ele[i].node_2-1].x/scale;
    z_end=470-pt_co[pt_ele[i].node_2-1].z/scale;
    line(x_start,z_start,x_end,z_end);
}
setcolor(RED);
for(i=0;i<n_n;i++){
    xx=*(640)/2+*/pt_co[i].x/scale;
    zz=470-pt_co[i].z/scale;
    write_node_sym(xx,zz);
}
/*
for(i=0;i<n_n;i++){
    setcolor(BLUE);
    xx=640/2+pt_co[i].x/scale;
    yy=470-pt_co[i].y/scale;
    write_node_no(i,xx,yy);
} */
for(i=0;i<n_n;i++){
    write_bc(pt_co[i].x,pt_co[i].z,pt_co[i].bou[0],pt_co[i].bou[1],pt_co[i].bou[2]);
}
getch();
closegraph();
olrser();
scale_y=(y_max+50)/640;
scale_z=(z_max+50)/480;

```



```

if(scale_y<=1&&scale_z<=1)scale=max(scale_y,scale_z);
if(scale_y<=1&&scale_z>1)scale=scale_z;
if(scale_y>1&&scale_z<=1)scale=scale_y;
if(scale_y>1&&scale_z>1)scale=max(scale_y,scale_z);
initgraph(&GraphDriver,&GraphMode,"");
if(graphresult()!=grOk){
    printf("Graphics System Error\n");
    printf("\n%s\n",grapherrormsg(graphresult()));
    exit(1);
}
printf("scale 1 : %f\n",scale);
for(i=0;i<n_e;i++){
    y_start=*(640/2+*/pt_co[pt_ele[i].node_1-1].y/scale;
    z_start=470-pt_co[pt_ele[i].node_1-1].z/scale;
    y_end=*(640/2+*/pt_co[pt_ele[i].node_2-1].y/scale;
    z_end=470-pt_co[pt_ele[i].node_2-1].z/scale;
    line(y_start,z_start,y_end,z_end);
}
setcolor(RED);
for(i=0;i<n_n;i++){
    yy=*/640/2+*/pt_co[i].y/scale;
    zz=470-pt_co[i].z/scale;
    write_node_sym(yy,zz);
}
/*
for(i=0;i<n_n;i++){
    setcolor(BLUE);
    xx=640/2+pt_co[i].x/scale;
    yy=470-pt_co[i].y/scale;
    write_node_no(i,xx,yy);
} */
for(i=0;i<n_n;i++){
    write_bo(pt_co[i].y,pt_co[i].z,pt_co[i].bou[0],pt_co[i].bou[1],pt_co[i].bou[2]);
}

```

```

getch();
closegraph();
free(pt_ele);
free(pt_oo);
return;
}
void write_node_sym(int x,int y)
{
int radius=2;
circle(x,y,radius);
}
void write_node_no(int n,int x,int y)
{
int radius=5;
circle(x+6,y-6,radius);
setcolor(GREEN);
outtextxy(x+6,y-6,&n+1);
}
void write_ele_no(void)
{
}
void write_load(void)
{
}
void write_dim_lin(void)
{
}
void write_fix(int x,int y);
void write_hinge(void);
void write_rol_x(void);
void write_rol_y(void);
void write_bo(int x,int y,int b1,int b2,int b3)
{
int b;

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

if(b1==0&&b2==0&&b3==0)b=0; /* Fix Support */
if(b1==0&&b2==0&&b3==1)b=1; /* Hinge Support */
if(b1==1&&b2==0&&b3==1)b=2; /* Allow x dir movement */
if(b1==0&&b2==1&&b3==1)b=3; /* Allow y dir movement */
if(b1==1&&b2==1&&b3==1)b=4; /* Free Movement */

switch(b){
  case 0:
    write_fix(x,y);
    break;
  case 1:
    write_hinge();
    break;
  case 2:
    write_rol_x();
    break;
  case 3:
    write_rol_y();
}
}

void write_fix(int x,int y)
{
}

void write_hinge(void)
{
}

void write_rol_x(void)
{
}

void write_rol_y(void)
{
}

void coo_out_printer(char *fn);
void ele_out_printer(char *fn);
void lds_out_printer(char *fn);

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

void dat_out_file(char *fn,int sor)
{
char fn1[15];
int i,j,k;

strcpy(fn1,fn);
window(3,4,77,22);
border(3,4,77,22);
clear_screen(2,74,3,18);
gotoxy(3,3);
printf("Select File:\n\n");
gotoxy(3,4);
printf("1> Node Data\n\n");
gotoxy(3,5);
printf("2> Element Data\n\n");
gotoxy(3,6);
printf("3> Load Data\n\n");
gotoxy(3,7);
scanf("%i",&i);
switch(i){
case 1:
    ooo_out_printer(fn);
    break;
case 2:
    ele_out_printer(fn);
    break;
case 3:
    lds_out_printer(fn);
    break;
default:
    return;
}
return;
}

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

void dat_printer_file(char *fn)
{
}

void ooo_out_printer(char *fn)
{
int no_node,i,j,k,l;
float a;
char fl[15];
FILE *fp1;

strcpy(fl,fn);
strcat(fl, ".ooo");
fp1=fopen(fl,"r");
fprintf(stderr,"\n");
fprintf(stderr,"\n");
fprintf(stderr,"\n");
fprintf(stderr,"\n");
fprintf(stderr,"\n");
fprintf(stderr,"\n");
fprintf(stderr,"    :- Project Name : %s\n",fn);
fprintf(stderr,"    :- Coordinate Input Data\n");
fprintf(stderr,"\n");
fscanf(fp1,"%i",&no_node);
fprintf(stderr,"    :-No of Node = %i\n",no_node);
fprintf(stderr,"\n");
fprintf(stderr,"    Node: X-Coor : Y-Coor : Z-Coor :Bou 1:Bou 2:Bou 3:Bou 4:Bou 5:Bou 6\n");
for(i=0;i<no_node;i++){
    fscanf(fp1,"%i",&k);
    fprintf(stderr,"    %4i",k);
    fscanf(fp1,"%f",&a);
    fprintf(stderr,"%10.2f",a);
    fscanf(fp1,"%f",&a);
    fprintf(stderr,"%10.2f",a);
    fscanf(fp1,"%f",&a);

```

```

fprintf(stdpm,"%10.2f",a);
fscanf(fp1,"%i",&k);
if(k==0)fprintf(stdpm," Fix ");
else fprintf(stdpm," ");
fscanf(fp1,"%i",&k);
if(k==0)fprintf(stdpm," Fix ");
else fprintf(stdpm," ");
fscanf(fp1,"%i",&k);
if(k==0)fprintf(stdpm," Fix ");
else fprintf(stdpm," ");
fscanf(fp1,"%i",&k);
if(k==0)fprintf(stdpm," Fix ");
else fprintf(stdpm," ");
fscanf(fp1,"%i",&k);
if(k==0)fprintf(stdpm," Fix ");
else fprintf(stdpm," ");
fscanf(fp1,"%f",&a);
fscanf(fp1,"%f",&a);
fscanf(fp1,"%f",&a);
fprintf(stdpm,"\n\n");
}
fclose(fp1);
}
void cle_out_printer(char *fn)
{
int no_ele,i,j,ele_no,node_1,node_2,hinge_1,hinge_2,moase;
float fy,Es,G,A;
float Ix,Iy,Iz,B,Tw,D,D1;
char fl[15];
FILE *fp;

```

```

strcpy(f1,fn);
stroat(f1,".ele");
fp=fopen(f1,"r");
fprintf(stdpm,"  :- Project Name : %s\n",fn);
fprintf(stdpm,"  :- Element Connectivity Input Data\n");
fprintf(stdpm,"\n");
fscanf(fp,"%f",&fy);
fscanf(fp,"%i",&no_ele);
fprintf(stdpm,"  :- No of Element = %i\n",no_ele);
fprintf(stdpm,"  :- Yield Strength = %12.3f\n",fy);
    fscanf(fp,"%i",&ele_no);
    fscanf(fp,"%i",&node_1);
    fscanf(fp,"%i",&node_2);
    fscanf(fp,"%f",&Es);
    fscanf(fp,"%f",&G);
    fscanf(fp,"%f",&Ix);
    fscanf(fp,"%f",&Iy);
    fscanf(fp,"%f",&Iz);
    fscanf(fp,"%f",&B);
    fscanf(fp,"%f",&Tw);
    fscanf(fp,"%f",&D);
    fscanf(fp,"%f",&D1);
    fscanf(fp,"%f",&A);
    fscanf(fp,"%i",&hinge_1);
    fscanf(fp,"%i",&hinge_2);
    fscanf(fp,"%i",&mcase);
fprintf(stdpm,"  :- Modulus of Elasticity = %12.3f\n",Es);
fprintf(stdpm,"  :- Modulus of Elasticity = %12.3f\n",G);
fprintf(stdpm,"\n");
fprintf(stdpm,"  Ele:Node1:Node2:  Ix  :  Iy  :  Iz  :  A  :  Con1: Con2\n");
fprintf(stdpm,"    %3i",ele_no);
fprintf(stdpm,"%6i",node_1);
fprintf(stdpm,"%6i",node_2);
fprintf(stdpm,"%11.3e",Ix);

```

```

fprintf(stdpm,"%11.3e",Iy);
fprintf(stdpm,"%11.3e",Iz);
fprintf(stdpm,"%11.3e ",A);
if(hinge_1==1)fprintf(stdpm,"Hinge");
else fprintf(stdpm," - ");
if(hinge_2==1)fprintf(stdpm,"Hinge");
else fprintf(stdpm," - ");
fprintf(stdpm,"\n\n");
for(i=1;i<no_ele;i++){
    fsoanf(fp,"%i\n",&ele_no);
    fsoanf(fp,"%i\n",&node_1);
    fsoanf(fp,"%i\n",&node_2);
    fsoanf(fp,"%f\n",&Es);
    fsoanf(fp,"%f\n",&G);
    fsoanf(fp,"%f\n",&Ix);
    fsoanf(fp,"%f\n",&Iy);
    fsoanf(fp,"%f\n",&Iz);
    fsoanf(fp,"%f\n",&B);
    fsoanf(fp,"%f\n",&Tw);
    fsoanf(fp,"%f\n",&D);
    fsoanf(fp,"%f\n",&D1);
    fsoanf(fp,"%f\n",&A);
    fsoanf(fp,"%i\n",&hinge_1);
    fsoanf(fp,"%i\n",&hinge_2);
    fsoanf(fp,"%i\n",&moase);

    fprintf(stdpm,"    %3i",ele_no);
    fprintf(stdpm,"%6i",node_1);
    fprintf(stdpm,"%6i",node_2);

    fprintf(stdpm,"%11.3f",Ix);
    fprintf(stdpm,"%11.3f",Iy);
    fprintf(stdpm,"%11.3f",Iz);
    fprintf(stdpm,"%11.3f ",A);
    if(hinge_1==1)fprintf(stdpm,"Hinge ");
    else fprintf(stdpm," - ");

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



```

    if(hinge_2==1)fprintf(stdpm,"Hinge");
    else fprintf(stdpm," - ");
    fprintf(stdpm,"\n\n");
}
fclose(fp);
fp=fopen(f1,"r");
fscanf(fp,"%f",&fy);
fscanf(fp,"%i",&no_ele);
fprintf(stdpm,"  Ele:Node1:Node2:  B   :  Tw   :  D   :  D1   : case \n\n");
for(i=0;i<no_ele;i++){
    fscanf(fp,"%i",&ele_no);
    fscanf(fp,"%i",&node_1);
    fscanf(fp,"%i",&node_2);
    fscanf(fp,"%f",&Es);
    fscanf(fp,"%f",&G);
    fscanf(fp,"%f",&Ix);
    fscanf(fp,"%f",&Iy);
    fscanf(fp,"%f",&Iz);
    fscanf(fp,"%f",&B);
    fscanf(fp,"%f",&Tw);
    fscanf(fp,"%f",&D);
    fscanf(fp,"%f",&D1);
    fscanf(fp,"%f",&A);
    fscanf(fp,"%i",&hinge_1);
    fscanf(fp,"%i",&hinge_2);
    fscanf(fp,"%i",&moase);
    fprintf(stdpm,"    %3i",ele_no);
    fprintf(stdpm,"%6i",node_1);
    fprintf(stdpm,"%6i",node_2);
    fprintf(stdpm,"%11.3f",B);
    fprintf(stdpm,"%11.3f",Tw);
    fprintf(stdpm,"%11.3f",D);
    fprintf(stdpm,"%11.3f",D1);
    fprintf(stdpm,"%4i",moase);
}

```



```

    fprintf(stdpm, "\n\n");
}
fclose(fp1);
}
void ooo_out_screen(char *fn);
void ele_out_screen(char *fn);
void lds_out_screen(char *fn);
void dat_out_screen(char *fn, int sor)
{
char fn1[15];
int i,j,k;
strcpy(fn1,fn);
window(3,4,77,22);
border(3,4,77,22);
clear_screen(2,74,3,18);
gotoxy(3,3);
printf("Select File\n\n");
gotoxy(3,4);
printf("1> Node Data\n\n");
gotoxy(3,5);
printf("2> Element Data\n\n");
gotoxy(3,6);
printf("3> Load Data\n\n");
gotoxy(3,7);
scanf("%i",&i);
switch(i){
case 1:
    ooo_out_screen(fn);
    break;
case 2:
    ele_out_screen(fn);
    break;
case 3:
    lds_out_screen(fn);

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

    break;
default:
    return;
}
return;
}
void ooo_out_screen(char *fn)
{
int no_node,i,j,k,l,node_no,bou[6];
float x,y,z;
char fl[15];
FILE *fp1;
clear_screen(2,74,3,18);
stropv(fl,fn);
streat(fl, ".ooo");
fp1=fopen(fl,"r");
gotoxy(3,3);
printf(":- Project Name : %s\n",fn);
gotoxy(3,4);
printf(":- Coordinate Input Data\n");
gotoxy(3,5);
printf("\n");
fscanf(fp1,"%i",&no_node);
gotoxy(3,6);
printf(":-No of Node = %i\n",no_node);
gotoxy(3,8);
printf("Node: X-Coor ; Y-Coor : Z-Coor :Bou 1:Bou 2:Bou 3:Bou 4:Bou 5:Bou 6\n");
gotoxy(3,9);
j=0;
for(i=0;i<no_node;i++){
    gotoxy(3,9+j);
    fscanf(fp1,"%i",&node_no);
    printf("%4i",node_no);
    fscanf(fp1,"%f",&x);

```

```

printf("%10.2f",x);
fscanf(fp1,"%f",&y);
printf("%10.2f",y);
fscanf(fp1,"%f",&z);
printf("%10.2f",z);
fscanf(fp1,"%i",&bou[0]);
if(bou[0]==0)printf(" Fix ");
else printf(" ");
fscanf(fp1,"%i",&bou[1]);
if(bou[1]==0)printf(" Fix ");
else printf(" ");
fscanf(fp1,"%i",&bou[2]);
if(bou[2]==0)printf(" Fix ");
else printf(" ");
fscanf(fp1,"%i",&bou[3]);
if(bou[3]==0)printf(" Fix ");
else printf(" ");
fscanf(fp1,"%i",&bou[4]);
if(bou[4]==0)printf(" Fix ");
else printf(" ");
fscanf(fp1,"%i",&bou[5]);
if(bou[5]==0)printf(" Fix ");
else printf(" ");
fscanf(fp1,"%f",&x);
fscanf(fp1,"%f",&y);
fscanf(fp1,"%f",&z);
printf("\n");
j++;
if(j>8){
    j=0;
    getch();
    getch();
    clear_screen(3,74,9,18);
}

```

```

}
getch();getch();
fclose(fp1);
}
void ele_out_screen(char *fn)
{
int no_ele,i,j,ele_no,node_1,node_2,hinge_1,hinge_2,ohk_i,moase;
float fy,Es,G,A;
float Ix,Iy,Iz,B,Tw,D,D1;
char f1[15];
FILE *fp;

clear_screen(2,74,3,18);
strcpy(f1,fn);
strcpy(f1,".ele");
fp=fopen(f1,"r");
gotoxy(3,3);
printf(":- Project Name : %s",fn);
gotoxy(3,4);
printf(":- Element Connectivity Input Data");
fscanf(fp,"%f",&fy);
fscanf(fp,"%i",&no_ele);
gotoxy(3,6);
printf(":- No of Element = %i",no_ele);
gotoxy(3,7);
printf(":- Yield Strength = %10.3f",fy);
fscanf(fp,"%i",&ele_no);
fscanf(fp,"%i",&node_1);
fscanf(fp,"%i",&node_2);
fscanf(fp,"%f",&Es);
fscanf(fp,"%f",&G);
fscanf(fp,"%f",&Ix);
fscanf(fp,"%f",&Iy);
fscanf(fp,"%f",&Iz);

```

```

fscanf(fp,"%f",&B);
fscanf(fp,"%f",&Tw);
fscanf(fp,"%f",&D);
fscanf(fp,"%f",&D1);
fscanf(fp,"%f",&A);
fscanf(fp,"%i",&hinge_1);
fscanf(fp,"%i",&hinge_2);
fscanf(fp,"%i",&moase);

gotoxy(3,8);
printf("- Modulus of Elasticity = %10.3f\n",Es);
gotoxy(3,10);
printf("G = ",G);
gotoxy(40,23);
printf("Press any key to Continue.....!!!");
getch();
clrscr();
gotoxy(3,5);
printf("Element Number : %i",ele_no);
gotoxy(3,6);
printf("Node 1 = %i",node_1);
gotoxy(3,7);
printf("Node 2 = %i",node_2);
gotoxy(3,8);
printf("Ix = %f",Ix);
gotoxy(3,9);
printf("Iy = %f",Iy);
gotoxy(3,10);
printf("Iz = %f",Iz);
gotoxy(3,11);
printf("B = %f",B);
gotoxy(3,12);
printf("Tw = %f",Tw);
gotoxy(3,13);
printf("D = %f",D);

```

ศูนย์วิทยทรัพยากร  
 วิทยาลัย

```

gotoxy(3,14);
printf("D1    = %f",D1);
gotoxy(3,15);
printf("A     = %f",A);
gotoxy(3,16);
if(hinge_1==1) {
    gotoxy(3,16);
    printf("End1 Con = Hinge ");
}
else
{
    gotoxy(3,16);
    printf("End1 Con = -");
}
if(hinge_2==1) {
    gotoxy(3,17);
    printf("End2 Con = Hinge");
}
else {
    gotoxy(3,17);
    printf("End2 Con = -");
}
gotoxy(3,18);
printf("case   = %i",mease);
getch();
j=1;
for(i=1;i<no_ele;i++){
    gotoxy(3,11+j);
    fscanf(fp,"%i\n",&ele_no);
    fscanf(fp,"%i\n",&node_1);
    fscanf(fp,"%i\n",&node_2);
    fscanf(fp,"%f\n",&Es);
    fscanf(fp,"%f\n",&G);
    fscanf(fp,"%f\n",&Ix);
}

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



```

fscanf(fp,"%f",&Iy);
fscanf(fp,"%f",&Iz);
fscanf(fp,"%f",&B);
fscanf(fp,"%f",&Tw);
fscanf(fp,"%f",&D);
fscanf(fp,"%f",&D1);
fscanf(fp,"%f",&A);
fscanf(fp,"%i",&hinge_1);
fscanf(fp,"%i",&hinge_2);
fscanf(fp,"%i",&moose);
olrsor();
gotoxy(3,5);
printf("Element Number : %i",ele_no);
gotoxy(3,6);
printf("Node 1 = %i",node_1);
gotoxy(3,7);
printf("Node 2 = %i",node_2);
gotoxy(3,8);
printf("Ix = %f",Ix);
gotoxy(3,9);
printf("Iy = %f",Iy);
gotoxy(3,10);
printf("Iz = %f",Iz);
gotoxy(3,11);
printf("B = %f",B);
gotoxy(3,12);
printf("Tw = %f",Tw);
gotoxy(3,13);
printf("D = %f",D);
gotoxy(3,14);
printf("D1 = %f",D1);
gotoxy(3,15);
printf("A = %f",A);
gotoxy(3,16);

```

```

if(hinge_1==1) {
    gotoxy(3,16);
    printf("End1 Con = Hinge ");
}
else
{
    gotoxy(3,16);
    printf("End1 Con = - ");
}
if(hinge_2==1) {
    gotoxy(3,17);
    printf("End2 Con = Hinge");
}
else {
    gotoxy(3,17);
    printf("End2 Con = - ");
}
gotoxy(3,18);
printf("case = %i",moase);
getch();
}
fclose(fp);
}
void lds_out_screen(char *fn)
{
    int no_ld,i,j,k,node_no,no_node;
    float x_load,y_load,z_load,Mx,My,Mz;
    float a;
    char fl[15];
    FILE *fp1;

    clear_screen(2,74,3,18);
    strcpy(fl,fn);
    stroat(fl,"lds");

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

fp1=fopen(f1,"r");
gotoxy(3,3);
printf("- Project Name : %s",fn);
gotoxy(3,4);
printf("- External Load Data");
fscanf(fp1,"%i\\",&no_node);
gotoxy(3,6);
printf("Node: X-load : Y-load : Z-load : Mx : My : Mz \\n");
j=0;
for(i=0;i<no_node;i++){
    gotoxy(3,8+j);
    fscanf(fp1,"%i\\",&node_no);
    printf("%4i ",node_no);
    fscanf(fp1,"%f\\",&x_load);
    printf("%10.2f",x_load);
    fscanf(fp1,"%f\\",&y_load);
    printf("%10.2f",y_load);
    fscanf(fp1,"%f\\",&z_load);
    printf("%10.2f",z_load);
    fscanf(fp1,"%f\\",&Mx);
    printf("%10.2f",Mx);
    fscanf(fp1,"%f\\",&My);
    printf("%10.2f",My);
    fscanf(fp1,"%f\\",&Mz);
    printf("%10.2f",Mz);
    j++;
    if(j>9){
        j=0;
        getch();
        getch();
        clear_screen(3,74,9,18);
    }
}
getch();

```

```

getch();
fclose(fp1);
}
void oclear_screen(int x1,int x2,int y1,int y2)
{
register int i,j;
for(i=x1;i<x2;i++){
for(j=y1;j<y2;j++){
gotoxy(i,j);
putch(0);
}
}
}
int get_req(FILE *fp);
void solving(char *fname,int mode,double fy,int no_node,int no_ele,int no_ld,struct co_or*pt_1, struct
ele_con *pt_2,struct load *pt_3);
void solution(int mode,char *fname)
{
struct co_or*pt_co;
struct ele_con *pt_ele;
double fy;
struct load *pt_ld;
int i,n_node,n_ele,n_ld,j;
FILE *fp;
char fname0[15],fname1[15],fname2[15];
strcpy(fname0,fname);
strcpy(fname1,fname);
strcpy(fname2,fname);
/* input node data */
strcpy(fname0,".coo");
fp=fopen(fname0,"r");
n_node=get_req(fp);
/* printf("%f",n_node); */
pt_co=alloo_co(n_node);

```

```

    get_node(fp,n_node,pt_co);
fclose(fp);
/* input element data */
stroat(fname1,".ele");
fp=fopen(fname1,"r");
fscanf(fp,"%lf",&fy);
n_ele=get_req(fp);
pt_ele=alloo_ele(n_ele);
get_ele(fp,n_ele,pt_ele);
fclose(fp);
/* input load data */
stroat(fname2,".lds");
fp=fopen(fname2,"r");
n_ld=get_req(fp);
pt_ld=alloo_ld(n_ld);
get_ld(fp,n_ld,pt_ld);
fclose(fp);
solving(fname,mode,fy,n_node,n_ele,n_ld,pt_co,pt_ele,pt_ld);
free(pt_co);
free(pt_ele);
free(pt_ld);
}
int get_req(FILE *fp)
{
    int req;
    fscanf(fp,"%d\n",&req);
    return(req);
}
struct oo_or*alloo_oo(int n)
{
    struct oo_or*pt;
    pt=(struct oo_or*)malloc(n*sizeof(struct oo_or));
    if(pt==NULL){
        printf("Out of Memory.!\n");

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

    exit(1);
}
return(pt);
}
void get_node(FILE *fp,int n,struct oo_or*pt)
{
register int i,j;
for(i=0;i<n;i++){
    fscanf(fp,"%i\\",&pt[i].node_no);
    fscanf(fp,"%lf\\",&pt[i].x);
    fscanf(fp,"%lf\\",&pt[i].y);
    fscanf(fp,"%lf\\",&pt[i].z);
    for(j=0;j<6;j++){
        fscanf(fp,"%i\\",&pt[i].bou[j]);
    }
    fscanf(fp,"%lf\\",&pt[i].xo);
    fscanf(fp,"%lf\\",&pt[i].yo);
    fscanf(fp,"%lf\\",&pt[i].zo);
}
}
struct ele_oon *alloo_ele(int n)
{
struct ele_oon *pt;
pt=( struct ele_oon *)malloc(n*sizeof(struct ele_oon));
if(pt==NULL){
    printf("Out of Memory.12n");
    exit(1);
}
return(pt);
}
void get_ele(FILE *fp,int n, struct ele_oon *pt)
{
register int i;
for(i=0;i<n;i++){

```

```

fscanf(fp,"%i\\",&pt[i].ele_no);
fscanf(fp,"%i\\",&pt[i].node_1);
fscanf(fp,"%i\\",&pt[i].node_2);
fscanf(fp,"%lf\\",&pt[i].Es);
fscanf(fp,"%lf\\",&pt[i].G);
fscanf(fp,"%lf\\",&pt[i].Ix);
fscanf(fp,"%lf\\",&pt[i].Iy);
fscanf(fp,"%lf\\",&pt[i].Iz);
fscanf(fp,"%lf\\",&pt[i].B);
fscanf(fp,"%lf\\",&pt[i].Tw);
fscanf(fp,"%lf\\",&pt[i].D);
fscanf(fp,"%lf\\",&pt[i].D1);
fscanf(fp,"%lf\\",&pt[i].A);
fscanf(fp,"%i\\",&pt[i].hinge_1);
fscanf(fp,"%i\\",&pt[i].hinge_2);
fscanf(fp,"%i\\",&pt[i].moase);
}
}
struct load *alloc_ld(int n)
{
struct load *pt;
pt=(struct load *)malloc(n*sizeof(struct load));
if(pt==NULL){
printf("Out of Memory.13n");
exit(1);
}
return(pt);
}
void get_ld(FILE *fp,int n,struct load *pt)
{
register int i;
for(i=0;i<n;i++){
fscanf(fp,"%i\\",&pt[i].node_no);
fscanf(fp,"%lf\\",&pt[i].x_load);

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

fscanf(fp,"%lf",&pt[i].y_load);
fscanf(fp,"%lf",&pt[i].z_load);
fscanf(fp,"%lf",&pt[i].Mx);
fscanf(fp,"%lf",&pt[i].My);
fscanf(fp,"%lf",&pt[i].Mz);
}
return;
}
struct dof{int x_dof;
           int y_dof;
           int z_dof;
           int thetax_dof;
           int thetay_dof;
           int thetaz_dof;
};
struct m_stress{double lf;
                double s[12];
};
int get_dof(int no_node,int no_ele,struct oo_or*pt_oo, struct ele_oon *pt_ele);
void gen_dof_no(int no_node,int no_dof,struct oo_or*pt_oo,struct dof *pt);
void print_disp(double lf,FILE *fp,int no_node,struct dof *dof_pt,double *pt_v);
int *alloo_h(int n);
void get_h(int no_dof,int *pt_h,int no_ele, struct ele_oon *pt_ele,struct dof *dof_pt);
double *alloo_K(int h);
void get_k(int no_ele,int *pt_h,double *pt_v,double *pt_k,struct oo_or*pt_oo, struct ele_oon *pt_ele,struct
dof *dof,struct m_stress *pt,struct m_stress *pt1,int order_index);
void chk_k(int no_dof,int *pt_h,double *pt_k);
void get_r(int n_node,int no_ld,double *pt1,struct load *pt2,struct dof *pt3);
int active_ool_solver(double *pt_k,int *pt_h,double *pt_r,int n_eq,int oheok1);
void oal_stress(int order_index,double *pt_v,double lf,int no_ele,struct oo_or*pt_oo, struct ele_oon *
pt_ele,double *pt_r,struct dof *pt_dof,struct m_stress *pt,struct m_stress *pt1,struct m_stress *pt2);
void int_f_vector(int no_dof,int no_ele,double *pt_v,double *pt_x,struct oo_or*pt_oo, struct ele_oon *
pt_ele,struct dof *dof_pt,struct m_stress *pt_s);
void residue_vector(int no_dof,double *pt_x,double *pt_r);

```



```

double eu_norm(int no_dof,double *pt_x);
void rev_coor(int n_node,double *pt_v,struct oo_or*pt_oo,struct dof *pt_dof);
int plastio_h_check(int no_ele,double fy, struct ele_oon *pt_ele,struct m_stress *pt_s);
FILE *fp2;
void solving(char *fn,int mode,double fy,int no_node,int no_ele,int no_ld,struct oo_or*pt_oo, struct ele_oon
*pt_ele,struct load *pt_ld)
{
struct dof *dof_pt;
struct m_stress *pt_s,*pt_sr,*pt_ss,*pt_srs;
register int i,j,k;
int no_dof,*pt_h,l=0,m,count,count1=0,count2=0,order_index,e_p_index,index1,pos_index=1; /*
pos_index=1 positive definite matrix */
/*pos_index=0 non-positive definite matrix */
double *pt_k,*pt_r,*pt_x,*pt_v,*pt_vs,norm_r,norm_l_factor,lf_interval,lf_step;
double diag_check=1e-15;
FILE *fp1;
char fn1[15],fn2[15];
switch(mode){
case 0:
order_index=1; /*1st order: order index=1*/
/*2nd order: order index=2*/
e_p_index=1; /*Elastio Analysis: e_p_index=1*/
/*Elastic-Plastio Analysis: e_p_index=2*/
lf_interval=1;
break;
case 1:
order_index=2;
e_p_index=1;
lf_interval=1;
break;
case 2:
order_index=1;
e_p_index=2;
lf_interval=0.005;

```

```

        break;
    default:
        order_index=2;
        e_p_index=2;
        lf_interval=0.005; /* default load factor interval for E-P analysis */
        break;
    }
no_dof=get_dof(no_node,no_ele,pt_co,pt_ele);
pt_s=malloc(no_ele*sizeof(struct m_stress));
if(pt_s==NULL)printf("Out of Memory.\n");
pt_ss=malloc(no_ele*sizeof(struct m_stress));
if(pt_ss==NULL)printf("Out of Memory.\n");
pt_sr=malloc(no_ele*sizeof(struct m_stress));
if(pt_sr==NULL)printf("Out of Memory.\n"); /*allocate memory for internal residue load vector*/
pt_srs=malloc(no_ele*sizeof(struct m_stress));
if(pt_srs==NULL)printf("Out of Memory.\n");
dof_pt=malloc(no_dof*sizeof(struct dof));
if(dof_pt==NULL)printf("Out of Memory.\n");
gen_dof_no(no_node,no_dof,pt_co,dof_pt);
pt_h=alloo_h(no_dof+1); /*allocate memory for input height index of stiffness metrix*/
get_h(no_dof,pt_h,no_ele,pt_ele,dof_pt); /*calculate column height*/
pt_k=alloo_K(pt_h[no_dof]); /*allocate memory for input stiffness co-ef*/
pt_r=alloo_K(no_dof); /*allocate memory for input load vector*/
pt_x=alloo_K(no_dof); /*allocate memory for internal load vector*/
pt_v=alloo_K(no_dof); /*allocate memory for external displacement vector*/
pt_vs=alloo_K(no_dof); /*allocate memory for external displacement vector*/
l_factor=0; /*load factor initialize */
for(j=0;j<no_dof;j++)pt_v[j]=0;
for(j=0;j<no_dof;j++)pt_vs[j]=0;
stropy(fn1,fn);
stropy(fn2,fn);
streat(fn2,".lfd");
streat(fn1,".str");
/* open output files*/

```

```

if((fp1=fopen(fn2,"w"))==NULL)printf("Cannot open .lfd output file.\n");
if((fp2=fopen(fn1,"w"))==NULL)printf("Cannot open .str output file.\n");
/* write displacement to .lfd output file */
fprintf(fp1,"%i\\n",no_node);
print_disp(l_factor,fp1,no_node,dof_pt,pt_v);
for(i=0;i<no_dof;i++)pt_v[i]=0;
/* write to .str file */
fprintf(fp2,"%i\\n",no_ele);
for(i=0;i<no_ele;i++){
    pt_sr[i].lf=0;
    for(j=0;j<12;j++)pt_sr[i].s[j]=0;
}
count=0;
m=0;
index1=0;
for(i=0;i<no_ele;i++){
    pt_ss[i].lf=0;
    for(j=0;j<12;j++)pt_ss[i].s[j]=0;
}
lf_step=0;
gotoxy(5,5);
printf("Iteration No-----> ");
gotoxy(5,6);
printf("Load Factor Step No-> ");
gotoxy(5,7);
printf("Plastic Hinge No-----> ");
gotoxy(5,8);
printf("Load Factor----- = ");
do{
    l_factor+=lf_interval;
    lf_step+=lf_interval;
    for(i=0;i<no_ele;i++){
        pt_s[i].lf=0;
        for(j=0;j<12;j++)pt_s[i].s[j]=0;
    }
}

```

```

        for(j=0;j<12;j++)pt_srs[i].s[j]=0; /*generate internal load vector for nonlinear geometry*/
    }
    for(i=0;i<no_ele;i++){
        pt_sr[i].lf=0;
        for(j=0;j<12;j++)pt_sr[i].s[j]=pt_ss[i].s[j];
    }
    for(j=0;j<no_dof;j++)pt_v[j]=pt_vs[j];
    get_r(no_dof,no_ld,pt_r,pt_ld,dof_pt);
    for(j=0;j<no_dof;j++)pt_r[j]=l_factor; /*generate total load vector*/
    for(j=0;j<no_dof;j++)pt_x[j]=pt_r[j];
    get_r(no_dof,no_ld,pt_r,pt_ld,dof_pt);
    for(j=0;j<no_dof;j++)pt_r[j]=lf_step; /*generate step load vector*/
    norm_r=eu_norm(no_dof,pt_r);
    do{
        if(order_index==2||index1==0){
            for(i=0;i<pt_h[no_dof];i++)pt_k[i]=0;
            get_k(no_ele,pt_h,pt_v,pt_k,pt_co,pt_ele,dof_pt,pt_sr,pt_srs,order_index); /*assembling
stiffness oo-ef*/
        }
        ohk_k(no_dof,pt_h,pt_k);
        pos_index=active_cool_solver(pt_k,pt_h,pt_r,no_dof,index1);
        if(pos_index==1){
            if(order_index==1)index1++;
            for(i=0;i<no_dof;i++)pt_v[i]+=pt_r[i];
            cal_stress(order_index,pt_v,l_factor,no_ele,pt_co,pt_ele,pt_r,dof_pt,pt_s,pt_srs);
            int_f_vector(no_dof,no_ele,pt_v,pt_r,pt_co,pt_ele,dof_pt,pt_s);
            residue_vector(no_dof,pt_x,pt_r);
/*
            for(j=0;j<no_dof;j++){
                printf("pos_index = %i pt_x[%i] = %lf pt_r[%i] = %lf\n",pos_index,j,pt_x[j],j,pt_r[j]);getch()
;*/

            norm=eu_norm(no_dof,pt_r);
            for(i=0;i<no_dof;i++)pt_x[i]=pt_r[i];
            for(i=0;i<no_ele;i++){
                for(j=0;j<12;j++)pt_srs[i].s[j]=pt_s[i].s[j];

```

```

    }
}
else{
    norm=-1;
}
++count1;
gotoxy(28,5);
printf("%i",count1 );
/* printf("norm = %lf\n",norm);getch();getch();*/
}while(order_index==2&&norm>=.1*norm_r/100);
if(pos_index==1){
    if(l_factor>=1)l_factor=.0005;
    /* write displacement to .lfd output file */
    if(e_p_index==2)l=plastic_h_check(no_ele,fy,pt_ele,pt_sr);
    if(l==1){
        ++m;
        count=m;
    }
    if(l==1||e_p_index==1){
        print_disp(l_factor,fp1,no_node,dof_pt,pt_v);
        lf_step=0;
        index1=0;
        gotoxy(28,7);
        printf("%i",m);
        gotoxy(28,8);
        printf("%f",l_factor);
        for(i=0;i<no_ele;i++){
            pt_ss[i].lf=l_factor;
            for(j=0;j<12;j++)pt_ss[i].s[j]=pt_sr[i].s[j];
        }
        for(j=0;j<no_dof;j++)pt_vs[j]=pt_v[j];
        fprintf(fp2,"%f\n",l_factor);
        fprintf(fp2,"%i\n",m);
        for(j=0;j<no_ele;j++){

```

```

if(pt_ele[j].hinge_1==1||pt_ele[j].hinge_2==1){
    fprintf(fp2,"%i\\",j+1);
    if(pt_ele[j].hinge_1==1&&pt_ele[j].hinge_2==0)fprintf(fp2,"N\\");
    if(pt_ele[j].hinge_1==0&&pt_ele[j].hinge_2==1)fprintf(fp2,"F\\");
    if(pt_ele[j].hinge_1==1&&pt_ele[j].hinge_2==1)fprintf(fp2,"B\\");
}
}
fprintf(fp2,"-I\\n");
for(i=0;i<no_ele;i++){
    for(j=0;j<12;j++)fprintf(fp2,"%f\\",pt_ss[i].s[j]);
    fprintf(fp2,"\\n");
}
}
}
++count2;
gotoxy(28,6);
printf("%i",count2);
}while(c_p_index==2&&pos_index==1);
fprintf(fp1,"-I\\");
fprintf(fp2,"-I\\");
fclose(fp1);
fclose(fp2);
free(pt_s);
free(pt_ss);
free(dof_pt);
free(pt_h);
free(pt_k);
free(pt_r);
free(pt_x);
free(pt_v);
free(pt_vs);
free(pt_sr);
return;
}

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

int get_dof(int no_node,int no_ele,struct eo_or*pt_eo, struct ele_eon *pt_ele)
{
int j,i,no_dof,no_free,no_hing;
no_free=0;
no_hing=0;
for(i=0;i<no_node;i++)no_free=no_free+pt_eo[i].bou[0]+pt_eo[i].bou[1]+pt_eo[i].bou[2]+pt_eo[i].bou[3]+
pt_eo[i].bou[4]+pt_eo[i].bou[5];
for(i=0;i<no_ele;i++)no_hing=no_hing+pt_ele[i].hinge_1+pt_ele[i].hinge_2;
no_dof=no_free;
return(no_dof);
}

void gen_dof_no(int no_node,int no_dof,struct eo_or*pt_eo,struct dof *dof_pt)
{register int i;
int j=0;
for(i=0;i<no_node;i++){
if(pt_eo[i].bou[0]==1)dof_pt[i].x_dof=++j;
else dof_pt[i].x_dof=0;
if(pt_eo[i].bou[1]==1)dof_pt[i].y_dof=++j;
else dof_pt[i].y_dof=0;
if(pt_eo[i].bou[2]==1)dof_pt[i].z_dof=++j;
else dof_pt[i].z_dof=0;
if(pt_eo[i].bou[3]==1)dof_pt[i].thetax_dof=++j;
else dof_pt[i].thetax_dof=0;
if(pt_eo[i].bou[4]==1)dof_pt[i].thetay_dof=++j;
else dof_pt[i].thetay_dof=0;
if(pt_eo[i].bou[5]==1)dof_pt[i].thetaz_dof=++j;
else dof_pt[i].thetaz_dof=0;
if(j>no_dof)printf("data error\n");
}
return;
}

int *aloo_h(int n)
{
int *pt;

```

```

pt=(int *)malloc(n*sizeof(int));
if(pt==NULL){
    printf("Out of Memory.\n");
    exit(1);
}
return(pt);
}
void gen_lm(int ele_no,int *lm, struct ele_oon *pt_ele,struct dof *pt_dof);
void cal_h(int *pt_h,int *lm);
void get_h(int no_dof,int *pt_h,int no_ele, struct ele_oon *pt_ele,struct dof *pt_dof)
{
    register i;
    int lm[12],*h;
    h=(int *)malloc(no_dof*sizeof(int));
    if(h==NULL){
        printf("Out of Memory.\n");
        exit(1);
    }
    for(i=0;i<no_dof;i++)h[i]=0;
    for(i=0;i<no_ele;i++){
        gen_lm(i,lm,pt_ele,pt_dof);
        cal_h(h,lm);
    }
    pt_h[0]=0;
    for(i=0;i<no_dof;i++)pt_h[i+1]=pt_h[i]+h[i];
    free(h);
    return;
}
void gen_lm(int i,int *lm, struct ele_oon *pt_ele,struct dof *pt_dof)
{
    lm[0]=pt_dof[pt_ele[i].node_1-1].x_dof;
    lm[1]=pt_dof[pt_ele[i].node_1-1].y_dof;
    lm[2]=pt_dof[pt_ele[i].node_1-1].z_dof;
    lm[3]=pt_dof[pt_ele[i].node_1-1].thetax_dof;

```



```

lm[4]=pt_dof[pt_ele[i].node_1-1].thetay_dof;
lm[5]=pt_dof[pt_ele[i].node_1-1].thetaz_dof;
lm[6]=pt_dof[pt_ele[i].node_2-1].x_dof;
lm[7]=pt_dof[pt_ele[i].node_2-1].y_dof;
lm[8]=pt_dof[pt_ele[i].node_2-1].z_dof;
lm[9]=pt_dof[pt_ele[i].node_2-1].thetax_dof;
lm[10]=pt_dof[pt_ele[i].node_2-1].thetay_dof;
lm[11]=pt_dof[pt_ele[i].node_2-1].thetaz_dof;
return;
}
void oal_h(int *pt_h,int *lm)
{
register int i,j,k;
int tempt_h;
for(i=0;i<12;i++){
j=lm[i];
for(k=0;k<12;k++){
if((k==j)&&(lm[k]!=0)&&(lm[k]<j)){
tempt_h=j-lm[k];
if(tempt_h>pt_h[j-1]-1)pt_h[j-1]=tempt_h+1;
}
if(k!=j){
if((j!=0)&&(lm[k]!=0)&&(lm[k]<j)){
tempt_h=j-lm[k];
if(tempt_h>pt_h[j-1]-1)pt_h[j-1]=tempt_h+1;
}else
{
tempt_h=0;
if(tempt_h>pt_h[j-1]-1)pt_h[j-1]=tempt_h+1;
}
}
}
}
return;

```

```

}
double *aloo_K(int h)
{
double *pt;
pt=(double *)malloc(h*sizeof(double));
if(pt==NULL){
printf("Out of Memory.\n");
exit(1);
}
return(pt);
}
void cal_local_disp(int *lm,double *pt_r,double *v,double o,double s,double es,double xx,double yy,double
zz,double ll,double l);
void form_stiff(int order,int i,double u,double v0,double w,double l,double *st_m,double E,double G,double
Ix,double Iy,double Iz,double A,double tya,double tza,double tyb,double tzb,double fx,double Fx,double
Fy,double Fz);
void rev_stiff(int n,double *st_m);
void rotat(double *st_m,double o,double s,double es,double xx,double yy,double zz,double ll,double l);
void assembling(double *st_m,int *lm,int *pt_h,double *pt_k);
void get_k(int no_ele,int *pt_h,double *pt_v,double *pt_k,struct oo_or *pt_oo, struct ele_oon *pt_ele,struct
dof *pt_dof,struct m_stress *pt_sr,struct m_stress *pt_srs,int order)
{
register int i,j;
int lm[12];
double fx,Fx,Fy,Fz,v[12],l,x[4],y[4],z[4],st_m[78],n,o,s,es,xx,yy,zz,ll,u,v0,w,tya,tyb,tza,tzb;
for(i=0;i<no_ele;i++){
x[0]=pt_oo[pt_ele[i].node_1-1].xo;
x[1]=pt_oo[pt_ele[i].node_2-1].xo;
y[0]=pt_oo[pt_ele[i].node_1-1].yo;
y[1]=pt_oo[pt_ele[i].node_2-1].yo;
z[0]=pt_oo[pt_ele[i].node_1-1].zo;
z[1]=pt_oo[pt_ele[i].node_2-1].zo;
xx=x[1]-x[0];
yy=y[1]-y[0];

```

```

zz=z[1]-z[0];
ll=sqrt((x[0]-x[1])*(x[0]-x[1])+(y[0]-y[1])*(y[0]-y[1]));
l=sqrt((x[0]-x[1])*(x[0]-x[1])+(y[0]-y[1])*(y[0]-y[1])+(z[0]-z[1])*(z[0]-z[1]));
o=(x[1]-x[0])/l;
s=(y[1]-y[0])/l;
os=(z[1]-z[0])/l;
if(order==2){
Fx=pt_sr[i].s[6];
Fy=pt_sr[i].s[7];
Fz=pt_sr[i].s[8];
gen_lm(i,lm,pt_ele,pt_dof);
cal_local_disp(lm,pt_v,v,o,s,os,xx,yy,zz,ll,l);
x[2]=v[0];
x[3]=v[6];
y[2]=v[1];
y[3]=v[7];
z[2]=v[2];
z[3]=v[8];
tya=v[4];
tza=v[5];
tyb=v[10];
tzb=v[11];
u=x[3]-x[2];
v0=y[3]-y[2];
w=z[3]-z[2];
}
else
{
fx=0.0;
Fx=0.0;
Fy=0.0;
Fz=0.0;
tya=0.0;
tza=0.0;

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

tyb=0.0;
tzb=0.0;
u=0.0;
v0=0.0;
w=0.0;
}
form_stiff(order,i,u,v0,w,l,st_m,pt_ele[i].Es,pt_ele[i].G,pt_ele[i].Ix,pt_ele[i].Iy,pt_ele[i].Iz,pt_ele[i].
A,tya,tza,tyb,tzb,fx,Fx,Fy,Fz);
if((pt_ele[i].hinge_1==1)&&(pt_ele[i].hinge_2==1)){
    st_m[6]=0;st_m[45]=0;st_m[51]=0;
    rev_stiff(4,st_m);
    rev_stiff(5,st_m);
    rev_stiff(10,st_m);
    rev_stiff(11,st_m);
}
if((pt_ele[i].hinge_1==1)&&(pt_ele[i].hinge_2==0)){
    st_m[6]=0;st_m[51]=0;
    rev_stiff(4,st_m);
    rev_stiff(5,st_m);
}
if((pt_ele[i].hinge_1==0)&&(pt_ele[i].hinge_2==1)){
    st_m[45]=0;st_m[51]=0;
    rev_stiff(10,st_m);
    rev_stiff(11,st_m);
}
rotat(st_m,o,s,es,xx,yy,zz,ll,l);
gen_lm(i,lm,pt_ele,pt_dof);
assembling(st_m,lm,pt_h,pt_k);
}
return;
}
void form_stiff(int order,int i,double u,double v0,double w,double l,double *st_m,double E,double G,double
Ix,double Iy,double Iz,double A,double tya,double tza,double tyb,double tzb,double fx,double Fx,double
Fy,double Fz)

```

```

{ double P,aa[6][12],k[6][6],lt,ll,sum,y,z,y1,z1,y2,z2;
  int q;
  register int j,m,o,t;
  lt=sqrt((1+u)*(1+u)+(v0*v0)+(w*w));
  ll=sqrt((1+u)*(1+u)+(v0*v0));
  tya=(tya+atan(w/(1+u)));
  tza=tza-atan(v0/(1+u));
  tyb=tyb+atan(w/(1+u));
  tzb=tzb-atan(v0/(1+u));
  for(j=0;j<6;j++){
  for(m=0;m<12;m++)aa[j][m]=0.0;
  }
  for(j=0;j<6;j++){
  for(m=0;m<6;m++)k[j][m]=0.0;
  }
  aa[0][0]=-(1+u)/lt;
  aa[0][1]=-v0/lt;
  aa[0][2]=-w/lt;
  aa[0][6]=(1+u)/lt;
  aa[0][7]=v0/lt;
  aa[0][8]=w/lt;
  aa[1][3]=-1;
  aa[1][9]=1;
  aa[2][0]=-w*(1+u)/ll/lt/lt;
  aa[2][1]=-w*v0/ll/lt/lt;
  aa[2][2]=(ll/lt)/lt;
  aa[2][4]=1;
  aa[2][6]=w*(1+u)/ll/lt/lt;
  aa[2][7]=w*v0/ll/lt/lt;
  aa[2][8]=-(ll/lt)/lt;
  aa[3][0]=v0/ll/lt;
  aa[3][1]=-(1+u)/ll/lt;
  aa[3][5]=1;
  aa[3][6]=-v0/ll/lt; /**/

```



ศูนย์วิทยทรัพยากร  
 ภาลงกรณ์มหาวิทยาลัย

$$\begin{aligned}
aa[3][7] &= (1+u)/l/l/t; \\
aa[4][0] &= -w*(1+u)/l/l/t/l/t; \\
aa[4][1] &= -w*v0/l/l/t/l/t; \\
aa[4][2] &= l/l/t/l/t; \\
aa[4][6] &= w*(1+u)/l/l/t/l/t; \\
aa[4][7] &= w*v0/l/l/t/l/t; \\
aa[4][8] &= -l/l/t/l/t; \\
aa[4][10] &= 1; \\
aa[5][0] &= v0/l/l/t; \\
aa[5][1] &= -(1+u)/l/l/t; \\
aa[5][6] &= -v0/l/l/t; /* */ \\
aa[5][7] &= (1+u)/l/l/t; \\
aa[5][11] &= 1; \\
k[0][0] &= (E*A)/l; \\
k[0][2] &= (E*A/30.0)*(4.0*tya-tyb); \\
k[0][3] &= (E*A/30.0)*(4.0*tza-tzb); \\
k[0][4] &= (E*A/30.0)*(4.0*tyb-tya); \\
k[0][5] &= (E*A/30.0)*(4.0*tzb-tza); \\
k[1][1] &= G*Ix/l; \\
k[2][2] &= 4*E*Iy/l+4.0*E*A*(l-1)/30.0+(E*A*/300.0)*(8.0*tya*tya-4.0*tya*tyb+3*tyb*tyb)+ \\
&(E*A*/900.0)*(8.0*tza*tza-4.0*tza*tzb+8.0*tzb*tzb); \\
k[2][3] &= E*A*/900.0*(4.0*tya-tyb)*(4.0*tza-tzb); \\
k[2][4] &= 2*E*Iy/l-E*A*(l-1)/30.0-(E*A*/300.0)*(2.0*tya*tya-6.0*tya*tyb+2*tyb*tyb)-(E*A*/900.0)* \\
&(2.0*tza*tza-tza*tzb+2.0*tzb*tzb); \\
k[2][5] &= (E*A*/900.0)*(4.0*tya-tyb)*(4.0*tzb-tza); \\
k[3][3] &= 4*E*Iz/l+4.0*E*A*(l-1)/30.0+(E*A*/300.0)*(8.0*tza*tza-4.0*tza*tzb+3*tzb*tzb)+(E*A*/900.0) \\
&*(8.0*tya*tya-4.0*tya*tyb+8.0*tyb*tyb); \\
k[3][4] &= (E*A*/900.0)*(4.0*tyb-tya)*(4.0*tza-tzb); \\
k[3][5] &= 2*E*Iz/l-E*A*(l-1)/30.0-(E*A*/300.0)*(2.0*tza*tza-6.0*tza*tzb+2.0*tzb*tzb)-(E*A*/900.0)* \\
&(2.0*tya*tya-tya*tyb+2.0*tyb*tyb); \\
k[4][4] &= 4*E*Iy/l+4.0*E*A*(l-1)/30.0+(E*A*/300.0)*(8.0*tyb*tyb-4.0*tya*tyb+3.0*tya*tya)+ \\
&(E*A*/900.0)*(8.0*tza*tza-4.0*tza*tzb+8.0*tzb*tzb); \\
k[4][5] &= E*A*/900.0*(4.0*tyb-tya)*(4.0*tzb-tza);
\end{aligned}$$

```

k[5][5]=2*E*Iz/1+4.0*E*A*(lt-1)/30.0+(E*A*1/300.0)*(8.0*tzb*tzb-4.0*tza*tzb+3.0*tza*tza)+
(E*A*1/900.0)*(8.0*tya*tya-4.0*tya*tyb+8.0*tyb*tyb);

k[2][0]=k[0][2];
k[3][0]=k[0][3];
k[4][0]=k[0][4];
k[5][0]=k[0][5];
k[3][2]=k[2][3];
k[4][2]=k[2][4];
k[5][2]=k[2][5];
k[4][3]=k[3][4];
k[5][3]=k[3][5];
k[5][4]=k[4][5];

q=0;
for(j=0;j<12;j++){
for(m=j;m>=0;m--){
st_m[q]=0;
for(o=0;o<6;o++){
for(t=0;t<6;t++)st_m[q]=st_m[q]+aa[o][j]*aa[t][m]*k[o][t];
}
q++;
}
}

if(order==2){
st_m[0]=st_m[0]+((-1+u)*(1+u)*(1+u)*w*w*ll*ll+w*w*(1+u)*v0*v0*lt*lt-v0*v0*(1+u)*lt*lt*lt)*Fx+
(v0*lt*lt*ll*ll*ll+v0*(1+u)*(1+u)*lt*lt*lt-v0*(1+u)*(1+u)*w*w*ll*ll)*Fy+(-
v0*v0*w*w*w*ll*ll+w*ll*ll*ll*(w*w+2*(1+u)*(1+u))*Fz)/lt/lt/lt/ll/ll/ll;
st_m[1]=st_m[1]+((1+u)*lt*lt*ll*ll+w*w*(1+u)*(1+u)*lt*lt+v0*v0*(1+u)*lt*lt*lt)*Fx+(w*w*v0*
(1+u)*(1+u)*lt*lt-w*w*v0*v0*ll*ll-(1+u)*(1+u)*lt*lt*lt*v0)*Fy+w*v0*v0*ll*ll*(lt*lt+ll*ll)*Fz/
ll/ll/ll/lt/lt/lt;
st_m[2]=st_m[2]+((-w*w*(1+u)*(1+u)*v0-v0*v0*v0*lt*lt)*ll*ll*Fx+(w*v0*(1+u)*(lt*lt+ll*ll))*Fz-
(w*w*v0*v0*(1+u)*lt*lt+w*w*v0*v0*(1+u)*ll*ll+(1+u)*(1+u)*lt*lt*lt)*Fy)/ll/ll/ll/lt/lt/lt;
st_m[3]=st_m[3]+((1+u)*(lt*lt+w*w)*Fx+(v0*(lt*lt+w*w))*Fy-w*ll*ll*Fz)/lt/lt/lt;
st_m[4]=st_m[4]+(w*v0*(1+u)*Fx*ll*ll*ll-(w*w*w*v0*v0*(2*ll*ll+w*w))+w*(1+u)*(1+u)*lt*lt*ll*
Fy+v0*ll*ll*ll+v0*w*w*lt*lt*lt*Fz)/ll/ll/ll/lt/lt/lt;

```

$$\begin{aligned} \text{st\_m}[5] &= \text{st\_m}[5] + (- (w^*w^*w^*(1+u)^*(1+u) + w^*v^0*v^0*1t*1t) / \Pi / \Pi * F_x + w^*v^0*(1+u)*F_y - (1+u)*\Pi*\Pi*F_z) / t/t/t/t; \\ \text{st\_m}[25] &= \text{st\_m}[25] - (- (w^*w^*w^*(1+u)^*(1+u) + w^*v^0*v^0*1t*1t) / \Pi / \Pi * F_x + w^*v^0*(1+u)*F_y - (1+u)*\Pi*\Pi*F_z) / \\ & t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[26] &= \text{st\_m}[26] - ((-w^*w^*(1+u)^*(1+u)*v^0-v^0*v^0*1t*1t)*\Pi*\Pi*F_x + (w^*v^0*(1+u)*(1t*1t+\Pi*\Pi))*F_z - \\ & (w^*w^*v^0*v^0*(1+u)*1t+t+w^*w^*v^0*v^0*(1+u)*\Pi*\Pi+(1+u)^*(1+u)^*(1+u)*1t*1t*1t)*F_y) / \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[27] &= \text{st\_m}[27] - (((1+u)^*(1+u)^*(1+u)*w^*w^*\Pi*\Pi + w^*w^*(1+u)*v^0*v^0*1t-v^0*v^0*(1+u)*1t*1t*1t)*F_x + \\ & (v^0*1t*1t*\Pi*\Pi*\Pi*v^0*(1+u)^*(1+u)*1t*1t*1t-v^0*(1+u)^*(1+u)*w^*w^*\Pi*\Pi)*F_y + (- \\ & v^0*v^0*w^*w^*w^*\Pi*\Pi + w^*\Pi*\Pi*\Pi*(w^*w+2*(1+u)^*(1+u))) * F_z) / t/t/t/t/\Pi/\Pi/\Pi; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[33] &= \text{st\_m}[33] - (w^*v^0*(1+u)*F_x*\Pi*\Pi*\Pi - (w^*w^*w^*v^0*v^0*(2*\Pi*\Pi+w^*w) + w^*(1+u)^*(1+u)*1t*1t*\Pi*\Pi)* \\ & F_y + v^0*\Pi*\Pi*\Pi + v^0*w^*w^*1t*1t*1t*F_z) / \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[34] &= \text{st\_m}[34] - (((1+u)*1t*1t*\Pi*\Pi + w^*w^*(1+u)^*(1+u)^*(1+u)*1t+t+v^0*v^0*(1+u)*1t*1t*1t)*F_x + (w^*w^*v^0* \\ & (1+u)^*(1+u)*1t-t-w^*w^*v^0*v^0*\Pi*\Pi - (1+u)^*(1+u)*1t*1t*1t*v^0)*F_y + w^*v^0*v^0*\Pi*\Pi*(1t*1t+\Pi*\Pi)*F_z) / \\ & \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[35] &= \text{st\_m}[35] - ((-w^*w^*(1+u)^*(1+u)*v^0-v^0*v^0*1t*1t)*\Pi*\Pi*F_x + (w^*v^0*(1+u)*(1t*1t+\Pi*\Pi))*F_z - \\ & (w^*w^*v^0*v^0*(1+u)*1t+t+w^*w^*v^0*v^0*(1+u)*\Pi*\Pi+(1+u)^*(1+u)^*(1+u)*1t*1t*1t)*F_y) / \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\text{st\_m}[42] = \text{st\_m}[42] - ((1+u)^*(1t*1t+w^*w)*F_x + (v^0*(1t*1t+w^*w))*F_y - w^*\Pi*\Pi*F_z) / t/t/t/t;$$

$$\begin{aligned} \text{st\_m}[43] &= \text{st\_m}[43] - (w^*v^0*(1+u)*F_x*\Pi*\Pi*\Pi - (w^*w^*w^*v^0*v^0*(2*\Pi*\Pi+w^*w) + w^*(1+u)^*(1+u)*1t*1t*\Pi*\Pi)* \\ & F_y + v^0*\Pi*\Pi*\Pi + v^0*w^*w^*1t*1t*1t*F_z) / \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[44] &= \text{st\_m}[44] - (- (w^*w^*w^*(1+u)^*(1+u) + w^*v^0*v^0*1t*1t) / \Pi / \Pi * F_x + w^*v^0*(1+u)*F_y - (1+u)*\Pi*\Pi*F_z) / \\ & t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[21] &= \text{st\_m}[21] + (((1+u)^*(1+u)^*(1+u)*w^*w^*\Pi*\Pi + w^*w^*(1+u)*v^0*v^0*1t-v^0*v^0*(1+u)*1t*1t*1t)*F_x + \\ & (v^0*1t*1t*\Pi*\Pi*\Pi + v^0*(1+u)^*(1+u)*1t*1t*1t-v^0*(1+u)^*(1+u)*w^*w^*\Pi*\Pi)*F_y + (- \\ & v^0*v^0*w^*w^*w^*\Pi*\Pi + w^*\Pi*\Pi*\Pi*(w^*w+2*(1+u)^*(1+u))) * F_z) / t/t/t/t/\Pi/\Pi/\Pi; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[28] &= \text{st\_m}[28] + (((1+u)*1t*1t*\Pi*\Pi + w^*w^*(1+u)^*(1+u)^*(1+u)*1t+t+v^0*v^0*(1+u)*1t*1t*1t)*F_x + (w^*w^*v^0* \\ & (1+u)^*(1+u)*1t-t-w^*w^*v^0*v^0*\Pi*\Pi - (1+u)^*(1+u)*1t*1t*1t*v^0)*F_y + w^*v^0*v^0*\Pi*\Pi*(1t*1t+\Pi*\Pi)*F_z) / \\ & \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[29] &= \text{st\_m}[29] + ((-w^*w^*(1+u)^*(1+u)*v^0-v^0*v^0*1t*1t)*\Pi*\Pi*F_x + (w^*v^0*(1+u)*(1t*1t+\Pi*\Pi))*F_z - \\ & (w^*w^*v^0*v^0*(1+u)*1t+t+w^*w^*v^0*v^0*(1+u)*\Pi*\Pi+(1+u)^*(1+u)^*(1+u)*1t*1t*1t)*F_y) / \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\text{st\_m}[36] = \text{st\_m}[36] + ((1+u)^*(1t*1t+w^*w)*F_x + (v^0*(1t*1t+w^*w))*F_y - w^*\Pi*\Pi*F_z) / t/t/t/t;$$

$$\begin{aligned} \text{st\_m}[37] &= \text{st\_m}[37] + (w^*v^0*(1+u)*F_x*\Pi*\Pi*\Pi - (w^*w^*w^*v^0*v^0*(2*\Pi*\Pi+w^*w) + w^*(1+u)^*(1+u)*1t*1t*\Pi*\Pi)* \\ & F_y + v^0*\Pi*\Pi*\Pi + v^0*w^*w^*1t*1t*1t*F_z) / \Pi / \Pi / \Pi / t/t/t/t; \end{aligned}$$

$$\begin{aligned} \text{st\_m}[38] &= \text{st\_m}[38] + (- (w^*w^*w^*(1+u)^*(1+u) + w^*v^0*v^0*1t*1t) / \Pi / \Pi * F_x + w^*v^0*(1+u)*F_y - (1+u)*\Pi*\Pi*F_z) / \\ & t/t/t/t; \end{aligned}$$

}



```

return;
}
void rev_stiff(int n,double *st_m)
{register int i,j;
int l,m;
double v[12];
m=0;
for(i=0;i<=n;i++)m=m+i;
l=n;
for(i=0;i<=n;i++){
v[i]=st_m[m+l];
l--;
}
j=0;
for(i=n+1;i<12;i++){
m=m+i;
j++;
v[i]=st_m[m+j];
}
m=0;
for(i=0;i<12;i++){
l=i;
m=m+i;
for(j=0;j<=i;j++){
st_m[m+l]=st_m[m+l]-v[j]*v[i]/v[n];
l--;
}
}
return;
}
void at_k_a(double k[6][6],double o,double s,double os,double xx,double yy,double zz,double ll,double l);
void rotat(double *st_m,double o,double s,double os,double xx,double yy,double zz,double ll,double l)
{
double k1[6][6];

```

```

register int i,j,k,diag_index;
/* at*k1*a */
diag_index=0;
for(i=0;i<6;i++){
    diag_index=diag_index+i;
    k=0;
    for(j=i;j>=0;j--){
        k1[i][j]=st_m[diag_index+k];
        k=k++;
    }
    for(j=0;j<i;j++)k1[j][i]=k1[i][j];
}
at_k_a(k1,o,s,os,xx,yy,zz,ll,l);
diag_index=0;
for(i=0;i<6;i++){
    diag_index=diag_index+i;
    k=0;
    for(j=i;j>=0;j--){
        st_m[diag_index+k]=k1[i][j];
        k++;
    }
}
diag_index=15;
for(i=0;i<6;i++){
    diag_index=diag_index+i+6;
    k=diag_index+i+1;
    for(j=5;j>=0;j--){
        k1[j][i]=st_m[k];
        k++;
    }
}
at_k_a(k1,o,s,os,xx,yy,zz,ll,l);
diag_index=15;
for(i=0;i<6;i++){

```



ศูนย์วิทยทรัพยากร  
 วิทยาลัย  
 วิทยาลัย

```

diag_index=diag_index+i+6;
k=diag_index+i+1;
for(j=5;j>=0;j--){
    st_m[k]=k1[j][i];
    k++;
}
}
/* at*k3*a */
diag_index=15;
for(i=0;i<6;i++){
    diag_index=diag_index+i+6;
    k=0;
    for(j=i;j>=0;j--){
        k1[i][j]=st_m[diag_index+k];
        k=k++;
    }
    for(j=0;j<i;j++)k1[j][i]=k1[i][j];
}
at_k_a(k1,o,s,os,xx,yy,zz,ll,l);
diag_index=15;
for(i=0;i<6;i++){
    diag_index=diag_index+i+6;
    k=0;
    for(j=i;j>=0;j--){
        st_m[diag_index+k]=k1[i][j];
        k++;
    }
}
return;
}
void form_a(double a[6][6],double o,double s,double os,double xx,double yy,double zz,double ll,double l);
void a_transpose(double a[6][6]);
void mul(double a[6][6],double b[6][6]);
void at_k_a(double k1[6][6],double o,double s,double os,double xx,double yy,double zz,double ll,double l)

```

```

{
register int i,j;
double a[6][6];
form_a(a,o,s,os,xx,yy,zz,ll,l);
mul(k1,a);
a_transpose(a);
mul(a,k1);
for(i=0;i<6;i++){
for(j=0;j<6;j++)k1[i][j]=a[i][j];
}
return;
}
void form_a(double a[6][6],double o,double s,double os,double xx,double yy,double zz,double ll,double l)
{
register int i,j;
for(i=0;i<6;i++){
for(j=0;j<6;j++)a[i][j]=0.;
}
a[0][0]=o;
a[0][1]=s;
a[0][2]=os;
if(ll!=0)a[1][0]=0.-1.*yy/ll;
else a[1][0]=0;
if(ll!=0)a[1][1]=xx/ll;
else a[1][1]=1.;
a[1][2]=0.;
if(ll!=0)a[2][0]=0.-1.*zz*(xx/l)/ll;
else a[2][0]=-1.;
if(ll!=0)a[2][1]=0.-1.*(yy*zz/l)/ll;
else a[2][1]=0;
a[2][2]=ll/l;
a[3][3]=o;
a[3][4]=s;
a[3][5]=os;

```

```

if(l1!=0)a[4][3]=0.-1.*yy/l1;
else a[4][3]=0;
if(l1!=0)a[4][4]=xx/l1;
else a[4][4]=1.;
a[4][5]=0.;
if(l1!=0)a[5][3]=0.-1.*(zz*xx/l)/l1;
else a[5][3]=1.;
if(l1!=0)a[5][4]=0.-1.*(yy*zz/l)/l1;
else a[5][4]=0;
a[5][5]=l/l;
return;
}
void a_transpose(double a[6][6])
{
register int i,j;
double aa[6][6];
for(i=0;i<6;i++){
for(j=0;j<6;j++)aa[i][j]=a[j][i];
}
for(i=0;i<6;i++){
for(j=0;j<6;j++)a[i][j]=aa[i][j];
}
return;
}
void mul(double a[6][6],double b[6][6])
{
register int i,j,k;
double ab[6][6],sum;
for(i=0;i<6;i++){
for(j=0;j<6;j++){
sum=0;
for(k=0;k<6;k++)sum=sum+a[i][k]*b[k][j];
ab[i][j]=sum;
}
}
}

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

}
for(i=0;i<6;i++){
    for(j=0;j<6;j++)a[i][j]=ab[i][j];
}
return;
}
void assembling(double *st_m,int *lm,int *pt_h,double *pt_k)
{
register int i,j,k,l,m;
m=0;
for(i=0;i<12;i++){
    k=0;
    m=m+i;
    if(lm[i]!=0){
        for(j=i;j>=0;j--){
            if(lm[j]!=0){
                l=lm[i]-lm[j];
                pt_k[pt_h[lm[i]-1]+l]=pt_k[pt_h[lm[i]-1]+l]+st_m[m+k];
                k++;
            }
            continue;
        }
    }
    continue;
}
return;
}
void chk_k(int no_dof,int *pt_h,double *pt_k)
{
register int i,j;
for(i=0;i<no_dof;i++){
    j=i%6;
    if(j!=0&&j!=1&&j!=2){
        if(pt_k[pt_h[i]]==0)pt_k[pt_h[i]]=1;
    }
}
}

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

    }
}
return;
}
void get_r(int n_dof,int no_ld,double *pt_r,struct load *pt_ld,struct dof *pt_dof)
{
    int i,k,l,m,n,o,p,q;
    for(i=0;i<n_dof;i++)pt_r[i]=0.;
    for(i=0;i<no_ld;i++){
        k=pt_ld[i].node_no;
        l=pt_dof[k-1].x_dof;
        m=pt_dof[k-1].y_dof;
        n=pt_dof[k-1].z_dof;
        o=pt_dof[k-1].thetax_dof;
        p=pt_dof[k-1].thetay_dof;
        q=pt_dof[k-1].thetaz_dof;
        pt_r[l-1]=pt_ld[i].x_load;
        pt_r[m-1]=pt_ld[i].y_load;
        pt_r[n-1]=pt_ld[i].z_load;
        pt_r[o-1]=pt_ld[i].Mx;
        pt_r[p-1]=pt_ld[i].My;
        pt_r[q-1]=pt_ld[i].Mz;
    }
    return;
}
int decompose(int n_eq,int *pt_h,double *pt_k);
void forward_reduce(int n_eq,int *pt_h,double *pt_k,double *pt_r);
void baok_substi(int n_eq,int *pt_h,double *pt_k,double *pt_r);
int active_col_solver(double *pt_k,int *pt_h,double *pt_r,int n_eq,int index1)
{
    int h=1;
    if(index1==0)h=decompose(n_eq,pt_h,pt_k);
    if(h==1){
        forward_reduce(n_eq,pt_h,pt_k,pt_r);
    }
}

```

```

    back_substi(n_eq,pt_h,pt_k,pt_r);
}
return(h);
}
int decompose(int n_eq,int *pt_h,double *pt_k)
{
register int h,i,j,k,p,q,r,i_col,h_i,u,oh=1;
double b,o;
for(i=0;i<n_eq;i++){
h=pt_h[i+1]-pt_h[i]-2;
if(h>0){
p=i-h;
r=pt_h[i+1]-1;
for(j=0;j<h;j++){
r--;
i_col=pt_h[p];
h_i=pt_h[p+1]-pt_h[p]-2;
u=min(j,h_i);
o=0.;
for(k=0;k<=u;k++){
o=+pt_k[i_col+k+1]*pt_k[r+k+1];
}
pt_k[r]=pt_k[r]-o;
p++;
}
}
p=i;
b=0.;
for(j=pt_h[i]+1;j<=pt_h[i+1]-1;j++){
p--;
i_col=pt_h[p];
o=pt_k[j]/pt_k[i_col];
b=b+o*pt_k[j];
pt_k[j]=o;
}
}
}

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



```

    }
    pt_k[pt_h[i]]=pt_k[pt_h[i]]-b;
    if(pt_k[pt_h[i]]<=0){
        if(pt_k[pt_h[i]]==0)pt_k[pt_h[i]]=-1;
        check++;
    }
}
if(check!=1)i=n_eq;
}
if(check==1)return(1);
else return(0);
}
void forward_reduce(int n_eq,int *pt_h,double *pt_k,double *pt_r)
{
    register int i,j,k;
    double o;
    for(i=0;i<n_eq;i++){
        if(pt_h[i+1]-pt_h[i]-2>=0){
            j=i;
            o=0.;
            for(k=pt_h[i]+1;k<=pt_h[i+1]-1;k++){
                j--;
                o=pt_k[k]*pt_r[j];
            }
            pt_r[i]=pt_r[i]-o;
        }
        continue;
    }
    return;
}
void baok_substi(int n_eq,int *pt_h,double *pt_k,double *pt_r)
{
    register int i,j,k,l,u,p,q;
    for(i=0;i<n_eq;i++)pt_r[i]=pt_r[i]/pt_k[pt_h[i]];
    p=n_eq-1;

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

for(i=1;i<n_eq;i++){
l=pt_h[p]+1;
u=pt_h[p+1]-1;
q=p;
for(j=1;j<=u;j++){
q--;
pt_r[q]=pt_r[q]-pt_k[j]*pt_r[p];
}
p--;
}
return;
}
void stress(double *st_m,double *v);
void cal_stress(int order,double *pt_v,double l_f,int no_ele,struct co_or*pt_co, struct ele_con *
pt_ele,double *pt_r,struct dof *pt_dof,struct m_stress *pt_s,struct m_stress *pt_sr,struct m_stress *pt_srs)
{
register int i,j,k;
int lm[12],m,ar;
double fx,Fx,Fy,Fz,l,x[4],y[4],z[4],st_m[78],n1,n2,n3,o,s,es,v[12],xx,yy,zz,ll,u,v0,w,tya,tyb,tza,tzb;
for(i=0;i<no_ele;i++){
x[0]=pt_co[pt_ele[i].node_1-1].xo;
x[1]=pt_co[pt_ele[i].node_2-1].xo;
y[0]=pt_co[pt_ele[i].node_1-1].yo;
y[1]=pt_co[pt_ele[i].node_2-1].yo;
z[0]=pt_co[pt_ele[i].node_1-1].zo;
z[1]=pt_co[pt_ele[i].node_2-1].zo;
xx=x[1]-x[0];
yy=y[1]-y[0];
zz=z[1]-z[0];
ll=sqrt((x[0]-x[1])*(x[0]-x[1])+(y[0]-y[1])*(y[0]-y[1]));
l=sqrt((x[0]-x[1])*(x[0]-x[1])+(y[0]-y[1])*(y[0]-y[1])+(z[0]-z[1])*(z[0]-z[1]));
c=(x[1]-x[0])/l;
s=(y[1]-y[0])/l;
os=(z[1]-z[0])/l;

```

```

if(order==2){
Fx=pt_sr[i].s[6];
Fy=pt_sr[i].s[7];
Fz=pt_sr[i].s[8];
gen_lm(i,lm,pt_ele,pt_dof);
cal_local_disp(lm,pt_v,v,o,s,os,xx,yy,zz,ll,l);
x[2]=v[0];
x[3]=v[6];
y[2]=v[1];
y[3]=v[7];
z[2]=v[2];
z[3]=v[8];
tya=v[4];
tza=v[5];
tyb=v[10];
tzb=v[11];
u=x[3]-x[2];
v0=y[3]-y[2];
w=z[3]-z[2];
}
else
{
fx=0;
Fx=0;
Fy=0;
Fz=0;
tya=0;
tza=0;
tyb=0;
tzb=0;
u=0;
v0=0;
w=0;
}

```



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

for(k=0;k<12;k++)v[k]=0;
gen_lm(i,lm,pt_ele,pt_dof);
eal_local_disp(lm,pt_r,v,o,s,os,xx,yy,zz,ll,l); /* local displacement at each load step */
form_stiff(order,i,u,v0,w,l,st_m,pt_ele[i].Es,pt_ele[i].G,pt_ele[i].Ix,pt_ele[i].Iy,pt_ele[i].Iz,pt_ele[i].
A,tya,tza,tyb,tzb,fx,Fx,Fy,Fz);
if((pt_ele[i].hinge_1==1)&&(pt_ele[i].hinge_2==1)){
    st_m[6]=0;st_m[45]=0;st_m[51]=0;
    rev_stiff(4,st_m);
    rev_stiff(5,st_m);
    rev_stiff(10,st_m);
    rev_stiff(11,st_m);
}
if((pt_ele[i].hinge_1==1)&&(pt_ele[i].hinge_2==0)){
    st_m[6]=0;st_m[51]=0;
    rev_stiff(4,st_m);
    rev_stiff(5,st_m);
}
if((pt_ele[i].hinge_1==0)&&(pt_ele[i].hinge_2==1)){
    st_m[45]=0;st_m[51]=0;
    rev_stiff(10,st_m);
    rev_stiff(11,st_m);
}
stress(st_m,v);
for(j=0;j<12;j++)pt_sr[i].s[j]+=v[j];
pt_sr[i].lf=1_f;
for(j=0;j<12;j++)pt_s[i].s[j]=v[j];
}
return;
}
void mul_a_v(double a[6][6],double *v);
void eal_local_disp(int *lm,double *pt_r,double *v,double o,double s,double os,double xx,double yy,double
zz,double ll,double l)
{
register int i;

```

```

double a[6][6];
for(i=0;i<12;i++){
    if(lm[i]!=0)v[i]=pt_r[lm[i]-1];
    else v[i]=0;
}
form_a(a,o,s,os,xx,yy,zz,ll,l);
mul_a_v(a,&v[0]);
mul_a_v(a,&v[6]);
return;
}

void mul_a_v(double a[6][6],double *v)
{
    register int i,j;
    double s[6],l;
    for(j=0;j<6;j++)s[j]=v[j];
    for(i=0;i<6;i++){
        l=0;
        for(j=0;j<6;j++)l+=a[i][j]*s[j];
        v[i]=l;
    }
    return;
}

void stress(double *st_m,double *v)
{
    register int i,j,k,m,n;
    int o,p;
    double l,s[12];
    m=0;
    for(i=0;i<12;i++){
        l=0;
        k=i;
        m=m+i;
        for(j=0;j<i;j++){

```

```

    l=l+st_m[m+k]*v[j];
    k--;
}
n=m;
k=0;
for(j=i;j<12;j++){
    if(j>i)m+=j;
    l=l+st_m[m+k]*v[j];
    k++;
}
s[i]=l;
m=n;
}
for(i=0;i<12;i++)v[i]=s[i];
return;
}

void int_f_vector(int no_dof,int no_ele,double *pt_v,double *pt_x,struct oo_or*pt_co, struct ele_con *
pt_ele,struct dof *pt_dof,struct m_stress *pt_s)
{
    register int i,j,k;
    int lm[12];
    double l,x[2],y[2],z[4],st_m[78],a[6][6],o,s,os,v[12],xx,yy,zz,ll;
    for(i=0;i<no_dof;i++)pt_x[i]=0;
    for(i=0;i<no_ele;i++){
        x[0]=pt_co[pt_ele[i].node_1-1].xo;
        x[1]=pt_co[pt_ele[i].node_2-1].xo;
        y[0]=pt_co[pt_ele[i].node_1-1].yo;
        y[1]=pt_co[pt_ele[i].node_2-1].yo;
        z[0]=pt_co[pt_ele[i].node_1-1].zo;
        z[1]=pt_co[pt_ele[i].node_2-1].zo;
        xx=x[1]-x[0];
        yy=y[1]-y[0];
        zz=z[1]-z[0];
        ll=sqrt((x[0]-x[1])*(x[0]-x[1])+(y[0]-y[1])*(y[0]-y[1]));

```

```

l=sqrt((x[0]-x[1])*(x[0]-x[1])+(y[0]-y[1])*(y[0]-y[1])+(z[0]-z[1])*(z[0]-z[1]));
o=(x[1]-x[0])/l;
s=(y[1]-y[0])/l;
os=(z[1]-z[0])/l;
form_a(a,o,s,os,xx,yy,zz,ll,l);
a_transpose(a);
for(j=0;j<12;j++)v[j]=pt_s[i].s[j];
mul_a_v(a,&v[0]);
mul_a_v(a,&v[6]);
gen_lm(i,lm,pt_ele,pt_dof);
for(j=0;j<12;j++)if(lm[j]!=0)pt_x[lm[j]-1]+=v[j];
}
return;
}
void residuc_vector(int no_dof,double *pt_x,double *pt_r)
{
register int i;
for(i=0;i<no_dof;i++)pt_r[i]=pt_x[i]-pt_r[i];
return;
}
double eu_norm(int n,double *pt)
{
double a;
register int i;
a=0;
for(i=0;i<n;i++)a+=pt[i]*pt[i];
return(sqrt(a));
}
int plastio_m_index(double fy,double A,double B,double Tw,double D,double D1,double axial_f,double
end_mx,double end_my,double end_mz,int moase);
void updat_h1(int i, struct ele_oon *pt);
void updat_h2(int i, struct ele_oon *pt);
int plastio_h_check(int no_ele,double fy, struct ele_oon *pt_ele,struct m_stress *pt_s)
{

```

```

register int i,j,k,l=0;
double axial_f,end_mx1,end_mx2,end_my1,end_my2,end_mz1,end_mz2;
for(i=0;i<no_ele;i++){
    axial_f=pt_s[i].s[0];
    end_mx1=pt_s[i].s[3];
    end_my1=pt_s[i].s[4];
    end_mz1=pt_s[i].s[5];
    end_mx2=pt_s[i].s[9];
    end_my2=pt_s[i].s[10];
    end_mz2=pt_s[i].s[11];

    j=plastic_m_index(fy,pt_ele[i].A,pt_ele[i].B,pt_ele[i].Tw,pt_ele[i].D,pt_ele[i].D1,axial_f,
end_mx1,end_my1,end_mz1,pt_ele[i].moase);

    k=plastic_m_index(fy,pt_ele[i].A,pt_ele[i].B,pt_ele[i].Tw,pt_ele[i].D,pt_ele[i].D1,axial_f,end_mx2,end_my
2,end_mz2,pt_ele[i].moase);
    if(j!=0&&j!=1)printf("data error\n");
    if(k!=0&&k!=1)printf("data error\n");
    if(pt_ele[i].hinge_1==0){
        if(j==1){
            updat_h1(j,&pt_ele[i]);
            l=1;
        }
    }
    if(pt_ele[i].hinge_2==0){
        if(k==1){
            updat_h2(k,&pt_ele[i]);
            l=1;
        }
    }
}
return(l);
}

```



```

int plastio_m_index(double fy,double A,double B,double Tw,double D,double D1,double axial_f,double
end_mx,double end_my,double end_mz,int moase)
{
register int i;
double Mpx,Zpz,Zpy,a1,a2,b1,b2,o1,o2,e1,e2,p_2,t_2,mz,my;
p_2=(axial_f/fy/A)*(axial_f/fy/A);
if(B!=Tw&&D!=D1){
Mpx=fy*(D-D1)*B*(D+D1)/2.;
Zpz=B*D*D/4.0-B*D1*D1/4.0+Tw*D1*D1/4.0;
Zpy=B*B*D/4.0-B*B*D1/4.0+Tw*Tw*D1/4.0;
a1=A/2/Tw;
b1=4.0*Zpy/Tw/Tw/Tw;
o1=Tw*Tw*Tw*b1*b1/4.0/Zpz;
e1=Tw*a1*a1/Zpz;
a2=A/2/D;
b2=4.0*Zpz/D/D/D;
o2=D*D*D*b2*b2/4.0/Zpy;
e2=D*a2*a2/Zpy;
}
else{
Mpx=fy*B*D*D/8+fy*D*D*B/8;
Zpz=B*D*D/4.0;
Zpy=B*B*D/4.0;
e1=1;
o1=1;
e2=1;
o2=1;
}
t_2=end_mx/Mpx*end_mx/Mpx;
mz=fabs(end_mz/fy/Zpz);
my=fabs(end_my/fy/Zpy);
if(moase!=1){
my=fabs(end_mz/fy/Zpy);
mz=fabs(end_my/fy/Zpz);
}

```

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

```

}
if(my>=mz){
    if(my*sqrt(1-t_2)+0.75*c2*mz*mz+c2*p_2+t_2<=1)i=0;
    else i=1;
}
else{
    if(mz*sqrt(1-t_2)+0.75*c1*my*my+c1*p_2+t_2<=1)i=0;
    else i=1;
}
return(i);
}
void updat_h1(int i, struct ele_con *pt)
{
    pt->hinge_1=i;
}
void updat_h2(int i, struct ele_con *pt)
{
    pt->hinge_2=i;
}
void rev_coor(int n_node,double *pt_v,struct co_or *pt_co,struct dof *pt_dof)
{
    int i;
    for(i=0;i<n_node;i++){
        if(pt_dof[i].x_dof!=0)pt_co[i].x+=pt_v[pt_dof[i].x_dof];
        if(pt_dof[i].y_dof!=0)pt_co[i].y+=pt_v[pt_dof[i].y_dof];
        if(pt_dof[i].z_dof!=0)pt_co[i].z+=pt_v[pt_dof[i].z_dof];
    }
}
return;
}
void print_disp(double lf,FILE *fp,int no_node,struct dof *dof_pt,double *pt_v)
{
    register int i;
    fprintf(fp,"%f\\",lf);
    for(i=0;i<no_node;i++){

```

```

if(dof_pt[i].x_dof!=0)fprintf(fp,"%f\\",pt_v[dof_pt[i].x_dof-1]);
else fprintf(fp,"0\\");
if(dof_pt[i].y_dof!=0)fprintf(fp,"%f\\",pt_v[dof_pt[i].y_dof-1]);
else fprintf(fp,"0\\");
if(dof_pt[i].z_dof!=0)fprintf(fp,"%f\\",pt_v[dof_pt[i].z_dof-1]);
else fprintf(fp,"0\\");
if(dof_pt[i].thetax_dof!=0)fprintf(fp,"%f\\",pt_v[dof_pt[i].thetax_dof-1]);
else fprintf(fp,"0\\");
if(dof_pt[i].thetay_dof!=0)fprintf(fp,"%f\\",pt_v[dof_pt[i].thetay_dof-1]);
else fprintf(fp,"0\\");
if(dof_pt[i].thetaz_dof!=0)fprintf(fp,"%f\\",pt_v[dof_pt[i].thetaz_dof-1]);
else fprintf(fp,"0\\");
}
fprintf(fp,`\n`);
}

```

101

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

ผลการวิเคราะห์ตัวอย่างที่ 1

:- Project Name : nue5  
:- Coordinate Input Data

:-No of Node = 8

Node:	X-Coor :	Y-Coor :	Z-Coor :	Bou 1:	Bou 2:	Bou 3:	Bou 4:	Bou 5:	Bou 6:
1	0.00	0.00	243.80						
2	457.20	0.00	243.80						
3	457.20	304.80	243.80						
4	0.00	304.80	243.80						
5	0.00	0.00	0.00	Fix	Fix	Fix	Fix	Fix	Fix
6	457.20	0.00	0.00	Fix	Fix	Fix	Fix	Fix	Fix
7	457.20	304.80	0.00	Fix	Fix	Fix	Fix	Fix	Fix
8	0.00	304.80	0.00	Fix	Fix	Fix	Fix	Fix	Fix

:- Project Name : nue5  
:- Element Connectivity Input Data

:- No of Element = 8  
:- Yield Strength = 3583.000  
:- Modulus of Elasticity = 2077472.000  
:- Modulus of Elasticity = 798165.000

Ele:	Node1:	Node2:	Ix :	Iy :	Iz :	A :	Con1:	Con2
1	5	1	1.384e+03	4.556e+04	6.699e+05	4.677e+02	-	-
2	6	2	2105.210	46320.000	783400.000	531.100	-	-
3	7	3	2105.210	46320.000	783400.000	531.100	-	-
4	8	4	2105.210	46320.000	783400.000	531.100	-	-
5	1	2	820.230	459900.000	28790.000	379.300	-	-
6	2	3	192.080	185700.000	5624.000	205.000	-	-
7	3	4	820.230	459900.000	28790.000	379.300	-	-
8	1	4	202.160	245100.000	7089.000	223.900	-	-

Ele:	Node1:	Node2:	B :	Tw :	D :	D1 :	case :
1	5	1	41.900	2.037	91.600	84.742	1
2	6	2	42.200	2.248	92.700	84.724	1
3	7	3	42.200	2.248	92.700	84.724	1
4	8	4	42.200	2.248	92.700	84.724	1
5	1	2	40.000	1.816	83.800	77.958	2
6	2	3	26.600	1.392	75.700	71.840	2
7	3	4	40.000	1.816	83.800	77.958	2
8	1	4	29.200	1.407	83.500	79.752	2

:- Project Name : nue5  
:- External Load Data

Node:	X-load :	Y-load :	Z-load :	Mx :	My :	Mz :
1	0.00	46228.00	0.00	0.00	0.00	0.00
2	-161799.00	46228.00	0.00	0.00	0.00	0.00
3	-161799.00	0.00	0.00	0.00	0.00	0.00

- Project Name : nue5  
- Internal Member Force

Load Factor= 1.118 :Hinge No=1

Ele No=1:Near\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	3.355e+04	-2.786e+04	-8.803e+04	1.806e+00	-1.108e+07	4.660e+06
	-3.355e+04	2.786e+04	8.803e+04	-1.806e+00	-1.043e+07	2.134e+06
2	-5.867e+04	-2.885e+04	-9.289e+04	-4.910e+01	-1.167e+07	5.058e+06
	5.867e+04	2.885e+04	9.289e+04	4.910e+01	-1.091e+07	1.972e+06
3	-3.475e+04	-2.282e+04	-9.237e+04	3.493e+01	-1.161e+07	3.877e+06
	3.475e+04	2.282e+04	9.237e+04	-3.493e+01	-1.086e+07	1.686e+06
4	5.987e+04	-2.388e+04	-8.866e+04	-7.810e+01	-1.118e+07	3.960e+06
	-5.987e+04	2.388e+04	8.866e+04	7.810e+01	-1.051e+07	1.864e+06
5	8.806e+04	-2.189e+01	4.667e+04	-8.413e+01	1.043e+07	5.797e+03
	-8.806e+04	2.189e+01	-4.667e+04	8.413e+01	1.091e+07	4.424e+03
6	2.284e+04	2.479e+01	-1.200e+04	7.169e+00	-1.971e+06	-4.473e+03
	-2.284e+04	-2.479e+01	1.200e+04	-7.169e+00	-1.686e+06	-3.271e+03
7	8.863e+04	-1.441e+01	-4.676e+04	-3.873e+01	-1.086e+07	3.306e+03
	-8.863e+04	1.441e+01	4.676e+04	3.873e+01	-1.051e+07	3.436e+03
8	2.387e+04	2.987e+01	-1.312e+04	-8.183e+00	-2.134e+06	-5.795e+03
	-2.387e+04	-2.987e+01	1.312e+04	8.183e+00	-1.864e+06	-3.514e+03

Load Factor= 1.119 :Hinge No=2

Ele No=1:Both\Ele No=2:Both\Ele No=3:Both\Ele No=4:Both\

Ele No=5:Both\Ele No=6:Both\Ele No=8:Both\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	7.068e+04	-3.682e+04	-1.246e+05	1.806e+00	-1.108e+07	4.660e+06
	-7.068e+04	3.682e+04	1.246e+05	2.258e+03	-1.951e+07	4.324e+06
2	-1.256e+05	-5.647e+04	-2.332e+05	-7.573e+03	-2.938e+07	9.854e+06
	1.256e+05	5.647e+04	2.332e+05	7.573e+03	-2.708e+07	3.904e+06
3	-7.099e+04	-4.407e+04	-1.873e+05	2.478e+02	-2.350e+07	7.423e+06
	7.099e+04	4.407e+04	1.873e+05	-2.478e+02	-2.199e+07	3.317e+06
4	1.259e+05	-6.951e+04	-1.789e+05	-9.209e+03	-2.264e+07	1.176e+07
	-1.259e+05	6.951e+04	1.789e+05	9.209e+03	-2.128e+07	5.199e+06
5	1.268e+05	-1.734e+03	1.019e+05	-3.810e+02	1.951e+07	4.478e+05
	-1.268e+05	1.734e+03	-1.019e+05	3.810e+02	2.708e+07	3.429e+05
6	4.523e+04	1.950e+03	-2.369e+04	4.867e+02	-3.904e+06	-3.505e+05
	-4.523e+04	-1.950e+03	2.369e+04	-4.867e+02	-3.318e+06	-2.594e+05
7	1.766e+05	-1.163e+03	-9.468e+04	3.261e+02	-2.199e+07	2.597e+05
	-1.766e+05	1.163e+03	9.468e+04	-3.261e+02	-2.128e+07	2.681e+05
8	6.835e+04	2.282e+03	-3.125e+04	-3.594e+02	-4.324e+06	-4.501e+05
	-6.835e+04	-2.282e+03	3.125e+04	3.594e+02	-5.199e+06	-2.773e+05

จุฬาลงกรณ์มหาวิทยาลัย

: - Project Name : nue5  
: - Nodal Displacement

Load Factor=		0.000				
Node:	X-Disp	Y-Disp	Z-Disp	THETA-x	THETA-y	THETA-z
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
5	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
6	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
7	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
8	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
Load Factor=		1.118				
Node:	X-Disp	Y-Disp	Z-Disp	THETA-x	THETA-y	THETA-z
1	-1.227e+00	5.393e-02	-1.329e-02	2.560e-04	8.390e-04	-0.000e+00
2	-1.278e+00	5.634e-02	7.663e-03	3.140e-04	9.550e-04	7.000e-06
3	-1.272e+00	3.999e-02	2.448e-03	2.020e-04	9.410e-04	-5.000e-06
4	-1.220e+00	3.829e-02	-1.804e-02	1.750e-04	8.550e-04	1.100e-05
5	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
6	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
7	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
8	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
Load Factor=		1.119				
Node:	X-Disp	Y-Disp	Z-Disp	THETA-x	THETA-y	THETA-z
1	-3.182e+00	1.660e-01	-4.635e-02	3.320e-04	1.056e-03	4.980e-04
2	-3.256e+00	1.086e-01	1.653e-03	5.980e-04	2.873e-03	1.099e-03
3	-2.574e+00	7.493e-02	-2.830e-04	3.660e-04	1.905e-03	-3.600e-05
4	-2.471e+00	1.198e-01	-4.256e-02	5.940e-04	1.735e-03	1.336e-03
5	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
6	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
7	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
8	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

ผลการวิเคราะห์ตัวอย่างที่ 2

:- Project Name : nue2  
 :- Coordinate Input Data

:- No of Node = 13

Node:	X-Coor :	Y-Coor :	Z-Coor :	Bou 1:	Bou 2:	Bou 3:	Bou 4:	Bou 5:	Bou 6:
1	80.00	69.28	20.00						
2	40.00	69.28	14.90						
3	59.38	104.99	14.90						
4	100.62	104.99	14.90						
5	120.00	69.28	14.90						
6	100.62	33.57	14.90						
7	59.38	33.57	14.90						
8	0.00	69.28	0.00	Fix	Fix	Fix	Fix	Fix	Fix
9	40.00	138.56	0.00	Fix	Fix	Fix	Fix	Fix	Fix
10	120.00	138.56	0.00	Fix	Fix	Fix	Fix	Fix	Fix
11	160.00	69.28	0.00	Fix	Fix	Fix	Fix	Fix	Fix
12	120.00	0.00	0.00	Fix	Fix	Fix	Fix	Fix	Fix
13	40.00	0.00	0.00	Fix	Fix	Fix	Fix	Fix	Fix

:- Project Name : nue2  
 :- Element Connectivity Input Data

:- No of Element = 18  
 :- Yield Strength = 635.000  
 :- Modulus of Elasticity = 432000.000  
 :- Modulus of Elasticity = 184320.000

Ele:	Node1:	Node2:	Ix :	Iy :	Iz :	A :	Con1:	Con2:
1	1	2	2.083e+01	1.333e+01	5.210e+00	1.000e+01	-	-
2	1	3	20.830	13.330	5.210	10.000	-	-
3	1	4	20.830	13.330	5.210	10.000	-	-
4	1	5	20.830	13.330	5.210	10.000	-	-
5	1	6	20.830	13.330	5.210	10.000	-	-
6	1	7	20.830	13.330	5.210	10.000	-	-
7	2	3	20.830	13.330	5.210	10.000	-	-
8	3	4	20.830	13.330	5.210	10.000	-	-
9	4	5	20.830	13.330	5.210	10.000	-	-
10	5	6	20.830	13.330	5.210	10.000	-	-
11	6	7	20.830	13.330	5.210	10.000	-	-
12	2	7	20.830	13.330	5.210	10.000	-	-
13	2	8	20.830	13.330	5.210	10.000	-	-
14	3	9	20.830	13.330	5.210	10.000	-	-
15	4	10	20.830	13.330	5.210	10.000	-	-
16	5	11	20.830	13.330	5.210	10.000	-	-
17	6	12	20.830	13.330	5.210	10.000	-	-
18	7	13	20.830	13.330	5.210	10.000	-	-

Ele:	Node1:	Node2:	B :	Tw :	D :	D1 :	case :
1	1	2	2.500	2.500	4.000	4.000	1
2	1	3	2.500	2.500	4.000	4.000	1
3	1	4	2.500	2.500	4.000	4.000	1
4	1	5	2.500	2.500	4.000	4.000	1
5	1	6	2.500	2.500	4.000	4.000	1
6	1	7	2.500	2.500	4.000	4.000	1
7	2	3	2.500	2.500	4.000	4.000	1
8	3	4	2.500	2.500	4.000	4.000	1
9	4	5	2.500	2.500	4.000	4.000	1
10	5	6	2.500	2.500	4.000	4.000	1
11	6	7	2.500	2.500	4.000	4.000	1

12	2	7	2.500	2.500	4.000	4.000	1
13	2	8	2.500	2.500	4.000	4.000	1
14	3	9	2.500	2.500	4.000	4.000	1
15	4	10	2.500	2.500	4.000	4.000	1
16	5	11	2.500	2.500	4.000	4.000	1
17	6	12	2.500	2.500	4.000	4.000	1
18	7	13	2.500	2.500	4.000	4.000	1

:- Project Name : nue2  
:- External Load Data

Node:	X-load :	Y-load :	Z-load :	Mx :	My :	Mz :
1	0.00	0.00	-20000.00	0.00	0.00	0.00



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



- Project Name : nue2  
- Internal Member Force

Load Factor= 1.000 :Hinge No=0

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	2.298e+04	-2.073e-01	-6.050e+02	-9.388e-02	-1.043e+05	1.449e+00
	-2.298e+04	2.073e-01	6.050e+02	9.388e-02	-8.015e+04	2.842e+00
2	2.253e+04	3.649e-01	-4.845e+02	9.557e+01	-9.978e+04	1.259e+01
	-2.253e+04	-3.649e-01	4.845e+02	-9.557e+01	-7.869e+04	2.962e+00
3	2.253e+04	-6.522e-01	-4.844e+02	-9.642e+01	-9.978e+04	-1.876e+01
	-2.253e+04	6.522e-01	4.844e+02	9.642e+01	-7.869e+04	7.199e+00
4	2.298e+04	-2.868e-01	-6.050e+02	-6.116e-02	-1.043e+05	9.181e+00
	-2.298e+04	2.868e-01	6.050e+02	6.116e-02	-8.015e+04	-1.642e+00
5	2.253e+04	3.934e-01	-4.844e+02	9.520e+01	-9.978e+04	1.047e+01
	-2.253e+04	-3.934e-01	4.844e+02	-9.520e+01	-7.869e+04	3.889e+00
6	2.253e+04	-6.810e-01	-4.845e+02	-9.621e+01	-9.978e+04	-1.517e+01
	-2.253e+04	6.810e-01	4.845e+02	9.621e+01	-7.869e+04	4.750e+00
7	-7.211e+03	3.061e+00	-3.395e+01	-9.764e+02	-2.524e+04	-5.021e+01
	7.211e+03	-3.061e+00	3.395e+01	9.764e+02	2.427e+04	-2.062e+01
8	-7.102e+03	1.573e-01	-6.373e-02	1.112e-01	-2.426e+04	1.405e+01
	7.102e+03	-1.573e-01	6.373e-02	-1.112e-01	2.426e+04	-2.064e+01
9	-7.211e+03	-2.493e+00	3.387e+01	9.765e+02	-2.427e+04	1.524e+01
	7.211e+03	2.493e+00	-3.387e+01	-9.765e+02	2.524e+04	3.222e+01
10	-7.212e+03	2.690e+00	-3.390e+01	-9.761e+02	-2.524e+04	-3.726e+01
	7.212e+03	-2.690e+00	3.390e+01	9.761e+02	2.427e+04	-1.844e+01
11	-7.102e+03	1.293e-01	-5.311e-02	2.420e-01	-2.426e+04	1.234e+01
	7.102e+03	-1.293e-01	5.311e-02	-2.420e-01	2.426e+04	-1.781e+01
12	-7.211e+03	-2.727e+00	-3.384e+01	9.763e+02	-2.524e+04	4.414e+01
	7.211e+03	2.727e+00	3.384e+01	-9.763e+02	2.427e+04	1.286e+01
13	1.604e+04	-8.549e-02	2.305e+03	-1.710e-01	5.436e+04	3.417e+00
	-1.604e+04	8.549e-02	-2.305e+03	1.710e-01	3.487e+04	2.624e+00
14	1.517e+04	1.671e+00	2.316e+03	-9.360e+01	5.471e+04	-4.466e+01
	-1.517e+04	-1.671e+00	-2.316e+03	9.360e+01	3.361e+04	-4.302e+01
15	1.517e+04	-1.581e+00	2.316e+03	9.475e+01	5.471e+04	4.723e+01
	-1.517e+04	1.581e+00	-2.316e+03	-9.475e+01	3.361e+04	4.129e+01
16	1.604e+04	-3.110e-01	2.305e+03	-1.747e+00	5.436e+04	6.482e+00
	-1.604e+04	3.110e-01	-2.305e+03	1.747e+00	3.487e+04	8.837e+00
17	1.517e+04	1.746e+00	2.316e+03	-9.343e+01	5.471e+04	-4.604e+01
	-1.517e+04	-1.746e+00	-2.316e+03	9.343e+01	3.361e+04	-4.494e+01
18	1.517e+04	-1.697e+00	2.316e+03	9.416e+01	5.471e+04	4.910e+01
	-1.517e+04	1.697e+00	-2.316e+03	-9.416e+01	3.361e+04	4.428e+01

จุฬาลงกรณ์มหาวิทยาลัย

-- Project Name : nue2  
-- Nodal Displacement

Load Factor=		0.000				
Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
4	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
5	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
6	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
7	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
8	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
9	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
10	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
11	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
12	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
13	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
Load Factor=		1.000				
Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	5.000e-06	1.500e-05	-7.625e+00	-3.000e-06	1.000e-06	3.700e-05
2	-3.193e-02	4.320e-04	-5.866e-01	-0.000e+00	-1.499e-01	6.000e-06
3	-1.280e-02	2.000e-02	-5.293e-01	-1.222e-01	-7.178e-02	1.040e-04
4	1.355e-02	1.957e-02	-5.293e-01	-1.223e-01	7.178e-02	-1.460e-04
5	3.194e-02	-4.030e-04	-5.866e-01	-0.000e+00	1.499e-01	5.500e-05
6	1.280e-02	-1.997e-02	-5.293e-01	1.222e-01	7.178e-02	9.100e-05
7	-1.354e-02	-1.954e-02	-5.293e-01	1.223e-01	-7.178e-02	-1.240e-04
8	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
9	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
10	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
11	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
12	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
13	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

ผลการวิเคราะห์ตัวอย่างที่ 3

:- Project Name : good1  
:- Coordinate Input Data

:-No of Node = 14

Node:	X-Coor :	Y-Coor :	Z-Coor :	Bou 1:	Bou 2:	Bou 3:	Bou 4:	Bou 5:	Bou 6:
1	0.00	0.00	0.00	Fix	Fix	Fix	Fix	Fix	Fix
2	240.00	0.00	0.00	Fix	Fix	Fix	Fix	Fix	Fix
3	0.00	0.00	300.00						
4	120.00	0.00	300.00						
5	240.00	0.00	300.00						
6	0.00	0.00	600.00						
7	120.00	0.00	600.00						
8	240.00	0.00	600.00						
9	0.00	0.00	900.00						
10	120.00	0.00	900.00						
11	240.00	0.00	900.00						
12	0.00	0.00	1200.00						
13	120.00	0.00	1200.00						
14	240.00	0.00	1200.00						

:- Project Name : good1  
:- Element Connectivity Input Data

:- No of Element = 16  
:- Yield Strength = 36.000  
:- Modulus of Elasticity = 30000.000  
:- Modulus of Elasticity = 12000.000

Ele:	Node1:	Node2:	Ix	Iy	Iz	A	Con1:	Con2
1	1	3	5.834e-01	1.440e+02	1.440e+05	1.175e+01	-	-
2	3	6	0.583	144.000	144000.000	11.750	-	-
3	6	9	0.583	144.000	144000.000	11.750	-	-
4	9	12	0.583	144.000	144000.000	11.750	-	-
5	2	5	0.583	144.000	144000.000	11.750	-	-
6	5	8	0.583	144.000	144000.000	11.750	-	-
7	8	11	0.583	144.000	144000.000	11.750	-	-
8	11	14	0.583	144.000	144000.000	11.750	-	-
9	3	4	0.583	144.000	144000.000	11.750	-	-
10	4	5	0.583	144.000	144000.000	11.750	-	-
11	6	7	0.583	144.000	144000.000	11.750	-	-
12	7	8	0.583	144.000	144000.000	11.750	-	-
13	9	10	0.583	144.000	144000.000	11.750	-	-
14	10	11	0.583	144.000	144000.000	11.750	-	-
15	12	13	0.583	144.000	144000.000	11.750	-	-
16	13	14	0.583	144.000	144000.000	11.750	-	-

Ele:	Node1:	Node2:	B	Tw	D	D1	case :
1	1	3	8.000	0.294	11.940	10.908	0
2	3	6	8.000	0.294	11.940	10.908	0
3	6	9	8.000	0.294	11.940	10.908	0
4	9	12	8.000	0.294	11.940	10.908	0
5	2	5	8.000	0.294	11.940	10.908	0
6	5	8	8.000	0.294	11.940	10.908	0
7	8	11	8.000	0.294	11.940	10.908	0
8	11	14	8.000	0.294	11.940	10.908	0
9	3	4	8.000	0.294	11.940	10.908	0
10	4	5	8.000	0.294	11.940	10.908	0
11	6	7	8.000	0.294	11.940	10.908	0
12	7	8	8.000	0.294	11.940	10.908	0

13	9	10	8.000	0.294	11.940	10.908	0
14	10	11	8.000	0.294	11.940	10.908	0
15	12	13	8.000	0.294	11.940	10.908	0
16	13	14	8.000	0.294	11.940	10.908	0

:- Project Name : good1

:- External Load Data

Node:	X-load :	Y-load :	Z-load :	Mx :	My :	Mz :
3	2.00	0.00	-10.00	0.00	0.00	0.00
4	0.00	0.00	-20.00	0.00	0.00	0.00
5	0.00	0.00	-10.00	0.00	0.00	0.00
6	2.00	0.00	-10.00	0.00	0.00	0.00
7	0.00	0.00	-20.00	0.00	0.00	0.00
8	0.00	0.00	-10.00	0.00	0.00	0.00
9	2.00	0.00	-10.00	0.00	0.00	0.00
10	0.00	0.00	-20.00	0.00	0.00	0.00
11	0.00	0.00	-10.00	0.00	0.00	0.00
12	2.00	0.00	-10.00	0.00	0.00	0.00
13	0.00	0.00	-20.00	0.00	0.00	0.00
14	0.00	0.00	-10.00	0.00	0.00	0.00



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

:- Project Name : good1  
 :- Internal Member Force

Load Factor= 1.456 :Hinge No=1

Ele No=10:Far\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	8.885e+01	0.000e+00	4.389e+00	0.000e+00	9.088e+02	0.000e+00
	-8.885e+01	0.000e+00	-4.389e+00	0.000e+00	4.080e+02	0.000e+00
2	7.072e+01	0.000e+00	1.730e+00	0.000e+00	2.164e+02	0.000e+00
	-7.072e+01	0.000e+00	-1.730e+00	0.000e+00	3.026e+02	0.000e+00
3	5.051e+01	0.000e+00	7.266e-01	0.000e+00	4.372e+01	0.000e+00
	-5.051e+01	0.000e+00	-7.266e-01	0.000e+00	1.743e+02	0.000e+00
4	2.687e+01	0.000e+00	-1.909e+00	0.000e+00	-2.675e+02	0.000e+00
	-2.687e+01	0.000e+00	1.909e+00	0.000e+00	-3.052e+02	0.000e+00
5	1.441e+02	0.000e+00	7.259e+00	0.000e+00	1.196e+03	0.000e+00
	-1.441e+02	0.000e+00	-7.259e+00	0.000e+00	9.819e+02	0.000e+00
6	1.040e+02	0.000e+00	7.006e+00	0.000e+00	1.031e+03	0.000e+00
	-1.040e+02	0.000e+00	-7.006e+00	0.000e+00	1.071e+03	0.000e+00
7	6.597e+01	0.000e+00	5.097e+00	0.000e+00	7.217e+02	0.000e+00
	-6.597e+01	0.000e+00	-5.097e+00	0.000e+00	8.075e+02	0.000e+00
8	3.137e+01	0.000e+00	4.821e+00	0.000e+00	6.013e+02	0.000e+00
	-3.137e+01	0.000e+00	-4.821e+00	0.000e+00	8.450e+02	0.000e+00
9	2.530e-01	0.000e+00	3.571e+00	0.000e+00	-6.244e+02	0.000e+00
	-2.530e-01	0.000e+00	-3.571e+00	0.000e+00	1.053e+03	0.000e+00
10	2.530e-01	0.000e+00	-2.555e+01	0.000e+00	-1.053e+03	0.000e+00
	-2.530e-01	0.000e+00	2.555e+01	0.000e+00	-2.013e+03	0.000e+00
11	1.908e+00	0.000e+00	5.648e+00	0.000e+00	-3.463e+02	0.000e+00
	-1.908e+00	0.000e+00	-5.648e+00	0.000e+00	1.024e+03	0.000e+00
12	1.908e+00	0.000e+00	-2.347e+01	0.000e+00	-1.024e+03	0.000e+00
	-1.908e+00	0.000e+00	2.347e+01	0.000e+00	-1.793e+03	0.000e+00
13	2.763e-01	0.000e+00	9.078e+00	0.000e+00	9.324e+01	0.000e+00
	-2.763e-01	0.000e+00	-9.078e+00	0.000e+00	9.962e+02	0.000e+00
14	2.763e-01	0.000e+00	-2.004e+01	0.000e+00	-9.962e+02	0.000e+00
	-2.763e-01	0.000e+00	2.004e+01	0.000e+00	-1.409e+03	0.000e+00
15	4.821e+00	0.000e+00	1.231e+01	0.000e+00	3.052e+02	0.000e+00
	-4.821e+00	0.000e+00	-1.231e+01	0.000e+00	1.172e+03	0.000e+00
16	4.821e+00	0.000e+00	-1.681e+01	0.000e+00	-1.172e+03	0.000e+00
	-4.821e+00	0.000e+00	1.681e+01	0.000e+00	-8.450e+02	0.000e+00

Load Factor= 1.609 :Hinge No=2

Ele No=10:Far\Ele No=12:Far\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	9.860e+01	0.000e+00	5.159e+00	0.000e+00	1.085e+03	0.000e+00
	-9.860e+01	0.000e+00	-5.159e+00	0.000e+00	4.628e+02	0.000e+00
2	7.778e+01	0.000e+00	2.159e+00	0.000e+00	2.503e+02	0.000e+00
	-7.778e+01	0.000e+00	-2.159e+00	0.000e+00	3.975e+02	0.000e+00
3	5.578e+01	0.000e+00	7.543e-01	0.000e+00	3.262e+01	0.000e+00
	-5.578e+01	0.000e+00	-7.543e-01	0.000e+00	1.937e+02	0.000e+00
4	2.969e+01	0.000e+00	-2.101e+00	0.000e+00	-2.940e+02	0.000e+00
	-2.969e+01	0.000e+00	2.101e+00	0.000e+00	-3.364e+02	0.000e+00
5	1.588e+02	0.000e+00	7.713e+00	0.000e+00	1.340e+03	0.000e+00
	-1.588e+02	0.000e+00	-7.713e+00	0.000e+00	9.737e+02	0.000e+00
6	1.153e+02	0.000e+00	7.495e+00	0.000e+00	1.039e+03	0.000e+00
	-1.153e+02	0.000e+00	-7.495e+00	0.000e+00	1.209e+03	0.000e+00
7	7.294e+01	0.000e+00	5.682e+00	0.000e+00	8.038e+02	0.000e+00
	-7.294e+01	0.000e+00	-5.682e+00	0.000e+00	9.007e+02	0.000e+00
8	3.467e+01	0.000e+00	5.319e+00	0.000e+00	6.619e+02	0.000e+00
	-3.467e+01	0.000e+00	-5.319e+00	0.000e+00	9.339e+02	0.000e+00
9	2.183e-01	0.000e+00	4.732e+00	0.000e+00	-7.131e+02	0.000e+00
	-2.183e-01	0.000e+00	-4.732e+00	0.000e+00	1.281e+03	0.000e+00
10	2.183e-01	0.000e+00	-2.745e+01	0.000e+00	-1.281e+03	0.000e+00
	-2.183e-01	0.000e+00	2.745e+01	0.000e+00	-2.013e+03	0.000e+00
11	1.813e+00	0.000e+00	5.910e+00	0.000e+00	-4.301e+02	0.000e+00

	-1.813e+00	0.000e+00	-5.910e+00	0.000e+00	1.139e+03	0.000e+00
12	1.813e+00	0.000e+00	-2.627e+01	0.000e+00	-1.139e+03	0.000e+00
	-1.813e+00	0.000e+00	2.627e+01	0.000e+00	-2.013e+03	0.000e+00
13	3.624e-01	0.000e+00	9.997e+00	0.000e+00	1.003e+02	0.000e+00
	-3.624e-01	0.000e+00	-9.997e+00	0.000e+00	1.099e+03	0.000e+00
14	3.624e-01	0.000e+00	-2.218e+01	0.000e+00	-1.099e+03	0.000e+00
	-3.624e-01	0.000e+00	2.218e+01	0.000e+00	-1.563e+03	0.000e+00
15	5.319e+00	0.000e+00	1.360e+01	0.000e+00	3.364e+02	0.000e+00
	-5.319e+00	0.000e+00	-1.360e+01	0.000e+00	1.296e+03	0.000e+00
16	5.319e+00	0.000e+00	-1.858e+01	0.000e+00	-1.296e+03	0.000e+00
	-5.319e+00	0.000e+00	1.858e+01	0.000e+00	-9.339e+02	0.000e+00

Load Factor= 1.653 :Hinge No=3

Ele No=5:Near\Ele No=10:Far\Ele No=12:Far\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	1.014e+02	0.000e+00	5.373e+00	0.000e+00	1.138e+03	0.000e+00
	-1.014e+02	0.000e+00	-5.373e+00	0.000e+00	4.735e+02	0.000e+00
2	7.988e+01	0.000e+00	2.374e+00	0.000e+00	2.807e+02	0.000e+00
	-7.988e+01	0.000e+00	-2.374e+00	0.000e+00	4.315e+02	0.000e+00
3	5.716e+01	0.000e+00	8.398e-01	0.000e+00	3.269e+01	0.000e+00
	-5.716e+01	0.000e+00	-8.398e-01	0.000e+00	2.192e+02	0.000e+00
4	3.048e+01	0.000e+00	-2.169e+00	0.000e+00	-3.064e+02	0.000e+00
	-3.048e+01	0.000e+00	2.169e+00	0.000e+00	-3.445e+02	0.000e+00
5	1.630e+02	0.000e+00	7.847e+00	0.000e+00	1.386e+03	0.000e+00
	-1.630e+02	0.000e+00	-7.847e+00	0.000e+00	9.682e+02	0.000e+00
6	1.184e+02	0.000e+00	7.541e+00	0.000e+00	1.045e+03	0.000e+00
	-1.184e+02	0.000e+00	-7.541e+00	0.000e+00	1.218e+03	0.000e+00
7	7.504e+01	0.000e+00	5.770e+00	0.000e+00	7.954e+02	0.000e+00
	-7.504e+01	0.000e+00	-5.770e+00	0.000e+00	9.357e+02	0.000e+00
8	3.562e+01	0.000e+00	5.474e+00	0.000e+00	6.810e+02	0.000e+00
	-3.562e+01	0.000e+00	-5.474e+00	0.000e+00	9.614e+02	0.000e+00
9	3.056e-01	0.000e+00	4.996e+00	0.000e+00	-7.542e+02	0.000e+00
	-3.056e-01	0.000e+00	-4.996e+00	0.000e+00	1.354e+03	0.000e+00
10	3.056e-01	0.000e+00	-2.805e+01	0.000e+00	-1.354e+03	0.000e+00
	-3.056e-01	0.000e+00	2.805e+01	0.000e+00	-2.013e+03	0.000e+00
11	1.771e+00	0.000e+00	6.203e+00	0.000e+00	-4.642e+02	0.000e+00
	-1.771e+00	0.000e+00	-6.203e+00	0.000e+00	1.209e+03	0.000e+00
12	1.771e+00	0.000e+00	-2.685e+01	0.000e+00	-1.209e+03	0.000e+00
	-1.771e+00	0.000e+00	2.685e+01	0.000e+00	-2.013e+03	0.000e+00
13	2.957e-01	0.000e+00	1.015e+01	0.000e+00	8.716e+01	0.000e+00
	-2.957e-01	0.000e+00	-1.015e+01	0.000e+00	1.131e+03	0.000e+00
14	2.957e-01	0.000e+00	-2.290e+01	0.000e+00	-1.131e+03	0.000e+00
	-2.957e-01	0.000e+00	2.290e+01	0.000e+00	-1.617e+03	0.000e+00
15	5.474e+00	0.000e+00	1.395e+01	0.000e+00	3.445e+02	0.000e+00
	-5.474e+00	0.000e+00	-1.395e+01	0.000e+00	1.330e+03	0.000e+00
16	5.474e+00	0.000e+00	-1.910e+01	0.000e+00	-1.330e+03	0.000e+00
	-5.474e+00	0.000e+00	1.910e+01	0.000e+00	-9.614e+02	0.000e+00

Load Factor= 1.936 :Hinge No=4

Ele No=1:Near\Ele No=5:Near\Ele No=10:Far\Ele No=12:Far\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	1.192e+02	0.000e+00	7.868e+00	0.000e+00	1.677e+03	0.000e+00
	-1.192e+02	0.000e+00	-7.868e+00	0.000e+00	6.832e+02	0.000e+00
2	9.355e+01	0.000e+00	3.609e+00	0.000e+00	4.312e+02	0.000e+00
	-9.355e+01	0.000e+00	-3.609e+00	0.000e+00	6.515e+02	0.000e+00
3	6.611e+01	0.000e+00	1.452e+00	0.000e+00	4.112e+01	0.000e+00
	-6.611e+01	0.000e+00	-1.452e+00	0.000e+00	3.945e+02	0.000e+00
4	3.562e+01	0.000e+00	-2.624e+00	0.000e+00	-3.898e+02	0.000e+00
	-3.562e+01	0.000e+00	2.624e+00	0.000e+00	-3.973e+02	0.000e+00
5	1.905e+02	0.000e+00	7.620e+00	0.000e+00	1.386e+03	0.000e+00
	-1.905e+02	0.000e+00	-7.620e+00	0.000e+00	9.002e+02	0.000e+00
6	1.388e+02	0.000e+00	8.007e+00	0.000e+00	1.113e+03	0.000e+00
	-1.388e+02	0.000e+00	-8.007e+00	0.000e+00	1.289e+03	0.000e+00
7	8.877e+01	0.000e+00	6.292e+00	0.000e+00	7.235e+02	0.000e+00

	-8.877e+01	0.000e+00	-6.292e+00	0.000e+00	1.164e+03	0.000e+00
8	4.182e+01	0.000e+00	6.496e+00	0.000e+00	8.071e+02	0.000e+00
	-4.182e+01	0.000e+00	-6.496e+00	0.000e+00	1.142e+03	0.000e+00
9	-3.872e-01	0.000e+00	6.330e+00	0.000e+00	-1.114e+03	0.000e+00
	3.872e-01	0.000e+00	-6.330e+00	0.000e+00	1.874e+03	0.000e+00
10	-3.872e-01	0.000e+00	-3.239e+01	0.000e+00	-1.874e+03	0.000e+00
	3.872e-01	0.000e+00	3.239e+01	0.000e+00	-2.013e+03	0.000e+00
11	1.715e+00	0.000e+00	8.087e+00	0.000e+00	-6.926e+02	0.000e+00
	-1.715e+00	0.000e+00	-8.087e+00	0.000e+00	1.663e+03	0.000e+00
12	1.715e+00	0.000e+00	-3.063e+01	0.000e+00	-1.663e+03	0.000e+00
	-1.715e+00	0.000e+00	3.063e+01	0.000e+00	-2.013e+03	0.000e+00
13	-2.040e-01	0.000e+00	1.113e+01	0.000e+00	-4.688e+00	0.000e+00
	2.040e-01	0.000e+00	-1.113e+01	0.000e+00	1.340e+03	0.000e+00
14	-2.040e-01	0.000e+00	-2.759e+01	0.000e+00	-1.340e+03	0.000e+00
	2.040e-01	0.000e+00	2.759e+01	0.000e+00	-1.971e+03	0.000e+00
15	6.496e+00	0.000e+00	1.626e+01	0.000e+00	3.973e+02	0.000e+00
	-6.496e+00	0.000e+00	-1.626e+01	0.000e+00	1.554e+03	0.000e+00
16	6.496e+00	0.000e+00	-2.246e+01	0.000e+00	-1.554e+03	0.000e+00
	-6.496e+00	0.000e+00	2.246e+01	0.000e+00	-1.142e+03	0.000e+00

Load Factor= 1.967 :Hinge No=5  
 Ele No=1:Near\Ele No=5:Near\Ele No=10:Far\Ele No=12:Far\  
 Ele No=14:Far\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	1.209e+02	0.000e+00	8.042e+00	0.000e+00	1.677e+03	0.000e+00
	-1.209e+02	0.000e+00	-8.042e+00	0.000e+00	7.353e+02	0.000e+00
2	9.496e+01	0.000e+00	3.835e+00	0.000e+00	4.554e+02	0.000e+00
	-9.496e+01	0.000e+00	-3.835e+00	0.000e+00	6.950e+02	0.000e+00
3	6.706e+01	0.000e+00	1.515e+00	0.000e+00	3.771e+01	0.000e+00
	-6.706e+01	0.000e+00	-1.515e+00	0.000e+00	4.167e+02	0.000e+00
4	3.618e+01	0.000e+00	-2.673e+00	0.000e+00	-3.991e+02	0.000e+00
	-3.618e+01	0.000e+00	2.673e+00	0.000e+00	-4.027e+02	0.000e+00
5	1.938e+02	0.000e+00	7.694e+00	0.000e+00	1.386e+03	0.000e+00
	-1.938e+02	0.000e+00	-7.694e+00	0.000e+00	9.224e+02	0.000e+00
6	1.411e+02	0.000e+00	7.967e+00	0.000e+00	1.090e+03	0.000e+00
	-1.411e+02	0.000e+00	-7.967e+00	0.000e+00	1.300e+03	0.000e+00
7	9.030e+01	0.000e+00	6.353e+00	0.000e+00	7.133e+02	0.000e+00
	-9.030e+01	0.000e+00	-6.353e+00	0.000e+00	1.193e+03	0.000e+00
8	4.250e+01	0.000e+00	6.607e+00	0.000e+00	8.203e+02	0.000e+00
	-4.250e+01	0.000e+00	-6.607e+00	0.000e+00	1.162e+03	0.000e+00
9	-2.731e-01	0.000e+00	6.322e+00	0.000e+00	-1.191e+03	0.000e+00
	2.731e-01	0.000e+00	-6.322e+00	0.000e+00	1.949e+03	0.000e+00
10	-2.731e-01	0.000e+00	-3.302e+01	0.000e+00	-1.949e+03	0.000e+00
	2.731e-01	0.000e+00	3.302e+01	0.000e+00	-2.013e+03	0.000e+00
11	1.614e+00	0.000e+00	8.229e+00	0.000e+00	-7.327e+02	0.000e+00
	-1.614e+00	0.000e+00	-8.229e+00	0.000e+00	1.720e+03	0.000e+00
12	1.614e+00	0.000e+00	-3.111e+01	0.000e+00	-1.720e+03	0.000e+00
	-1.614e+00	0.000e+00	3.111e+01	0.000e+00	-2.013e+03	0.000e+00
13	-2.535e-01	0.000e+00	1.121e+01	0.000e+00	-1.760e+01	0.000e+00
	2.535e-01	0.000e+00	-1.121e+01	0.000e+00	1.363e+03	0.000e+00
14	-2.535e-01	0.000e+00	-2.813e+01	0.000e+00	-1.363e+03	0.000e+00
	2.535e-01	0.000e+00	2.813e+01	0.000e+00	-2.013e+03	0.000e+00
15	6.607e+00	0.000e+00	1.651e+01	0.000e+00	4.027e+02	0.000e+00
	-6.607e+00	0.000e+00	-1.651e+01	0.000e+00	1.578e+03	0.000e+00
16	6.607e+00	0.000e+00	-2.283e+01	0.000e+00	-1.578e+03	0.000e+00
	-6.607e+00	0.000e+00	2.283e+01	0.000e+00	-1.162e+03	0.000e+00

Load Factor= 1.992 :Hinge No=6  
 Ele No=1:Near\Ele No=5:Near\Ele No=9:Far\Ele No=10:Both\  
 Ele No=12:Far\Ele No=14:Far\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	1.224e+02	0.000e+00	8.187e+00	0.000e+00	1.677e+03	0.000e+00
	-1.224e+02	0.000e+00	-8.187e+00	0.000e+00	7.790e+02	0.000e+00
2	9.612e+01	0.000e+00	4.023e+00	0.000e+00	4.776e+02	0.000e+00

	-9.612e+01	0.000e+00	-4.023e+00	0.000e+00	7.293e+02	0.000e+00
3	6.789e+01	0.000e+00	1.619e+00	0.000e+00	4.632e+01	0.000e+00
	-6.789e+01	0.000e+00	-1.619e+00	0.000e+00	4.394e+02	0.000e+00
4	3.657e+01	0.000e+00	-2.675e+00	0.000e+00	-4.053e+02	0.000e+00
	-3.657e+01	0.000e+00	2.675e+00	0.000e+00	-3.971e+02	0.000e+00
5	1.964e+02	0.000e+00	7.753e+00	0.000e+00	1.386e+03	0.000e+00
	-1.964e+02	0.000e+00	-7.753e+00	0.000e+00	9.400e+02	0.000e+00
6	1.430e+02	0.000e+00	7.932e+00	0.000e+00	1.073e+03	0.000e+00
	1.430e+02	0.000e+00	-7.932e+00	0.000e+00	1.307e+03	0.000e+00
7	9.151e+01	0.000e+00	6.351e+00	0.000e+00	7.063e+02	0.000e+00
	-9.151e+01	0.000e+00	-6.351e+00	0.000e+00	1.199e+03	0.000e+00
8	4.313e+01	0.000e+00	6.660e+00	0.000e+00	8.140e+02	0.000e+00
	-4.313e+01	0.000e+00	-6.660e+00	0.000e+00	1.184e+03	0.000e+00
9	-1.794e-01	0.000e+00	6.303e+00	0.000e+00	-1.257e+03	0.000e+00
	1.794e-01	0.000e+00	-6.303e+00	0.000e+00	2.013e+03	0.000e+00
10	-1.794e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	1.794e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	1.581e+00	0.000e+00	8.306e+00	0.000e+00	-7.756e+02	0.000e+00
	-1.581e+00	0.000e+00	-8.306e+00	0.000e+00	1.772e+03	0.000e+00
12	1.581e+00	0.000e+00	-3.154e+01	0.000e+00	-1.772e+03	0.000e+00
	-1.581e+00	0.000e+00	3.154e+01	0.000e+00	-2.013e+03	0.000e+00
13	-3.086e-01	0.000e+00	1.140e+01	0.000e+00	-3.410e+01	0.000e+00
	3.086e-01	0.000e+00	-1.140e+01	0.000e+00	1.402e+03	0.000e+00
14	-3.086e-01	0.000e+00	-2.845e+01	0.000e+00	-1.402e+03	0.000e+00
	3.086e-01	0.000e+00	2.845e+01	0.000e+00	-2.013e+03	0.000e+00
15	6.660e+00	0.000e+00	1.665e+01	0.000e+00	3.971e+02	0.000e+00
	-6.660e+00	0.000e+00	-1.665e+01	0.000e+00	1.601e+03	0.000e+00
16	6.660e+00	0.000e+00	-2.320e+01	0.000e+00	-1.601e+03	0.000e+00
	-6.660e+00	0.000e+00	2.320e+01	0.000e+00	-1.184e+03	0.000e+00

Load Factor= 2.046 :Hinge No=7

Ele No=1:Near\Ele No=5:Both\Ele No=9:Far\Ele No=10:Both\

Ele No=12:Far\Ele No=14:Far\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	1.253e+02	0.000e+00	8.254e+00	0.000e+00	1.677e+03	0.000e+00
	-1.253e+02	0.000e+00	-8.254e+00	0.000e+00	7.989e+02	0.000e+00
2	9.746e+01	0.000e+00	4.279e+00	0.000e+00	3.292e+02	0.000e+00
	-9.746e+01	0.000e+00	-4.279e+00	0.000e+00	9.544e+02	0.000e+00
3	6.926e+01	0.000e+00	2.169e+00	0.000e+00	8.484e+01	0.000e+00
	-6.926e+01	0.000e+00	-2.169e+00	0.000e+00	5.660e+02	0.000e+00
4	3.728e+01	0.000e+00	-2.682e+00	0.000e+00	-4.338e+02	0.000e+00
	-3.728e+01	0.000e+00	2.682e+00	0.000e+00	-3.709e+02	0.000e+00
5	2.021e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00
	-2.021e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.481e+02	0.000e+00	7.997e+00	0.000e+00	9.644e+02	0.000e+00
	-1.481e+02	0.000e+00	-7.997e+00	0.000e+00	1.435e+03	0.000e+00
7	9.442e+01	0.000e+00	6.015e+00	0.000e+00	5.782e+02	0.000e+00
	-9.442e+01	0.000e+00	-6.015e+00	0.000e+00	1.226e+03	0.000e+00
8	4.456e+01	0.000e+00	6.774e+00	0.000e+00	7.869e+02	0.000e+00
	-4.456e+01	0.000e+00	-6.774e+00	0.000e+00	1.245e+03	0.000e+00
9	1.165e-01	0.000e+00	7.373e+00	0.000e+00	-1.128e+03	0.000e+00
	-1.165e-01	0.000e+00	-7.373e+00	0.000e+00	2.013e+03	0.000e+00
10	1.165e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-1.165e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	1.983e+00	0.000e+00	7.743e+00	0.000e+00	-1.039e+03	0.000e+00
	-1.983e+00	0.000e+00	-7.743e+00	0.000e+00	1.968e+03	0.000e+00
12	1.983e+00	0.000e+00	-3.318e+01	0.000e+00	-1.968e+03	0.000e+00
	-1.983e+00	0.000e+00	3.318e+01	0.000e+00	-2.013e+03	0.000e+00
13	-7.596e-01	0.000e+00	1.152e+01	0.000e+00	-1.322e+02	0.000e+00
	7.596e-01	0.000e+00	-1.152e+01	0.000e+00	1.515e+03	0.000e+00
14	-7.596e-01	0.000e+00	-2.940e+01	0.000e+00	-1.515e+03	0.000e+00
	7.596e-01	0.000e+00	2.940e+01	0.000e+00	-2.013e+03	0.000e+00
15	6.774e+00	0.000e+00	1.682e+01	0.000e+00	3.709e+02	0.000e+00
	-6.774e+00	0.000e+00	-1.682e+01	0.000e+00	1.647e+03	0.000e+00



16 6.774e+00 0.000e+00 -2.410e+01 0.000e+00 -1.647e+03 0.000e+00  
 -6.774e+00 0.000e+00 2.410e+01 0.000e+00 -1.245e+03 0.000e+00

Load Factor= 2.059 :Hinge No=8  
 Ele No=1:Near\Ele No=5:Both\Ele No=9:Far\Ele No=10:Both\  
 Ele No=11:Far\Ele No=12:Both\Ele No=14:Far\  
 Ele No=13:Both

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	1.260e+02	0.000e+00	8.354e+00	0.000e+00	1.677e+03	0.000e+00
	-1.260e+02	0.000e+00	-8.354e+00	0.000e+00	8.289e+02	0.000e+00
2	9.777e+01	0.000e+00	4.229e+00	0.000e+00	2.692e+02	0.000e+00
	-9.777e+01	0.000e+00	-4.229e+00	0.000e+00	9.996e+02	0.000e+00
3	6.957e+01	0.000e+00	2.326e+00	0.000e+00	9.911e+01	0.000e+00
	-6.957e+01	0.000e+00	-2.326e+00	0.000e+00	5.987e+02	0.000e+00
4	3.744e+01	0.000e+00	-2.689e+00	0.000e+00	-4.417e+02	0.000e+00
	-3.744e+01	0.000e+00	2.689e+00	0.000e+00	-3.649e+02	0.000e+00
5	2.034e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00
	-2.034e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.492e+02	0.000e+00	8.122e+00	0.000e+00	9.644e+02	0.000e+00
	-1.492e+02	0.000e+00	-8.122e+00	0.000e+00	1.472e+03	0.000e+00
7	9.511e+01	0.000e+00	5.908e+00	0.000e+00	5.409e+02	0.000e+00
	-9.511e+01	0.000e+00	-5.908e+00	0.000e+00	1.231e+03	0.000e+00
8	4.490e+01	0.000e+00	6.806e+00	0.000e+00	7.816e+02	0.000e+00
	-4.490e+01	0.000e+00	-6.806e+00	0.000e+00	1.260e+03	0.000e+00
9	-7.771e-03	0.000e+00	7.623e+00	0.000e+00	-1.098e+03	0.000e+00
	7.771e-03	0.000e+00	-7.623e+00	0.000e+00	2.013e+03	0.000e+00
10	-7.771e-03	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	7.771e-03	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	2.214e+00	0.000e+00	7.620e+00	0.000e+00	-1.099e+03	0.000e+00
	-2.214e+00	0.000e+00	-7.620e+00	0.000e+00	2.013e+03	0.000e+00
12	2.214e+00	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-2.214e+00	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
13	-8.979e-01	0.000e+00	1.154e+01	0.000e+00	-1.570e+02	0.000e+00
	8.979e-01	0.000e+00	-1.154e+01	0.000e+00	1.542e+03	0.000e+00
14	-8.979e-01	0.000e+00	-2.963e+01	0.000e+00	-1.542e+03	0.000e+00
	8.979e-01	0.000e+00	2.963e+01	0.000e+00	-2.013e+03	0.000e+00
15	6.806e+00	0.000e+00	-1.685e+01	0.000e+00	3.649e+02	0.000e+00
	-6.806e+00	0.000e+00	1.685e+01	0.000e+00	1.658e+03	0.000e+00
16	6.806e+00	0.000e+00	-2.432e+01	0.000e+00	-1.658e+03	0.000e+00
	-6.806e+00	0.000e+00	2.432e+01	0.000e+00	-1.260e+03	0.000e+00

Load Factor= 2.062 :Hinge No=9  
 Ele No=1:Near\Ele No=5:Both\Ele No=6:Far\Ele No=9:Far\  
 Ele No=10:Both\Ele No=11:Far\Ele No=12:Both\Ele No=14:Far\  
 Ele No=13:Both

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	1.261e+02	0.000e+00	8.378e+00	0.000e+00	1.677e+03	0.000e+00
	-1.261e+02	0.000e+00	-8.378e+00	0.000e+00	8.361e+02	0.000e+00
2	9.785e+01	0.000e+00	4.198e+00	0.000e+00	2.548e+02	0.000e+00
	-9.785e+01	0.000e+00	-4.198e+00	0.000e+00	1.005e+03	0.000e+00
3	6.955e+01	0.000e+00	2.353e+00	0.000e+00	8.686e+01	0.000e+00
	-6.955e+01	0.000e+00	-2.353e+00	0.000e+00	6.191e+02	0.000e+00
4	3.744e+01	0.000e+00	-2.671e+00	0.000e+00	-4.432e+02	0.000e+00
	-3.744e+01	0.000e+00	2.671e+00	0.000e+00	-3.581e+02	0.000e+00
5	2.037e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00
	-2.037e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.495e+02	0.000e+00	8.171e+00	0.000e+00	9.644e+02	0.000e+00
	-1.495e+02	0.000e+00	-8.171e+00	0.000e+00	1.487e+03	0.000e+00
7	9.537e+01	0.000e+00	5.893e+00	0.000e+00	5.262e+02	0.000e+00
	-9.537e+01	0.000e+00	-5.893e+00	0.000e+00	1.242e+03	0.000e+00
8	4.502e+01	0.000e+00	6.794e+00	0.000e+00	7.713e+02	0.000e+00
	-4.502e+01	0.000e+00	-6.794e+00	0.000e+00	1.267e+03	0.000e+00
9	-5.694e-02	0.000e+00	7.683e+00	0.000e+00	-1.091e+03	0.000e+00
	5.694e-02	0.000e+00	-7.683e+00	0.000e+00	2.013e+03	0.000e+00
10	-5.694e-02	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	5.694e-02	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00

11	2.278e+00	0.000e+00	7.680e+00	0.000e+00	-1.091e+03	0.000e+00
	-2.278e+00	0.000e+00	-7.680e+00	0.000e+00	2.013e+03	0.000e+00
12	2.278e+00	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-2.278e+00	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
13	-9.011e-01	0.000e+00	1.149e+01	0.000e+00	-1.759e+02	0.000e+00
	9.011e-01	0.000e+00	-1.149e+01	0.000e+00	1.555e+03	0.000e+00
14	-9.011e-01	0.000e+00	-2.974e+01	0.000e+00	-1.555e+03	0.000e+00
	9.011e-01	0.000e+00	2.974e+01	0.000e+00	-2.013e+03	0.000e+00
15	6.794e+00	0.000e+00	1.683e+01	0.000e+00	3.581e+02	0.000e+00
	-6.794e+00	0.000e+00	-1.683e+01	0.000e+00	1.661e+03	0.000e+00
16	6.794e+00	0.000e+00	-2.440e+01	0.000e+00	-1.661e+03	0.000e+00
	-6.794e+00	0.000e+00	2.440e+01	0.000e+00	-1.267e+03	0.000e+00

Load Factor= 2.168 :Hinge No=10

Ele No=1:Near\Ele No=5:Both\Ele No=6:Far\Ele No=7:Far\

Ele No=9:Far\Ele No=10:Both\Ele No=11:Far\Ele No=12:Both\Ele No=14:Far

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	1.320e+02	0.000e+00	9.230e+00	0.000e+00	1.677e+03	0.000e+00
	-1.320e+02	0.000e+00	-9.230e+00	0.000e+00	1.092e+03	0.000e+00
2	1.005e+02	0.000e+00	4.837e+00	0.000e+00	-2.564e+02	0.000e+00
	-1.005e+02	0.000e+00	-4.837e+00	0.000e+00	1.708e+03	0.000e+00
3	6.902e+01	0.000e+00	1.066e+00	0.000e+00	-8.716e+02	0.000e+00
	-6.902e+01	0.000e+00	-1.066e+00	0.000e+00	1.191e+03	0.000e+00
4	3.739e+01	0.000e+00	-1.522e+00	0.000e+00	-3.905e+02	0.000e+00
	-3.739e+01	0.000e+00	1.522e+00	0.000e+00	-6.612e+01	0.000e+00
5	2.149e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00
	-2.149e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.596e+02	0.000e+00	8.171e+00	0.000e+00	9.644e+02	0.000e+00
	-1.596e+02	0.000e+00	-8.171e+00	0.000e+00	1.487e+03	0.000e+00
7	1.044e+02	0.000e+00	7.606e+00	0.000e+00	5.262e+02	0.000e+00
	-1.044e+02	0.000e+00	-7.606e+00	0.000e+00	1.756e+03	0.000e+00
8	4.933e+01	0.000e+00	5.858e+00	0.000e+00	2.574e+02	0.000e+00
	-4.933e+01	0.000e+00	-5.858e+00	0.000e+00	1.500e+03	0.000e+00
9	-5.694e-02	0.000e+00	9.813e+00	0.000e+00	-8.353e+02	0.000e+00
	5.694e-02	0.000e+00	-9.813e+00	0.000e+00	2.013e+03	0.000e+00
10	-5.694e-02	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	5.694e-02	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	5.652e-01	0.000e+00	9.810e+00	0.000e+00	-8.359e+02	0.000e+00
	-5.652e-01	0.000e+00	-9.810e+00	0.000e+00	2.013e+03	0.000e+00
12	5.652e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-5.652e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
13	1.748e+00	0.000e+00	9.955e+00	0.000e+00	-8.010e+02	0.000e+00
	-1.748e+00	0.000e+00	-9.955e+00	0.000e+00	1.996e+03	0.000e+00
14	1.748e+00	0.000e+00	-3.340e+01	0.000e+00	-1.996e+03	0.000e+00
	-1.748e+00	0.000e+00	3.340e+01	0.000e+00	-2.013e+03	0.000e+00
15	5.858e+00	0.000e+00	1.571e+01	0.000e+00	6.612e+01	0.000e+00
	-5.858e+00	0.000e+00	-1.571e+01	0.000e+00	1.819e+03	0.000e+00
16	5.858e+00	0.000e+00	-2.765e+01	0.000e+00	-1.819e+03	0.000e+00
	-5.858e+00	0.000e+00	2.765e+01	0.000e+00	-1.500e+03	0.000e+00

Load Factor= 2.171 :Hinge No=11

Ele No=1:Near\Ele No=5:Both\Ele No=6:Far\Ele No=7:Far\

Ele No=9:Far\Ele No=10:Both\Ele No=11:Far\Ele No=12:Both\Ele No=13:Far

Ele No=14:Both\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z:
1	1.322e+02	0.000e+00	9.258e+00	0.000e+00	1.677e+03	0.000e+00
	-1.322e+02	0.000e+00	-9.258e+00	0.000e+00	1.100e+03	0.000e+00
2	1.006e+02	0.000e+00	4.858e+00	0.000e+00	-2.732e+02	0.000e+00
	-1.006e+02	0.000e+00	-4.858e+00	0.000e+00	1.731e+03	0.000e+00
3	6.900e+01	0.000e+00	1.080e+00	0.000e+00	-9.031e+02	0.000e+00
	-6.900e+01	0.000e+00	-1.080e+00	0.000e+00	1.227e+03	0.000e+00
4	3.740e+01	0.000e+00	-1.543e+00	0.000e+00	-4.006e+02	0.000e+00
	-3.740e+01	0.000e+00	1.543e+00	0.000e+00	-6.232e+01	0.000e+00
5	2.152e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00

	-2.152e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.600e+02	0.000e+00	8.171e+00	0.000e+00	9.644e+02	0.000e+00
	-1.600e+02	0.000e+00	-8.171e+00	0.000e+00	1.487e+03	0.000e+00
7	1.047e+02	0.000e+00	7.606e+00	0.000e+00	5.262e+02	0.000e+00
	-1.047e+02	0.000e+00	-7.606e+00	0.000e+00	1.756e+03	0.000e+00
8	4.946e+01	0.000e+00	5.886e+00	0.000e+00	2.574e+02	0.000e+00
	-4.946e+01	0.000e+00	-5.886e+00	0.000e+00	1.508e+03	0.000e+00
9	-5.694e-02	0.000e+00	9.883e+00	0.000e+00	-8.269e+02	0.000e+00
	5.694e-02	0.000e+00	-9.883e+00	0.000e+00	2.013e+03	0.000e+00
10	-5.694e-02	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	5.694e-02	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	5.652e-01	0.000e+00	9.880e+00	0.000e+00	-8.275e+02	0.000e+00
	-5.652e-01	0.000e+00	-9.880e+00	0.000e+00	2.013e+03	0.000e+00
12	5.652e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-5.652e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
13	1.720e+00	0.000e+00	9.883e+00	0.000e+00	-8.266e+02	0.000e+00
	-1.720e+00	0.000e+00	-9.883e+00	0.000e+00	2.013e+03	0.000e+00
14	1.720e+00	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-1.720e+00	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
15	5.886e+00	0.000e+00	1.569e+01	0.000e+00	6.232e+01	0.000e+00
	-5.886e+00	0.000e+00	-1.569e+01	0.000e+00	1.820e+03	0.000e+00
16	5.886e+00	0.000e+00	-2.774e+01	0.000e+00	-1.820e+03	0.000e+00
	-5.886e+00	0.000e+00	2.774e+01	0.000e+00	-1.508e+03	0.000e+00

Load Factor= 2.178 :Hinge No=12

Ele No=1:Near\Ele No=2:Far\Ele No=5:Both\Ele No=6:Far\

Ele No=7:Far\Ele No=9:Far\Ele No=10:Both\Ele No=11:Far\Ele No=12:Both

Ele No=13:Far\Ele No=14:Both\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	1.326e+02	0.000e+00	9.310e+00	0.000e+00	1.677e+03	0.000e+00
	-1.326e+02	0.000e+00	-9.310e+00	0.000e+00	1.116e+03	0.000e+00
2	1.008e+02	0.000e+00	4.897e+00	0.000e+00	-3.044e+02	0.000e+00
	-1.008e+02	0.000e+00	-4.897e+00	0.000e+00	1.774e+03	0.000e+00
3	6.897e+01	0.000e+00	1.106e+00	0.000e+00	-9.616e+02	0.000e+00
	-6.897e+01	0.000e+00	-1.106e+00	0.000e+00	1.293e+03	0.000e+00
4	3.718e+01	0.000e+00	-1.711e+00	0.000e+00	-4.825e+02	0.000e+00
	-3.718e+01	0.000e+00	1.711e+00	0.000e+00	-3.085e+01	0.000e+00
5	2.159e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00
	-2.159e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.606e+02	0.000e+00	8.171e+00	0.000e+00	9.644e+02	0.000e+00
	-1.606e+02	0.000e+00	-8.171e+00	0.000e+00	1.487e+03	0.000e+00
7	1.053e+02	0.000e+00	7.606e+00	0.000e+00	5.262e+02	0.000e+00
	-1.053e+02	0.000e+00	-7.606e+00	0.000e+00	1.756e+03	0.000e+00
8	4.994e+01	0.000e+00	6.067e+00	0.000e+00	2.574e+02	0.000e+00
	-4.994e+01	0.000e+00	-6.067e+00	0.000e+00	1.563e+03	0.000e+00
9	-5.694e-02	0.000e+00	1.001e+01	0.000e+00	-8.113e+02	0.000e+00
	5.694e-02	0.000e+00	-1.001e+01	0.000e+00	2.013e+03	0.000e+00
10	-5.694e-02	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	5.694e-02	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	5.652e-01	0.000e+00	1.001e+01	0.000e+00	-8.119e+02	0.000e+00
	-5.652e-01	0.000e+00	-1.001e+01	0.000e+00	2.013e+03	0.000e+00
12	-5.652e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	5.652e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
13	1.539e+00	0.000e+00	1.001e+01	0.000e+00	-8.110e+02	0.000e+00
	-1.539e+00	0.000e+00	-1.001e+01	0.000e+00	2.013e+03	0.000e+00
14	1.539e+00	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-1.539e+00	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
15	6.067e+00	0.000e+00	1.540e+01	0.000e+00	3.085e+01	0.000e+00
	-6.067e+00	0.000e+00	-1.540e+01	0.000e+00	1.817e+03	0.000e+00
16	6.067e+00	0.000e+00	-2.816e+01	0.000e+00	-1.817e+03	0.000e+00
	-6.067e+00	0.000e+00	2.816e+01	0.000e+00	-1.563e+03	0.000e+00

Load Factor= 2.343 :Hinge No=13

Ele No=1:Near\Ele No=2:Far\Ele No=5:Both\Ele No=6:Far\

Ele No=7:Far\Ele No=8:Far\Ele No=9:Far\Ele No=10:Both\Ele No=11:Far\  
 Ele No=12:Both\Ele No=13:Far\Ele No=14:Both\

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	1.486e+02	0.000e+00	8.793e+00	0.000e+00	1.677e+03	0.000e+00
	-1.486e+02	0.000e+00	-8.793e+00	0.000e+00	9.606e+02	0.000e+00
2	1.118e+02	0.000e+00	4.090e+00	0.000e+00	-5.465e+02	0.000e+00
	-1.118e+02	0.000e+00	-4.090e+00	0.000e+00	1.774e+03	0.000e+00
3	7.507e+01	0.000e+00	2.850e-01	0.000e+00	-1.359e+03	0.000e+00
	-7.507e+01	0.000e+00	-2.850e-01	0.000e+00	1.444e+03	0.000e+00
4	3.831e+01	0.000e+00	-3.056e+00	0.000e+00	-1.031e+03	0.000e+00
	-3.831e+01	0.000e+00	3.056e+00	0.000e+00	1.138e+02	0.000e+00
5	2.264e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00
	-2.264e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.694e+02	0.000e+00	8.171e+00	0.000e+00	9.644e+02	0.000e+00
	-1.694e+02	0.000e+00	-8.171e+00	0.000e+00	1.487e+03	0.000e+00
7	1.124e+02	0.000e+00	7.606e+00	0.000e+00	5.262e+02	0.000e+00
	-1.124e+02	0.000e+00	-7.606e+00	0.000e+00	1.756e+03	0.000e+00
8	5.543e+01	0.000e+00	7.325e+00	0.000e+00	2.575e+02	0.000e+00
	-5.543e+01	0.000e+00	-7.325e+00	0.000e+00	1.940e+03	0.000e+00
9	1.330e-01	0.000e+00	1.332e+01	0.000e+00	-4.142e+02	0.000e+00
	-1.330e-01	0.000e+00	-1.332e+01	0.000e+00	2.013e+03	0.000e+00
10	1.330e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-1.330e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	9.236e-01	0.000e+00	1.332e+01	0.000e+00	-4.147e+02	0.000e+00
	-9.236e-01	0.000e+00	-1.332e+01	0.000e+00	2.013e+03	0.000e+00
12	9.236e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-9.236e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
13	8.443e-01	0.000e+00	1.332e+01	0.000e+00	-4.138e+02	0.000e+00
	-8.443e-01	0.000e+00	-1.332e+01	0.000e+00	2.013e+03	0.000e+00
14	4.102e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-4.102e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
15	7.981e+00	0.000e+00	1.488e+01	0.000e+00	-1.139e+02	0.000e+00
	-7.981e+00	0.000e+00	-1.488e+01	0.000e+00	1.899e+03	0.000e+00
16	7.416e+00	0.000e+00	-3.199e+01	0.000e+00	-1.899e+03	0.000e+00
	-7.416e+00	0.000e+00	3.199e+01	0.000e+00	-1.940e+03	0.000e+00

Load Factor= 2.385 :Hinge No=14

Ele No=1:Near\Ele No=2:Far\Ele No=5:Both\Ele No=6:Far\  
 Ele No=7:Far\Ele No=8:Far\Ele No=9:Far\Ele No=10:Both\Ele No=11:Far\  
 Ele No=12:Both\Ele No=13:Far\Ele No=14:Both\Ele No=15:Far\Ele No=16:N

Ele :	Axial :	Shear-y :	Shear-z :	Torsion :	Bending -y:	Bending -z :
1	1.527e+02	0.000e+00	8.662e+00	0.000e+00	1.677e+03	0.000e+00
	-1.527e+02	0.000e+00	-8.662e+00	0.000e+00	9.213e+02	0.000e+00
2	1.147e+02	0.000e+00	3.886e+00	0.000e+00	-6.080e+02	0.000e+00
	-1.147e+02	0.000e+00	-3.886e+00	0.000e+00	1.774e+03	0.000e+00
3	7.665e+01	0.000e+00	7.649e-02	0.000e+00	-1.460e+03	0.000e+00
	-7.665e+01	0.000e+00	-7.649e-02	0.000e+00	1.482e+03	0.000e+00
4	3.863e+01	0.000e+00	-3.105e+00	0.000e+00	-1.170e+03	0.000e+00
	-3.863e+01	0.000e+00	3.105e+00	0.000e+00	2.381e+02	0.000e+00
5	2.290e+02	0.000e+00	8.114e+00	0.000e+00	1.386e+03	0.000e+00
	-2.290e+02	0.000e+00	-8.114e+00	0.000e+00	1.048e+03	0.000e+00
6	1.716e+02	0.000e+00	8.171e+00	0.000e+00	9.644e+02	0.000e+00
	-1.716e+02	0.000e+00	-8.171e+00	0.000e+00	1.487e+03	0.000e+00
7	1.142e+02	0.000e+00	7.606e+00	0.000e+00	5.261e+02	0.000e+00
	-1.142e+02	0.000e+00	-7.606e+00	0.000e+00	1.756e+03	0.000e+00
8	5.679e+01	0.000e+00	7.325e+00	0.000e+00	2.575e+02	0.000e+00
	-5.679e+01	0.000e+00	-7.325e+00	0.000e+00	1.940e+03	0.000e+00
9	1.722e-01	0.000e+00	1.416e+01	0.000e+00	-3.133e+02	0.000e+00
	-1.722e-01	0.000e+00	-1.416e+01	0.000e+00	2.013e+03	0.000e+00
10	1.722e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-1.722e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
11	8.805e-01	0.000e+00	1.416e+01	0.000e+00	-3.139e+02	0.000e+00
	-8.805e-01	0.000e+00	-1.416e+01	0.000e+00	2.013e+03	0.000e+00
12	8.805e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00

	-8.805e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
13	1.015e+00	0.000e+00	1.416e+01	0.000e+00	-3.130e+02	0.000e+00
	-1.015e+00	0.000e+00	-1.416e+01	0.000e+00	2.013e+03	0.000e+00
14	3.308e-01	0.000e+00	-3.355e+01	0.000e+00	-2.013e+03	0.000e+00
	-3.308e-01	0.000e+00	3.355e+01	0.000e+00	-2.013e+03	0.000e+00
15	8.049e+00	0.000e+00	1.478e+01	0.000e+00	-2.382e+02	0.000e+00
	-8.049e+00	0.000e+00	-1.478e+01	0.000e+00	2.012e+03	0.000e+00
16	7.484e+00	0.000e+00	-3.293e+01	0.000e+00	-2.012e+03	0.000e+00
	7.484e+00	0.000e+00	3.293e+01	0.000e+00	-1.940e+03	0.000e+00



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

- Project Name : good1  
- Nodal Displacement

Load Factor= 0.000  
Node: X-Disp : Y-Disp : Z-Disp : THETA-x : THETA-y : THETA-z :  
1 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
2 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
3 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
4 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
5 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
6 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
7 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
8 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
9 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
10 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
11 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
12 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
13 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
14 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00

Load Factor= 1.456  
Node: X-Disp : Y-Disp : Z-Disp : THETA-x : THETA-y : THETA-z :  
1 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
2 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
3 4.894e+00 0.000e+00 -7.562e-02 0.000e+00 -1.739e-02 0.000e+00  
4 4.894e+00 0.000e+00 -8.834e-01 0.000e+00 5.909e-03 0.000e+00  
5 4.894e+00 0.000e+00 -1.226e-01 0.000e+00 -7.423e-03 0.000e+00  
6 1.056e+01 0.000e+00 -1.358e-01 0.000e+00 -1.440e-02 0.000e+00  
7 1.056e+01 0.000e+00 -9.096e-01 0.000e+00 4.637e-03 0.000e+00  
8 1.056e+01 0.000e+00 -2.112e-01 0.000e+00 -6.036e-03 0.000e+00  
9 1.458e+01 0.000e+00 -1.788e-01 0.000e+00 -9.864e-03 0.000e+00  
10 1.458e+01 0.000e+00 -9.126e-01 0.000e+00 2.677e-03 0.000e+00  
11 1.458e+01 0.000e+00 -2.673e-01 0.000e+00 -3.055e-03 0.000e+00  
12 1.674e+01 0.000e+00 -2.017e-01 0.000e+00 -1.117e-02 0.000e+00  
13 1.674e+01 0.000e+00 -1.231e+00 0.000e+00 8.650e-04 0.000e+00  
14 1.674e+01 0.000e+00 -2.940e-01 0.000e+00 5.407e-03 0.000e+00

Load Factor= 1.609  
Node: X-Disp : Y-Disp : Z-Disp : THETA-x : THETA-y : THETA-z :  
1 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
2 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
3 5.927e+00 0.000e+00 -8.392e-02 0.000e+00 -2.160e-02 0.000e+00  
4 5.927e+00 0.000e+00 -1.172e+00 0.000e+00 6.097e-03 0.000e+00  
5 5.927e+00 0.000e+00 -1.352e-01 0.000e+00 -1.273e-02 0.000e+00  
6 1.276e+01 0.000e+00 -1.501e-01 0.000e+00 -1.649e-02 0.000e+00  
7 1.276e+01 0.000e+00 -1.018e+00 0.000e+00 5.309e-03 0.000e+00  
8 1.276e+01 0.000e+00 -2.333e-01 0.000e+00 -6.825e-03 0.000e+00  
9 1.727e+01 0.000e+00 -1.976e-01 0.000e+00 -1.090e-02 0.000e+00  
10 1.727e+01 0.000e+00 -1.006e+00 0.000e+00 2.977e-03 0.000e+00  
11 1.727e+01 0.000e+00 -2.954e-01 0.000e+00 -3.458e-03 0.000e+00  
12 1.966e+01 0.000e+00 -2.228e-01 0.000e+00 -1.237e-02 0.000e+00  
13 1.966e+01 0.000e+00 -1.361e+00 0.000e+00 9.580e-04 0.000e+00  
14 1.966e+01 0.000e+00 -3.249e-01 0.000e+00 5.984e-03 0.000e+00

Load Factor= 1.653  
Node: X-Disp : Y-Disp : Z-Disp : THETA-x : THETA-y : THETA-z :  
1 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
2 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00  
3 6.262e+00 0.000e+00 -8.630e-02 0.000e+00 -2.309e-02 0.000e+00  
4 6.262e+00 0.000e+00 -1.267e+00 0.000e+00 6.187e-03 0.000e+00  
5 6.262e+00 0.000e+00 -1.387e-01 0.000e+00 -1.450e-02 0.000e+00  
6 1.364e+01 0.000e+00 -1.543e-01 0.000e+00 -1.785e-02 0.000e+00  
7 1.364e+01 0.000e+00 -1.110e+00 0.000e+00 5.379e-03 0.000e+00  
8 1.364e+01 0.000e+00 -2.395e-01 0.000e+00 -8.495e-03 0.000e+00  
9 1.846e+01 0.000e+00 -2.029e-01 0.000e+00 -1.138e-02 0.000e+00  
10 1.846e+01 0.000e+00 -1.037e+00 0.000e+00 3.122e-03 0.000e+00

11	1.846e+01	0.000e+00	-3.034e-01	0.000e+00	-3.622e-03	0.000e+00
12	2.094e+01	0.000e+00	-2.289e-01	0.000e+00	-1.270e-02	0.000e+00
13	2.094e+01	0.000e+00	-1.396e+00	0.000e+00	9.910e-04	0.000e+00
14	2.094e+01	0.000e+00	-3.337e-01	0.000e+00	6.113e-03	0.000e+00

Load Factor= 1.936

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	9.276e+00	0.000e+00	-1.015e-01	0.000e+00	-3.452e-02	0.000e+00
4	9.276e+00	0.000e+00	-1.964e+00	0.000e+00	6.986e-03	0.000e+00
5	9.276e+00	0.000e+00	-1.621e-01	0.000e+00	-2.612e-02	0.000e+00
6	2.036e+01	0.000e+00	-1.811e-01	0.000e+00	-2.687e-02	0.000e+00
7	2.036e+01	0.000e+00	-1.712e+00	0.000e+00	5.850e-03	0.000e+00
8	2.036e+01	0.000e+00	-2.802e-01	0.000e+00	-1.998e-02	0.000e+00
9	2.734e+01	0.000e+00	-2.374e-01	0.000e+00	-1.460e-02	0.000e+00
10	2.734e+01	0.000e+00	-1.239e+00	0.000e+00	4.080e-03	0.000e+00
11	2.734e+01	0.000e+00	-3.558e-01	0.000e+00	-4.686e-03	0.000e+00
12	3.039e+01	0.000e+00	-2.677e-01	0.000e+00	-1.485e-02	0.000e+00
13	3.039e+01	0.000e+00	-1.628e+00	0.000e+00	1.208e-03	0.000e+00
14	3.039e+01	0.000e+00	-3.914e-01	0.000e+00	6.931e-03	0.000e+00

Load Factor= 1.967

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1.022e+01	0.000e+00	-1.029e-01	0.000e+00	-3.646e-02	0.000e+00
4	1.022e+01	0.000e+00	-2.071e+00	0.000e+00	7.157e-03	0.000e+00
5	1.022e+01	0.000e+00	-1.649e-01	0.000e+00	-2.875e-02	0.000e+00
6	2.190e+01	0.000e+00	-1.837e-01	0.000e+00	-2.813e-02	0.000e+00
7	2.190e+01	0.000e+00	-1.790e+00	0.000e+00	5.934e-03	0.000e+00
8	2.190e+01	0.000e+00	-2.850e-01	0.000e+00	-2.148e-02	0.000e+00
9	2.916e+01	0.000e+00	-2.408e-01	0.000e+00	-1.498e-02	0.000e+00
10	2.916e+01	0.000e+00	-1.261e+00	0.000e+00	4.196e-03	0.000e+00
11	2.916e+01	0.000e+00	-3.618e-01	0.000e+00	-4.836e-03	0.000e+00
12	3.228e+01	0.000e+00	-2.716e-01	0.000e+00	-1.510e-02	0.000e+00
13	3.228e+01	0.000e+00	-1.654e+00	0.000e+00	1.230e-03	0.000e+00
14	3.227e+01	0.000e+00	-3.980e-01	0.000e+00	7.016e-03	0.000e+00

Load Factor= 1.992

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1.102e+01	0.000e+00	-1.041e-01	0.000e+00	-3.810e-02	0.000e+00
4	1.102e+01	0.000e+00	-2.162e+00	0.000e+00	7.305e-03	0.000e+00
5	1.102e+01	0.000e+00	-1.672e-01	0.000e+00	-3.100e-02	0.000e+00
6	2.323e+01	0.000e+00	-1.859e-01	0.000e+00	-2.936e-02	0.000e+00
7	2.323e+01	0.000e+00	-1.863e+00	0.000e+00	6.026e-03	0.000e+00
8	2.323e+01	0.000e+00	-2.889e-01	0.000e+00	-2.288e-02	0.000e+00
9	3.084e+01	0.000e+00	-2.437e-01	0.000e+00	-1.571e-02	0.000e+00
10	3.084e+01	0.000e+00	-1.313e+00	0.000e+00	4.226e-03	0.000e+00
11	3.084e+01	0.000e+00	-3.668e-01	0.000e+00	-5.772e-03	0.000e+00
12	3.411e+01	0.000e+00	-2.748e-01	0.000e+00	-1.543e-02	0.000e+00
13	3.411e+01	0.000e+00	-1.678e+00	0.000e+00	1.285e-03	0.000e+00
14	3.411e+01	0.000e+00	-4.035e-01	0.000e+00	7.072e-03	0.000e+00

Load Factor= 2.046

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1.678e+01	0.000e+00	-1.066e-01	0.000e+00	-5.686e-02	0.000e+00
4	1.678e+01	0.000e+00	-4.559e+00	0.000e+00	7.305e-03	0.000e+00
5	1.678e+01	0.000e+00	-1.720e-01	0.000e+00	-4.772e-02	0.000e+00
6	3.282e+01	0.000e+00	-1.896e-01	0.000e+00	-3.516e-02	0.000e+00
7	3.281e+01	0.000e+00	-2.160e+00	0.000e+00	6.614e-03	0.000e+00
8	3.281e+01	0.000e+00	-2.980e-01	0.000e+00	-3.138e-02	0.000e+00
9	4.199e+01	0.000e+00	-2.485e-01	0.000e+00	-1.845e-02	0.000e+00
10	4.199e+01	0.000e+00	-1.474e+00	0.000e+00	4.425e-03	0.000e+00

11	4.199e+01	0.000e+00	-3.783e-01	0.000e+00	-8.885e-03	0.000e+00
12	4.580e+01	0.000e+00	-2.802e-01	0.000e+00	-1.627e-02	0.000e+00
13	4.579e+01	0.000e+00	-1.729e+00	0.000e+00	1.458e-03	0.000e+00
14	4.579e+01	0.000e+00	-4.163e-01	0.000e+00	7.036e-03	0.000e+00

Load Factor= 2.059

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1.848e+01	0.000e+00	-1.072e-01	0.000e+00	-6.183e-02	0.000e+00
4	1.848e+01	0.000e+00	-5.189e+00	0.000e+00	7.305e-03	0.000e+00
5	1.848e+01	0.000e+00	-1.731e-01	0.000e+00	-5.120e-02	0.000e+00
6	3.543e+01	0.000e+00	-1.904e-01	0.000e+00	-3.647e-02	0.000e+00
7	3.543e+01	0.000e+00	-2.228e+00	0.000e+00	6.746e-03	0.000e+00
8	3.543e+01	0.000e+00	-3.001e-01	0.000e+00	-3.358e-02	0.000e+00
9	4.498e+01	0.000e+00	-2.496e-01	0.000e+00	-1.912e-02	0.000e+00
10	4.498e+01	0.000e+00	-1.513e+00	0.000e+00	4.476e-03	0.000e+00
11	4.498e+01	0.000e+00	-3.811e-01	0.000e+00	-9.598e-03	0.000e+00
12	4.892e+01	0.000e+00	-2.815e-01	0.000e+00	-1.646e-02	0.000e+00
13	4.892e+01	0.000e+00	-1.741e+00	0.000e+00	1.498e-03	0.000e+00
14	4.891e+01	0.000e+00	-4.193e-01	0.000e+00	7.019e-03	0.000e+00

Load Factor= 2.062

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1.919e+01	0.000e+00	-1.074e-01	0.000e+00	-6.404e-02	0.000e+00
4	1.919e+01	0.000e+00	-5.462e+00	0.000e+00	7.305e-03	0.000e+00
5	1.919e+01	0.000e+00	-1.734e-01	0.000e+00	-5.319e-02	0.000e+00
6	3.669e+01	0.000e+00	-1.906e-01	0.000e+00	-3.801e-02	0.000e+00
7	3.669e+01	0.000e+00	-2.420e+00	0.000e+00	6.746e-03	0.000e+00
8	3.669e+01	0.000e+00	-3.006e-01	0.000e+00	-3.505e-02	0.000e+00
9	4.654e+01	0.000e+00	-2.498e-01	0.000e+00	-1.953e-02	0.000e+00
10	4.654e+01	0.000e+00	-1.534e+00	0.000e+00	4.517e-03	0.000e+00
11	4.654e+01	0.000e+00	-3.818e-01	0.000e+00	-1.020e-02	0.000e+00
12	5.057e+01	0.000e+00	-2.817e-01	0.000e+00	-1.657e-02	0.000e+00
13	5.056e+01	0.000e+00	-1.745e+00	0.000e+00	1.527e-03	0.000e+00
14	5.056e+01	0.000e+00	-4.201e-01	0.000e+00	7.005e-03	0.000e+00

Load Factor= 2.168

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5.359e+01	0.000e+00	-1.123e-01	0.000e+00	-1.728e-01	0.000e+00
4	5.359e+01	0.000e+00	-1.880e+01	0.000e+00	7.305e-03	0.000e+00
5	5.359e+01	0.000e+00	-1.829e-01	0.000e+00	-1.420e-01	0.000e+00
6	9.772e+01	0.000e+00	-1.979e-01	0.000e+00	-1.046e-01	0.000e+00
7	9.772e+01	0.000e+00	-1.070e+01	0.000e+00	6.746e-03	0.000e+00
8	9.772e+01	0.000e+00	-3.187e-01	0.000e+00	-7.876e-02	0.000e+00
9	1.189e+02	0.000e+00	-2.566e-01	0.000e+00	-3.296e-02	0.000e+00
10	1.189e+02	0.000e+00	-2.213e+00	0.000e+00	5.885e-03	0.000e+00
11	1.189e+02	0.000e+00	-4.076e-01	0.000e+00	-3.607e-02	0.000e+00
12	1.263e+02	0.000e+00	-2.884e-01	0.000e+00	-2.169e-02	0.000e+00
13	1.263e+02	0.000e+00	-1.955e+00	0.000e+00	2.648e-03	0.000e+00
14	1.263e+02	0.000e+00	-4.496e-01	0.000e+00	7.071e-03	0.000e+00

Load Factor= 2.171

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5.493e+01	0.000e+00	-1.125e-01	0.000e+00	-1.770e-01	0.000e+00
4	5.493e+01	0.000e+00	-1.932e+01	0.000e+00	7.305e-03	0.000e+00
5	5.493e+01	0.000e+00	-1.832e-01	0.000e+00	-1.456e-01	0.000e+00
6	1.001e+02	0.000e+00	-1.981e-01	0.000e+00	-1.075e-01	0.000e+00
7	1.001e+02	0.000e+00	-1.106e+01	0.000e+00	6.746e-03	0.000e+00
8	1.001e+02	0.000e+00	-3.193e-01	0.000e+00	-8.049e-02	0.000e+00
9	1.218e+02	0.000e+00	-2.568e-01	0.000e+00	-3.349e-02	0.000e+00
10	1.218e+02	0.000e+00	-2.239e+00	0.000e+00	5.941e-03	0.000e+00



11	1.218e+02	0.000e+00	-4.085e-01	0.000e+00	-3.643e-02	0.000e+00
12	1.293e+02	0.000e+00	-2.887e-01	0.000e+00	-2.175e-02	0.000e+00
13	1.293e+02	0.000e+00	-1.956e+00	0.000e+00	2.673e-03	0.000e+00
14	1.293e+02	0.000e+00	-4.506e-01	0.000e+00	7.007e-03	0.000e+00

Load Factor= 2.178

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	5.835e+01	0.000e+00	-1.128e-01	0.000e+00	-1.881e-01	0.000e+00
4	5.835e+01	0.000e+00	-2.066e+01	0.000e+00	7.305e-03	0.000e+00
5	5.835e+01	0.000e+00	-1.838e-01	0.000e+00	-1.554e-01	0.000e+00
6	1.065e+02	0.000e+00	-1.986e-01	0.000e+00	-1.159e-01	0.000e+00
7	1.065e+02	0.000e+00	-1.209e+01	0.000e+00	6.746e-03	0.000e+00
8	1.065e+02	0.000e+00	-3.204e-01	0.000e+00	-8.683e-02	0.000e+00
9	1.301e+02	0.000e+00	-2.573e-01	0.000e+00	-3.762e-02	0.000e+00
10	1.301e+02	0.000e+00	-2.753e+00	0.000e+00	5.941e-03	0.000e+00
11	1.301e+02	0.000e+00	-4.100e-01	0.000e+00	-3.893e-02	0.000e+00
12	1.382e+02	0.000e+00	-2.889e-01	0.000e+00	-2.194e-02	0.000e+00
13	1.381e+02	0.000e+00	-1.947e+00	0.000e+00	2.864e-03	0.000e+00
14	1.381e+02	0.000e+00	-4.525e-01	0.000e+00	6.393e-03	0.000e+00

Load Factor= 2.343

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1.001e+12	0.000e+00	-1.265e-01	0.000e+00	-3.336e+09	0.000e+00
4	1.001e+12	0.000e+00	-4.003e+11	0.000e+00	7.305e-03	0.000e+00
5	1.001e+12	0.000e+00	-1.927e-01	0.000e+00	-3.336e+09	0.000e+00
6	2.002e+12	0.000e+00	-2.216e-01	0.000e+00	-1.609e-01	0.000e+00
7	2.002e+12	0.000e+00	-1.796e+01	0.000e+00	6.746e-03	0.000e+00
8	2.002e+12	0.000e+00	-3.368e-01	0.000e+00	-1.209e-01	0.000e+00
9	2.002e+12	0.000e+00	-2.855e-01	0.000e+00	-6.361e-02	0.000e+00
10	2.002e+12	0.000e+00	-6.341e+00	0.000e+00	5.941e-03	0.000e+00
11	2.002e+12	0.000e+00	-4.325e-01	0.000e+00	-5.492e-02	0.000e+00
12	2.002e+12	0.000e+00	-3.181e-01	0.000e+00	-2.388e-02	0.000e+00
13	2.002e+12	0.000e+00	-2.002e+00	0.000e+00	4.082e-03	0.000e+00
14	2.002e+12	0.000e+00	-4.797e-01	0.000e+00	3.510e-03	0.000e+00

Load Factor= 2.385

Node:	X-Disp :	Y-Disp :	Z-Disp :	THETA-x :	THETA-y :	THETA-z :
1	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
2	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
3	1.255e+12	0.000e+00	-1.299e-01	0.000e+00	-4.183e+09	0.000e+00
4	1.255e+12	0.000e+00	-5.019e+11	0.000e+00	7.305e-03	0.000e+00
5	1.255e+12	0.000e+00	-1.949e-01	0.000e+00	-4.183e+09	0.000e+00
6	2.510e+12	0.000e+00	-2.275e-01	0.000e+00	-1.779e-01	0.000e+00
7	2.510e+12	0.000e+00	-2.011e+01	0.000e+00	6.746e-03	0.000e+00
8	2.510e+12	0.000e+00	-3.409e-01	0.000e+00	-1.351e-01	0.000e+00
9	2.510e+12	0.000e+00	-2.928e-01	0.000e+00	-7.575e-02	0.000e+00
10	2.510e+12	0.000e+00	-7.917e+00	0.000e+00	5.941e-03	0.000e+00
11	2.510e+12	0.000e+00	-4.381e-01	0.000e+00	-6.241e-02	0.000e+00
12	2.510e+12	0.000e+00	-3.256e-01	0.000e+00	-2.687e-02	0.000e+00
13	2.510e+12	0.000e+00	-2.168e+00	0.000e+00	4.373e-03	0.000e+00
14	2.510e+12	0.000e+00	-4.864e-01	0.000e+00	5.363e-03	0.000e+00

## ประวัติผู้เขียน

นายทฤษฎี สิงห์ศิลารักษ์ เกิดวันที่ 22 ธันวาคม พ.ศ. 2514 ที่อำเภอโนนสูง จังหวัดนครราชสีมา สำเร็จการศึกษาปริญญาวิศวกรรมศาสตรบัณฑิต สาขาวิศวกรรมโยธา ภาควิชาวิศวกรรมโยธา มหาวิทยาลัยเกษตรศาสตร์ ในปีการศึกษา 2535 และเข้าศึกษาต่อในหลักสูตรวิศวกรรมศาสตรมหาบัณฑิต เมื่อ พ.ศ. 2536



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย