2D Truss Analysis Using Stiffness Method

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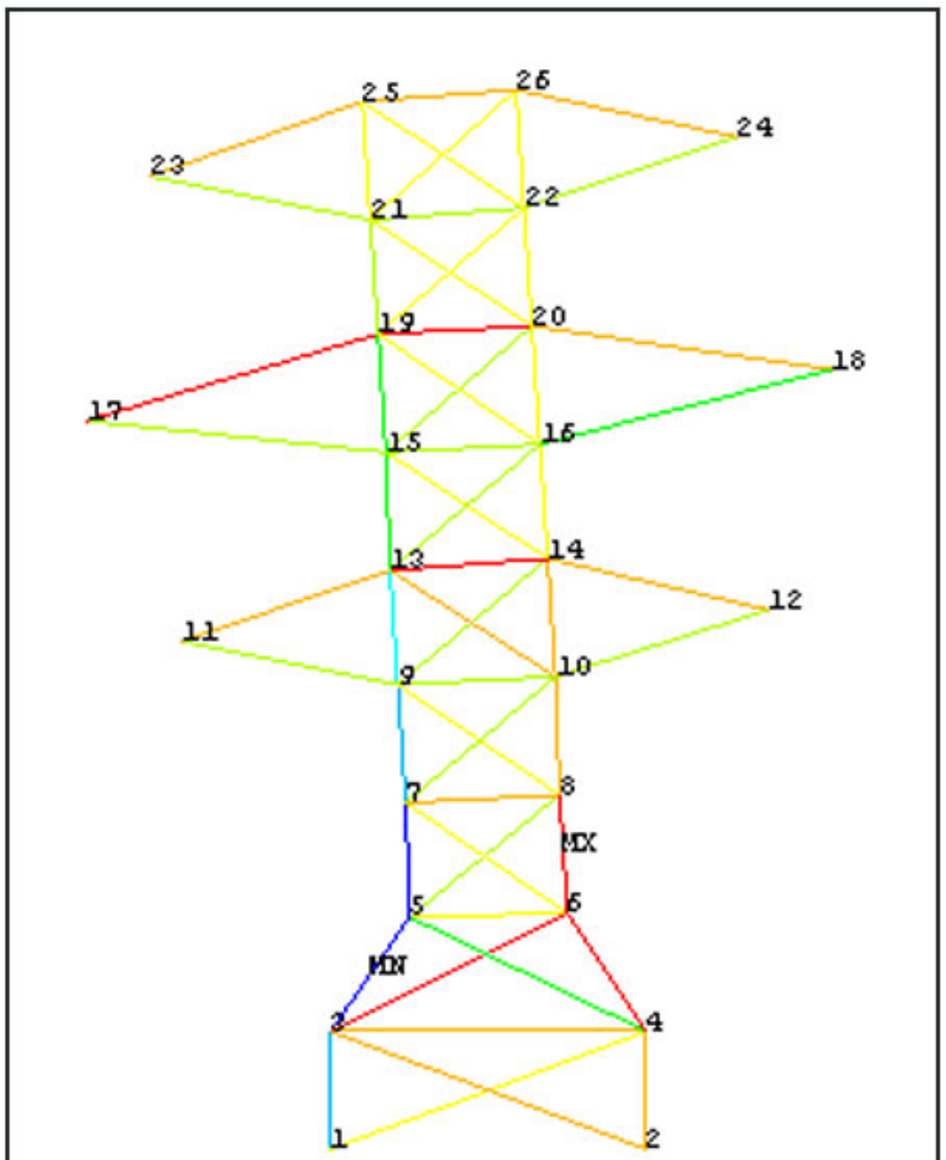
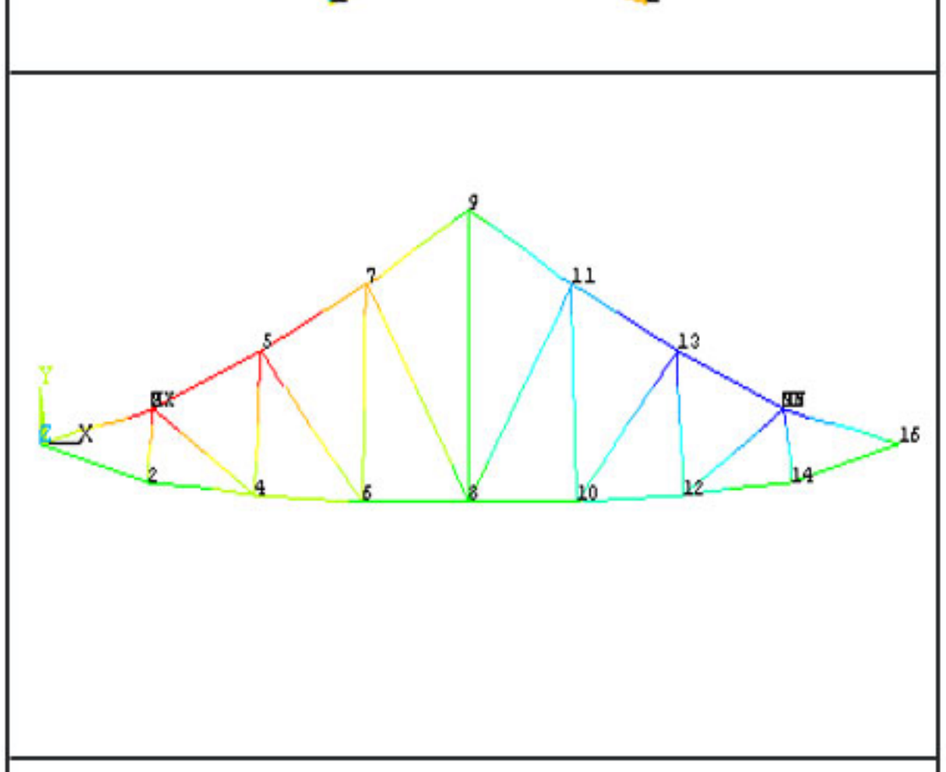
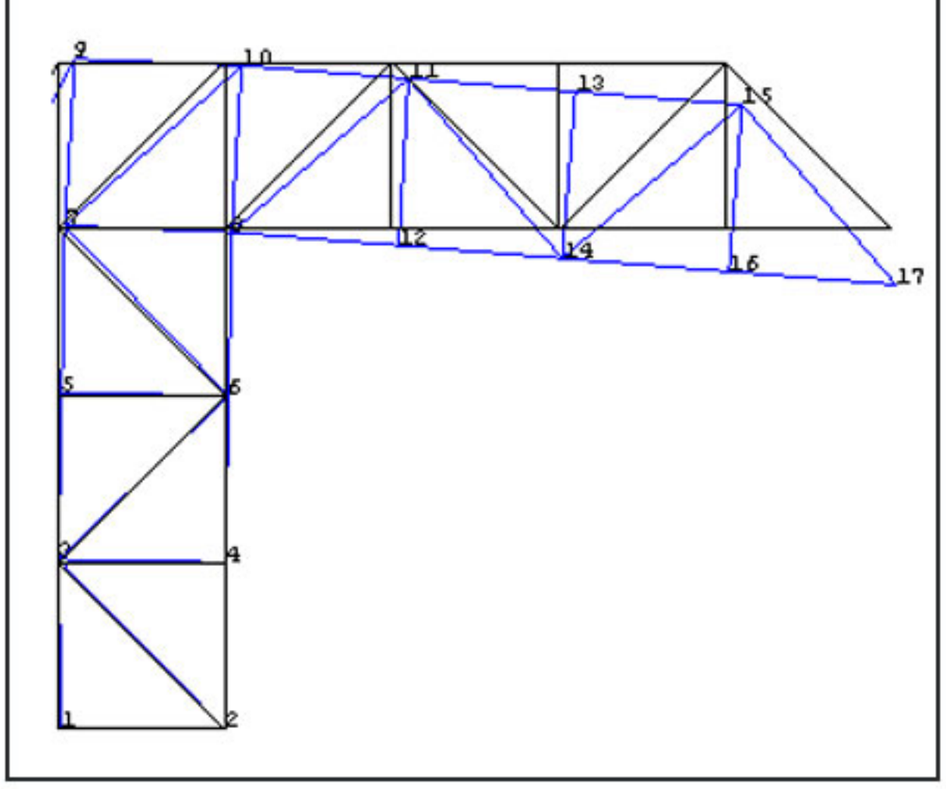
2D Truss Analysis Using Stiffness Method

This program is able to analyze all types of 2-D trusses (with all degree of freedom) using stiffness method (matrix analysis) under any kind of concentrated nodal loadings (Fx, Fy) and submit values of supportive reactions, nodal displacements, axial forces and element stresses and strains as MATLAB output. General feature of this program includes one “m-file" and an “Excel” input file which to run this program both of them (truss.m and Truss.xls) must be saved in MATLAB directory. Meanwhile notice that input file (Truss.xls) must be saved as “Excel 2003”. Using this program is very easy and user friendly (i.e. for each new example adjust input file and then save it. In entering file, some questions are asked and some tables exist which are related to problem inputs. In this file, variables are shown in blue color). Then using MATLAB software run "truss.m" file, later you can see results in MATLAB’s command window.

Finally, to test this program, different Examples are given which in these examples program outputs are compared with the results from ABAQUS or ANSYS software. Similarity of results shows that this program works without any deficiencies as well as these two softwares.





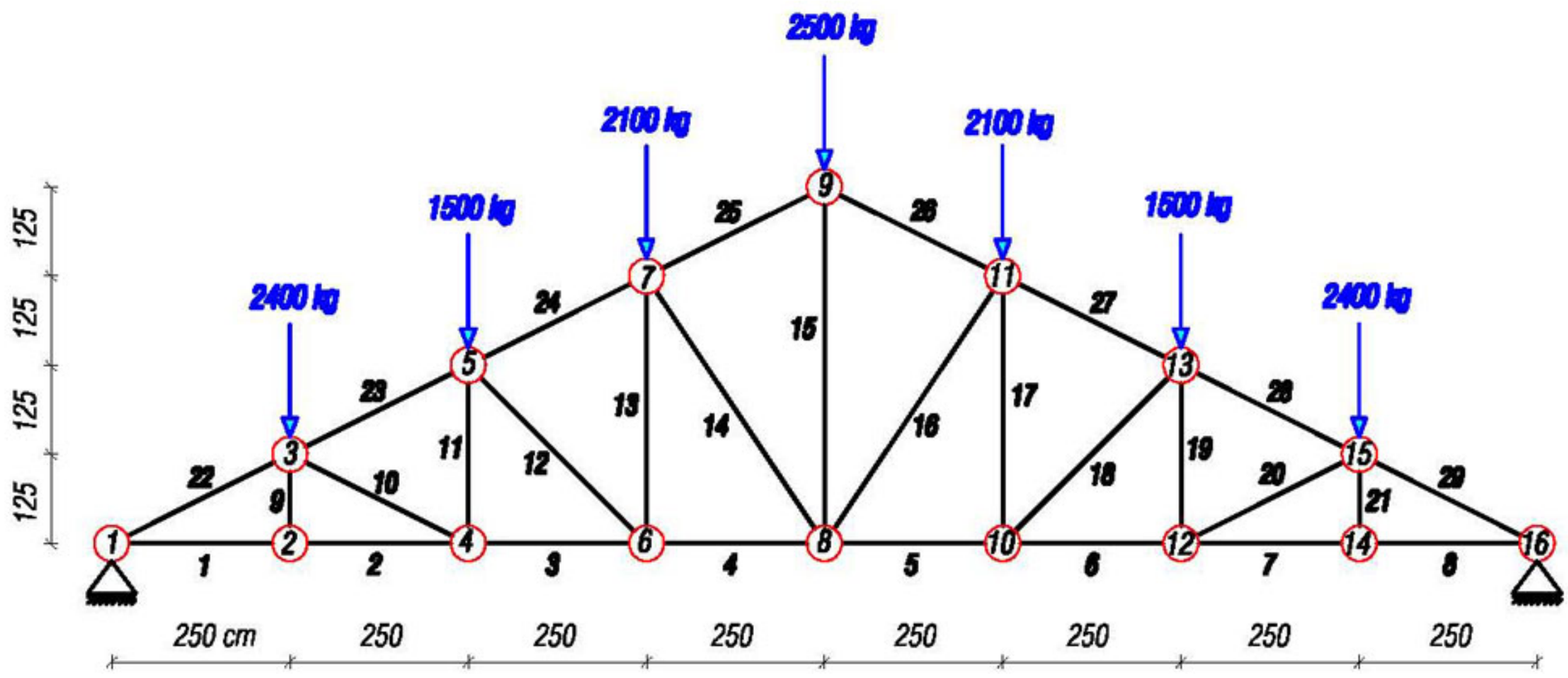


```
%=========================================================================%
%    2D truss analysis using stiffness method (matrix analysis)          %
%    Written by: "Sobhan Rostami & Ali Moeinadini"                        %
%    M.Sc students of structural engineering of Azad university of Kerman-Iran   %
%    E-mail: info@newcivil.com                                            %
%=========================================================================%
clc
clear all

%Input data:
NN=xlsread('Truss','input','E8');
Coor=xlsread('Truss','input','C14:E250');
for j=1:NN
    i=Coor(j,1);
    X(i)=Coor(j,2);
    Y(i)=Coor(j,3);
end

NE=xlsread('Truss','input','E9');
Pro=xlsread('Truss','input','N11:R250');
for j=1:NE
    i=Pro(j,1);
    E(i)=Pro(j,2);
    A(i)=Pro(j,3);
    Dir(i,1)=i;
    Dir(i,2)=Pro(j,4);
    Dir(i,3)=Pro(j,5);
end

NC=xlsread('Truss','input','AD8');
Cons=xlsread('Truss','input','Y14:Z26');

NF=xlsread('Truss','input','AB27');
Forc=xlsread('Truss','input','Y30:AA250');

%Definition of Global stiffness submatrixes for each element:
for i=1:NE
    L(i)=sqrt((X(Dir(i,3))-X(Dir(i,2)))^2+(Y(Dir(i,3))-Y(Dir(i,2)))^2);
    cos(i)=(X(Dir(i,3))-X(Dir(i,2)))/L(i);
    sin(i)=(Y(Dir(i,3))-Y(Dir(i,2)))/L(i);
end

for i=1:NE
    S(i)=E(i)*A(i)/L(i);
    k11(:,:,i)=S(i)*[(cos(i))^2 sin(i)*cos(i);sin(i)*cos(i) (sin(i))^2];
    k12(:,:,i)=-k11(:,:,i);
    k21(:,:,i)=k12(:,:,i);
    k22(:,:,i)=k11(:,:,i);
end

%Definition of structure stiffness matrix(plant of submatrixes):
K=zeros(2*NN,2*NN);
for n=1:NE
    i=Dir(n,2);
    j=Dir(n,3);
    K(2*i-1:2*i,2*i-1:2*i)=k11(:,:,n)+ K(2*i-1:2*i,2*i-1:2*i);
    K(2*i-1:2*i,2*j-1:2*j)=k12(:,:,n);
    K(2*j-1:2*j,2*i-1:2*i)=k21(:,:,n);
    K(2*j-1:2*j,2*j-1:2*j)=k22(:,:,n)+ K(2*j-1:2*j,2*j-1:2*j);
End

%Definition of primary external nodal forces vector:
F=zeros(2*NN,1);
for i=1:NF
    r=2*Forc(i,1);
    F(r-1)=Forc(i,2);
    F(r)=Forc(i,3);
end
```

```
%Elemination of rows and columns of K-matrix concern to supports:
S=K;
for i=1:NC
    r=2*Cons(i,1);
    if Cons(i,2)==0
        S(r-1,:)=0; S(:,r-1)=0; S(r-1,r-1)=1;
        S(r,:)=0; S(:,r)=0; S(r,r)=1;
    elseif Cons(i,2)==1
        S(r-1,:)=0; S(:,r-1)=0; S(r-1,r-1)=1;
    else
        S(r,:)=0; S(:,r)=0; S(r,r)=1;
    end
end

%-------------------------------------------------------------%
%Solution of equation "{F}=[S]{d}" by Gauss elimination method:
n=2*NN;

%creation of upper triangular matrix
s=0;
for j=1:n-1
    if S(j,j)==0
        k=j;
        for k=k+1:n
            if S(k,j)==0
                continue
            end
            break
        end
        B=S(j,:); C=F(j);
        S(j,:)=S(k,:); F(j)=F(k);
        S(k,:)=B; F(k)=C;
    end
    for i=1+s:n-1
        L=S(i+1,j)/S(j,j);
        S(i+1,:)=S(i+1,:)-L*S(j,:);
        F(i+1)=F(i+1)-L*F(j);
    end
    s=s+1;
end

%solution of equations
d=zeros(2*NN,1);
d(n)=F(n)/S(n,n);
for i=n-1:-1:1
    sum=0;
    for j=i+1:n
        sum=sum+S(i,j)*d(j);
    end
    d(i)=(1/S(i,i))*(F(i)-sum);
end
%-------------------------------------------------------------%

%Creation of external nodal forces vector:
W=K*d;

%Calculation of elements axial force:
for n=1:NE
    i=Dir(n,2);
    j=Dir(n,3);
    PJ=k21(:,:,n)*[d(2*i-1);d(2*i)]+ k22(:,:,n)*[d(2*j-1);d(2*j)];
    P(n)=PJ(1)*cos(n)+PJ(2)*sin(n);
    stress(n)=P(n)/A(n);
    strain(n)=stress(n)/E(n);
end
```

```
%Analysis results:
disp('2D-truss Analysis (OUTPUTS)')
disp('*****************************')
disp(' ')
disp('Node displacement :')
disp(' ')
for i=1:NN
    fprintf('dx%g\t',i); fprintf('= %G\n',d(2*i-1))
    fprintf('dy%g\t',i); fprintf('= %G\n',d(2*i))
    disp(' ')
end
disp('~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~')

disp('Support reactions :')
disp(' ')
for i=1:NC
    r=2*Cons(i,1);
    if Cons(i,2)==0
        fprintf('Rx%g\t',r/2); fprintf('= %G\n',W(r-1))
        fprintf('RY%g\t',r/2); fprintf('= %G\n',W(r))
    elseif Cons(i,2)==1
        fprintf('Rx%g\t',r/2); fprintf('= %G\n',W(r-1))
    else
        fprintf('Ry%g\t',r/2); fprintf('= %G\n',W(r))
    end
end
disp('~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~')

disp('Elements force :')
disp(' ')
for i=1:NE
    fprintf('P%g\t',i); fprintf('= %G\n',P(i))
end
disp('~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~')

disp('Elements stress :')
disp(' ')
for i=1:NE
    fprintf('Stress%g\t',i); fprintf('= %G\n',stress(i))
end
disp('~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~')

disp('Elements strain :')
disp(' ')
for i=1:NE
    fprintf('Strain%g\t',i); fprintf('= %G\n',strain(i))
end
disp('~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~')
disp('Finished!')
disp('Thank you for using of this Program')
```

Example 1 : Determine the reactions,nodal displacements,elements forces,elements stresses and straines for 2-D truss which is given then check the results with ANSYS software. ***(force unit is Kg and distance unit is Cm)***



Modulus of Elasticity (E) : 2.1E+6 kg/cm ^ 2

The area cross section for element number '15' is 20cm ^ 2 and for the others is 15cm ^ 2.

2D truss *analysis using stiffness method (matrix analysis)* *Page1/3*

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" Input Data in Excel "

% *Enter number of nodes :* *16*

% *Enter number of elements :* *29*

% *Please insert coordinates of the nodes,respect to nodes ID :*

ID	X	Y
1	0	0
2	250	0
3	250	125
4	500	0
5	500	250
6	750	0
7	750	375
8	1000	0
9	1000	500
10	1250	0
11	1250	375
12	1500	0
13	1500	250
14	1750	0
15	1750	125
16	2000	0

X : *horizontal coordinate*

Y : *vertical coordinate*

2D truss analysis using stiffness method (matrix analysis) Page2/3

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" Input Data in Excel "

% Please insert properties of the elements,respect to elements ID :

ID	E	A	Start	End
1	2.10E+06	15	1	2
2	2.10E+06	15	2	4
3	2.10E+06	15	4	6
4	2.10E+06	15	6	8
5	2.10E+06	15	8	10
6	2.10E+06	15	10	12
7	2.10E+06	15	12	14
8	2.10E+06	15	14	16
9	2.10E+06	15	2	3
10	2.10E+06	15	3	4
11	2.10E+06	15	4	5
12	2.10E+06	15	5	6
13	2.10E+06	15	6	7
14	2.10E+06	15	7	8
15	2.10E+06	20	8	9
16	2.10E+06	15	8	11
17	2.10E+06	15	10	11
18	2.10E+06	15	10	13
19	2.10E+06	15	12	13
20	2.10E+06	15	12	15
21	2.10E+06	15	14	15
22	2.10E+06	15	1	3
23	2.10E+06	15	3	5
24	2.10E+06	15	5	7
25	2.10E+06	15	7	9
26	2.10E+06	15	9	11
27	2.10E+06	15	11	13
28	2.10E+06	15	13	15
29	2.10E+06	15	15	16

E : *Modulus of elasticity*
A : *Area cross section*
Start : *start node of element*
End : *end node of element*

2D truss *analysis using stiffness method (matrix analysis)* *Page3/3*

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" Input Data in Excel "

% *Enter number of constrained nodes (number ofsupports) :* 2

ATTENTION :

< the code for constrained in X direction is '1' and in Y is '2' and for costrained in both directions is '0'>

ID	Relative Code
1	0
16	0

% *Enter number of nodes that loaded :* 7

ID	X-force	Y-force
3	0	-2400
5	0	-1500
7	0	-2100
11	0	-2100
13	0	-1500
15	0	-2400
9	0	-2500

X-force : *amount of concentrated force in X direction*

Y-force : *amount of concentrated force in Y direction*

Node displacement :			Elements force :			Elements stress :			Elements strain :		
dx1	=	0	P1	=	1650	Stress1	=	110	Strain1	=	5.23810E-05
dy1	=	0	P2	=	1650	Stress2	=	110	Strain2	=	5.23810E-05
dx2	=	0.0130952	P3	=	-750	Stress3	=	-50	Strain3	=	-2.38095E-05
dy2	=	-0.695788	P4	=	-2550	Stress4	=	-170	Strain4	=	-8.09524E-05
dx3	=	0.187066	P5	=	-2550	Stress5	=	-170	Strain5	=	-8.09524E-05
dy3	=	-0.695788	P6	=	-750	Stress6	=	-50	Strain6	=	-2.38095E-05
dx4	=	0.0261905	P7	=	1650	Stress7	=	110	Strain7	=	5.23810E-05
dy4	=	-0.964299	P8	=	1650	Stress8	=	110	Strain8	=	5.23810E-05
dx5	=	0.182351	P9	=	0	Stress9	=	0	Strain9	=	0.00000E+00
dy5	=	-0.954775	P10	=	-2683.28	Stress10	=	-178.885	Strain10	=	-8.51835E-05
dx6	=	0.0202381	P11	=	1200	Stress11	=	80	Strain11	=	3.80952E-05
dy6	=	-1.07648	P12	=	-2545.58	Stress12	=	-169.706	Strain12	=	-8.08122E-05
dx7	=	0.118246	P13	=	1800	Stress13	=	120	Strain13	=	5.71429E-05
dy7	=	-1.05505	P14	=	-3515.41	Stress14	=	-234.361	Strain14	=	-1.11600E-04
dx8	=	-3.50577E-16	P15	=	5850	Stress15	=	292.5	Strain15	=	1.39286E-04
dy8	=	-1.07343	P16	=	-3515.41	Stress16	=	-234.361	Strain16	=	-1.11600E-04
dx9	=	3.793E-16	P17	=	1800	Stress17	=	120	Strain17	=	5.71429E-05
dy9	=	-1.00379	P18	=	-2545.58	Stress18	=	-169.706	Strain18	=	-8.08122E-05
dx10	=	-0.0202381	P19	=	1200	Stress19	=	80	Strain19	=	3.80952E-05
dy10	=	-1.07648	P20	=	-2683.28	Stress20	=	-178.885	Strain20	=	-8.51835E-05
dx11	=	-0.118246	P21	=	0	Stress21	=	0	Strain21	=	0.00000E+00
dy11	=	-1.05505	P22	=	-16211.5	Stress22	=	-1080.77	Strain22	=	-5.14651E-04
dx12	=	-0.0261905	P23	=	-13528.2	Stress23	=	-901.881	Strain23	=	-4.29467E-04
dy12	=	-0.964299	P24	=	-11515.8	Stress24	=	-767.717	Strain24	=	-3.65579E-04
dx13	=	-0.182351	P25	=	-9335.58	Stress25	=	-622.372	Strain25	=	-2.96368E-04
dy13	=	-0.954775	P26	=	-9335.58	Stress26	=	-622.372	Strain26	=	-2.96368E-04
dx14	=	-0.0130952	P27	=	-11515.8	Stress27	=	-767.717	Strain27	=	-3.65579E-04
dy14	=	-0.695788	P28	=	-13528.2	Stress28	=	-901.881	Strain28	=	-4.29467E-04
dx15	=	-0.187066	P29	=	-16211.5	Stress29	=	-1080.77	Strain29	=	-5.14651E-04
dy15	=	-0.695788									
dx16	=	0									
dy16	=	0									

PRINT U NODAL SOLUTION PER NODE

***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

LOAD STEP= 1 SUBSTEP= 1
TIME= 1.0000 LOAD CASE= 0

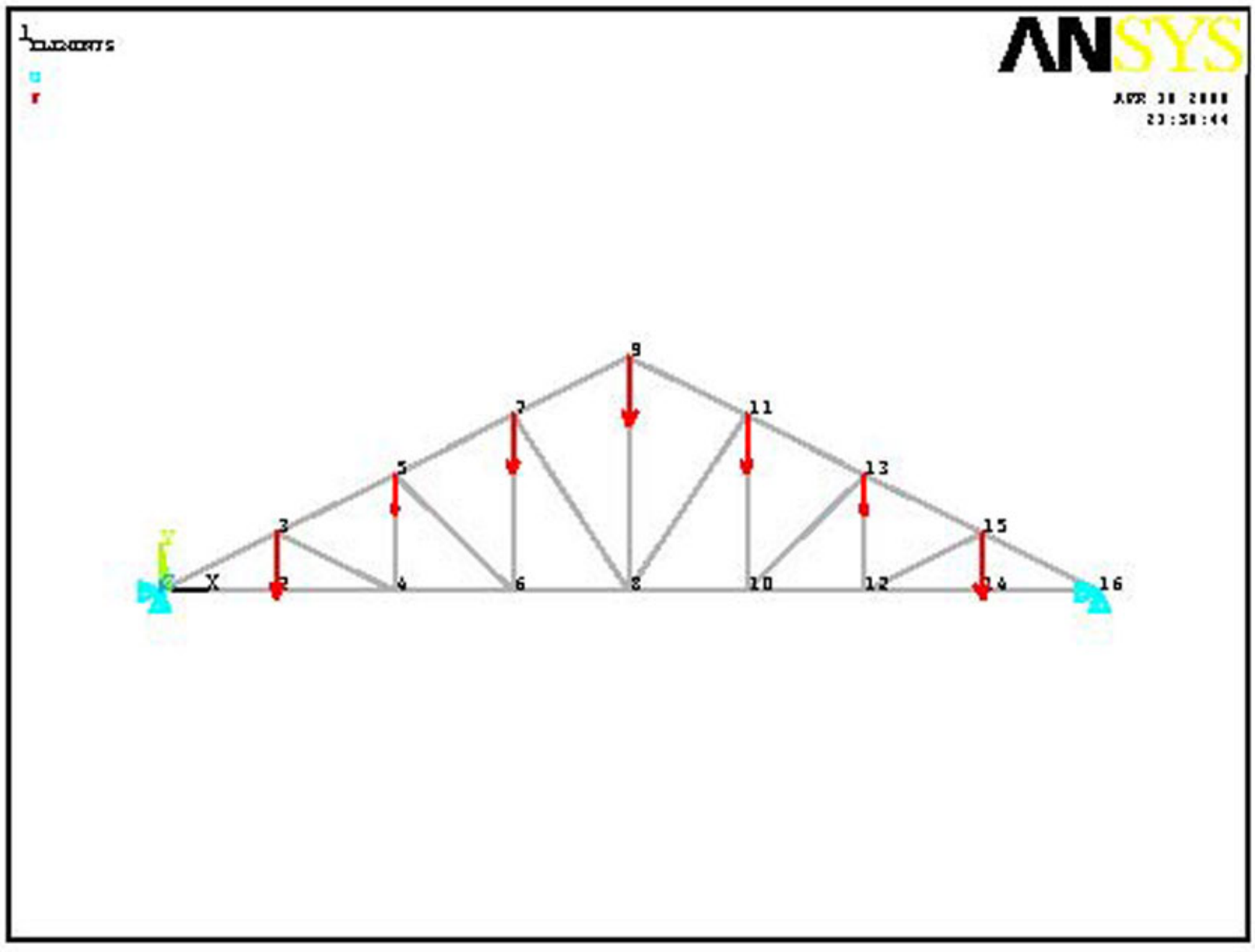
THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN THE GLOBAL COORDINATE SYSTEM

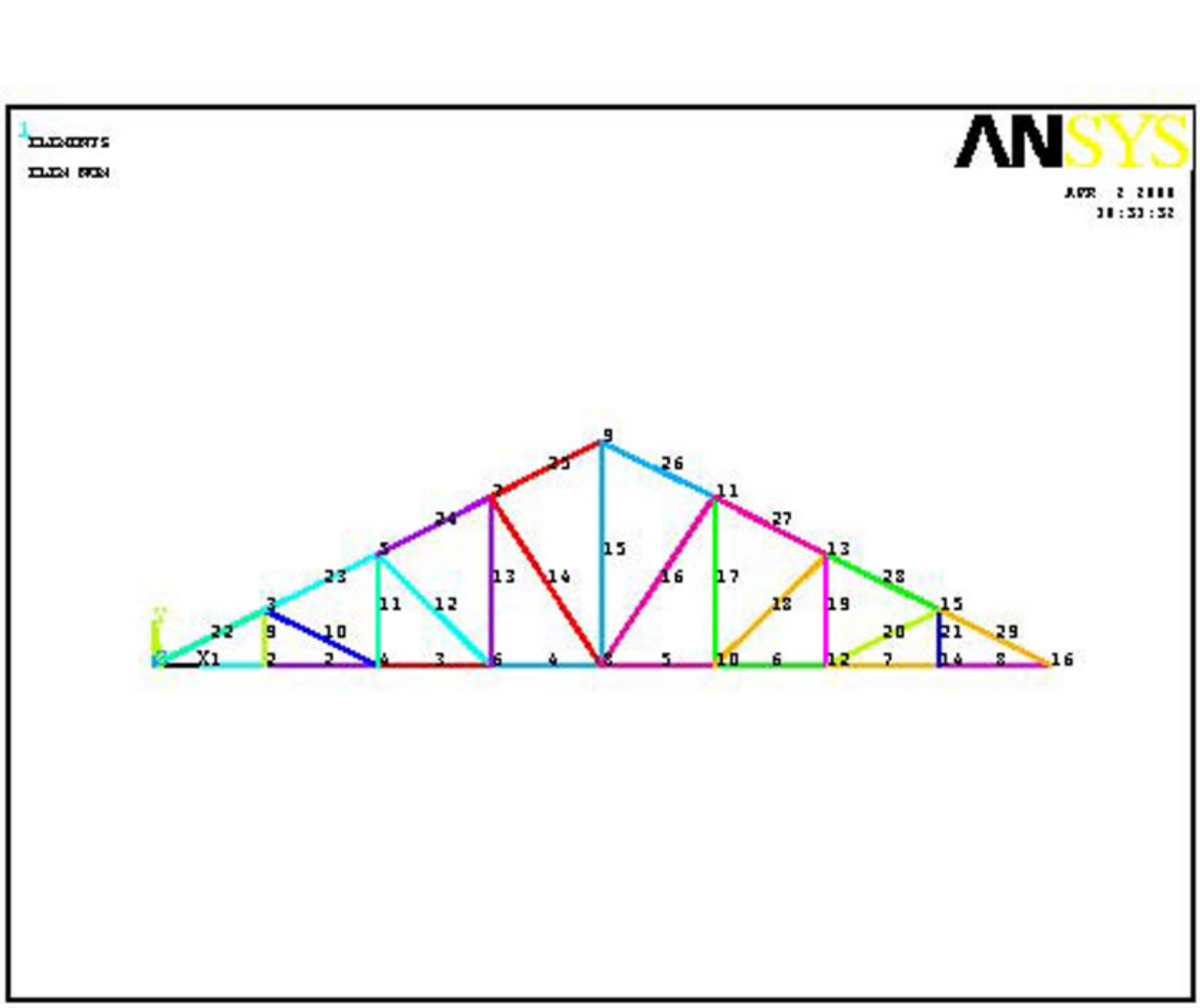
NODE	UX	UY	UZ	USUM
1	0.0000	0.0000	0.0000	0.0000
2	0.13095E-01	-0.69579	0.0000	0.69591
3	0.18707	-0.69579	0.0000	0.72050
4	0.26190E-01	-0.96430	0.0000	0.96465
5	0.18235	-0.95477	0.0000	0.97203
6	0.20238E-01	-1.0765	0.0000	1.0767
7	0.11825	-1.0551	0.0000	1.0617
8	-0.91990E-16	-1.0734	0.0000	1.0734
9	0.21756E-16	-1.0038	0.0000	1.0038
10	-0.20238E-01	-1.0765	0.0000	1.0767
11	-0.11825	-1.0551	0.0000	1.0617
12	-0.26190E-01	-0.96430	0.0000	0.96465
13	-0.18235	-0.95477	0.0000	0.97203
14	-0.13095E-01	-0.69579	0.0000	0.69591
15	-0.18707	-0.69579	0.0000	0.72050
16	0.0000	0.0000	0.0000	0.0000

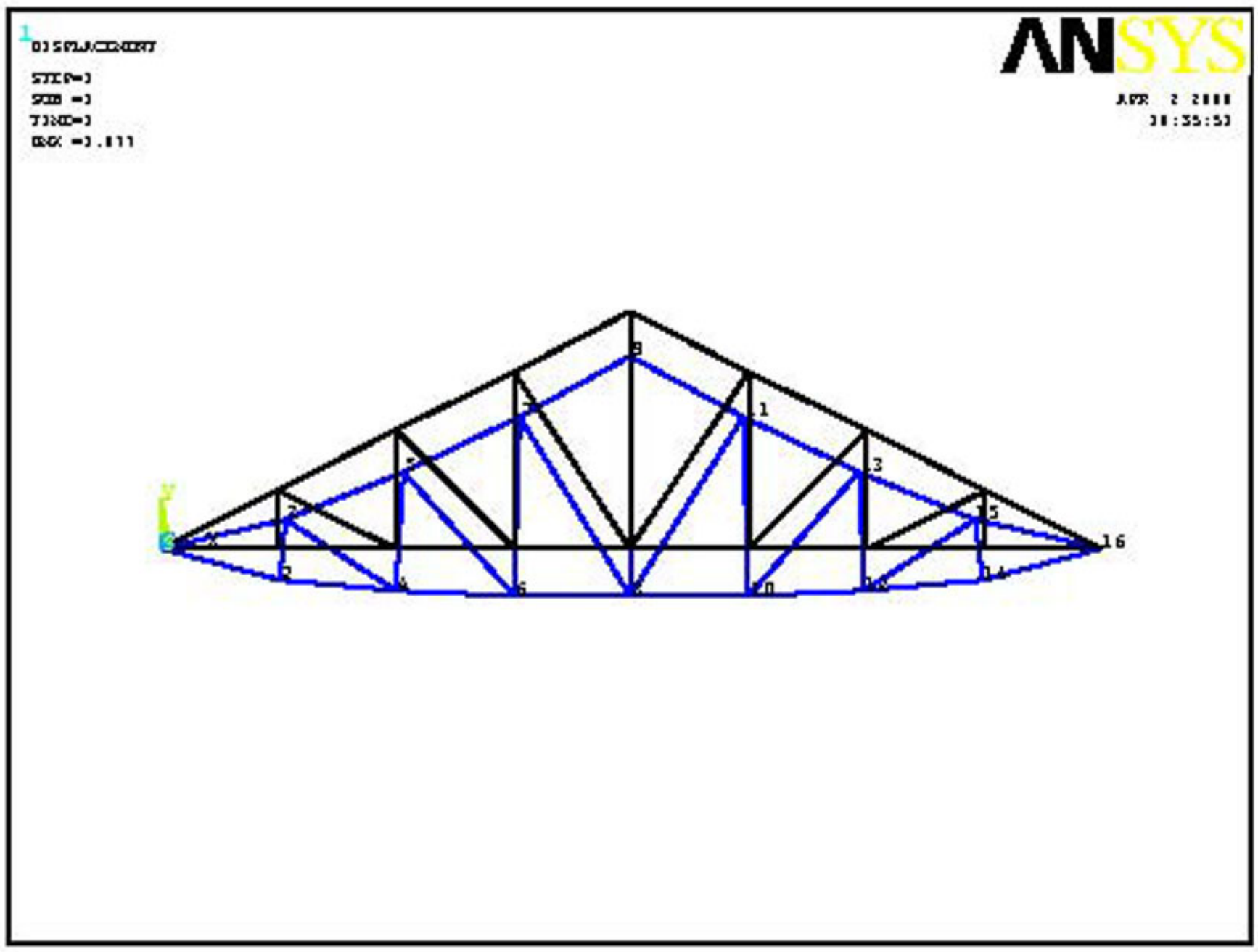
PRINT ELEMENT TABLE ITEMS PER ELEMENT

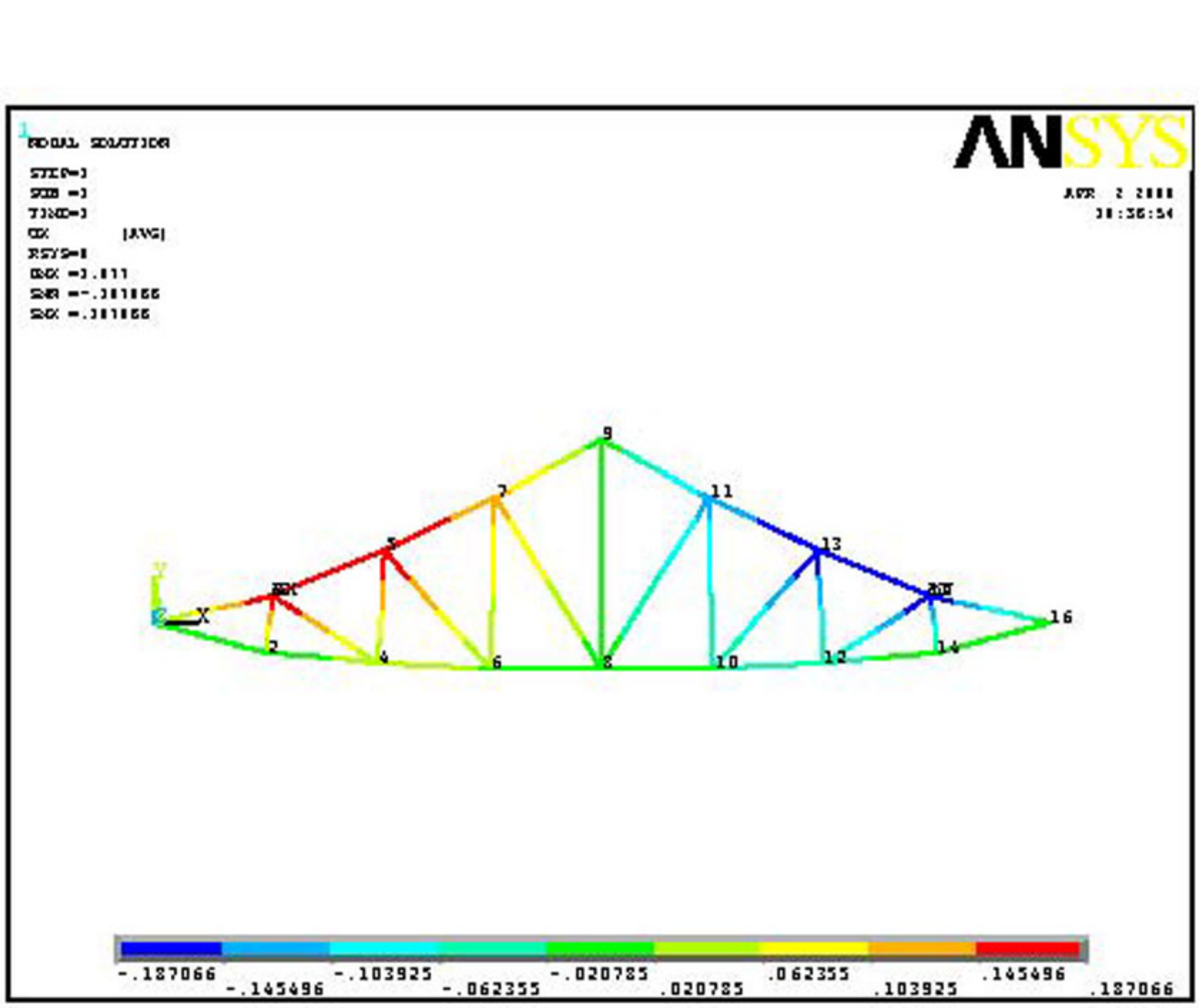
***** POST1 ELEMENT TABLE LISTING *****

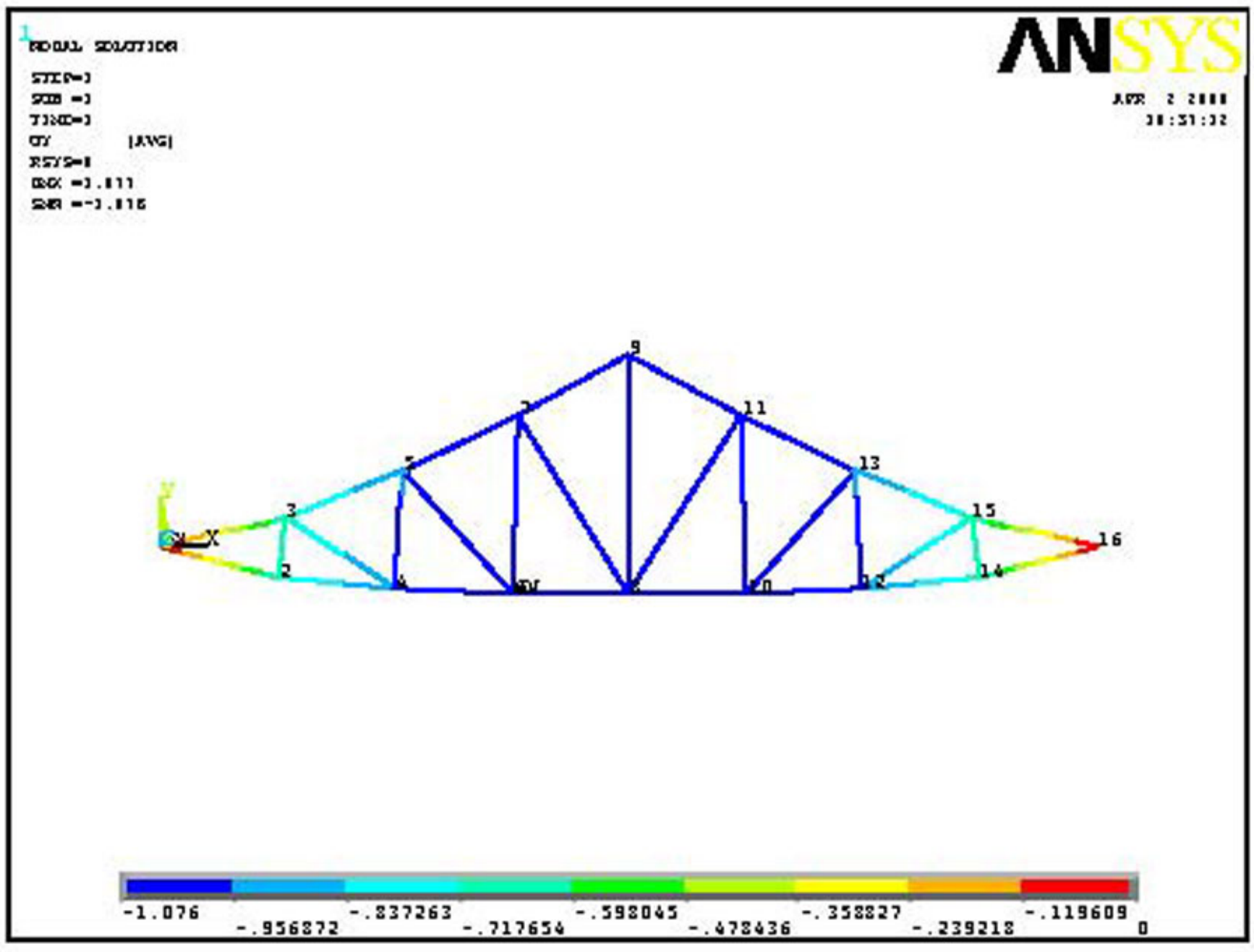
STAT ELEM	CURRENT AXFORCE	CURRENT AXSTRESS	CURRENT AXSTRAIN
1	1650.0	110.00	0.52381E-04
2	1650.0	110.00	0.52381E-04
3	-750.00	-50.000	-0.23810E-04
4	-2550.0	-170.00	-0.80952E-04
5	-2550.0	-170.00	-0.80952E-04
6	-750.00	-50.000	-0.23810E-04
7	1650.0	110.00	0.52381E-04
8	1650.0	110.00	0.52381E-04
9	0.0000	0.0000	0.0000
10	-2683.3	-178.89	-0.85184E-04
11	1200.0	80.000	0.38095E-04
12	-2545.6	-169.71	-0.80812E-04
13	1800.0	120.00	0.57143E-04
14	-3515.4	-234.36	-0.11160E-03
15	5850.0	292.50	0.13929E-03
16	-3515.4	-234.36	-0.11160E-03
17	1800.0	120.00	0.57143E-04
18	-2545.6	-169.71	-0.80812E-04
19	1200.0	80.000	0.38095E-04
20	-2683.3	-178.89	-0.85184E-04
21	0.0000	0.0000	0.0000
22	-16211.	-1080.8	-0.51465E-03
23	-13528.	-901.88	-0.42947E-03
24	-11516.	-767.72	-0.36558E-03
25	-9335.6	-622.37	-0.29637E-03
26	-9335.6	-622.37	-0.29637E-03
27	-11516.	-767.72	-0.36558E-03
28	-13528.	-901.88	-0.42947E-03
29	-16211.	-1080.8	-0.51465E-03

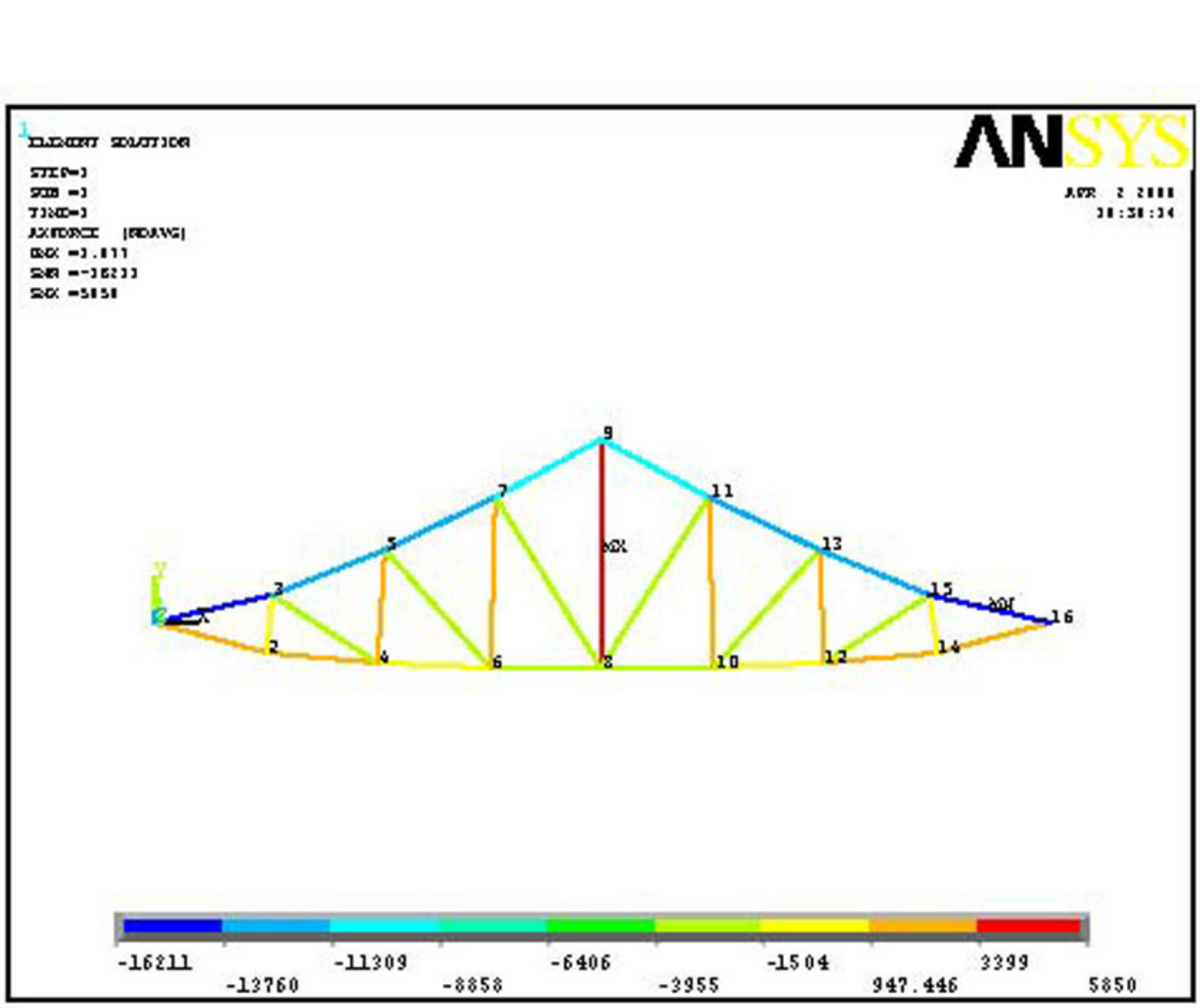

ELEMENTS
ANSYS
1
3
5
7
9
11
13
15
2
4
6
8
10
12
14
16
X

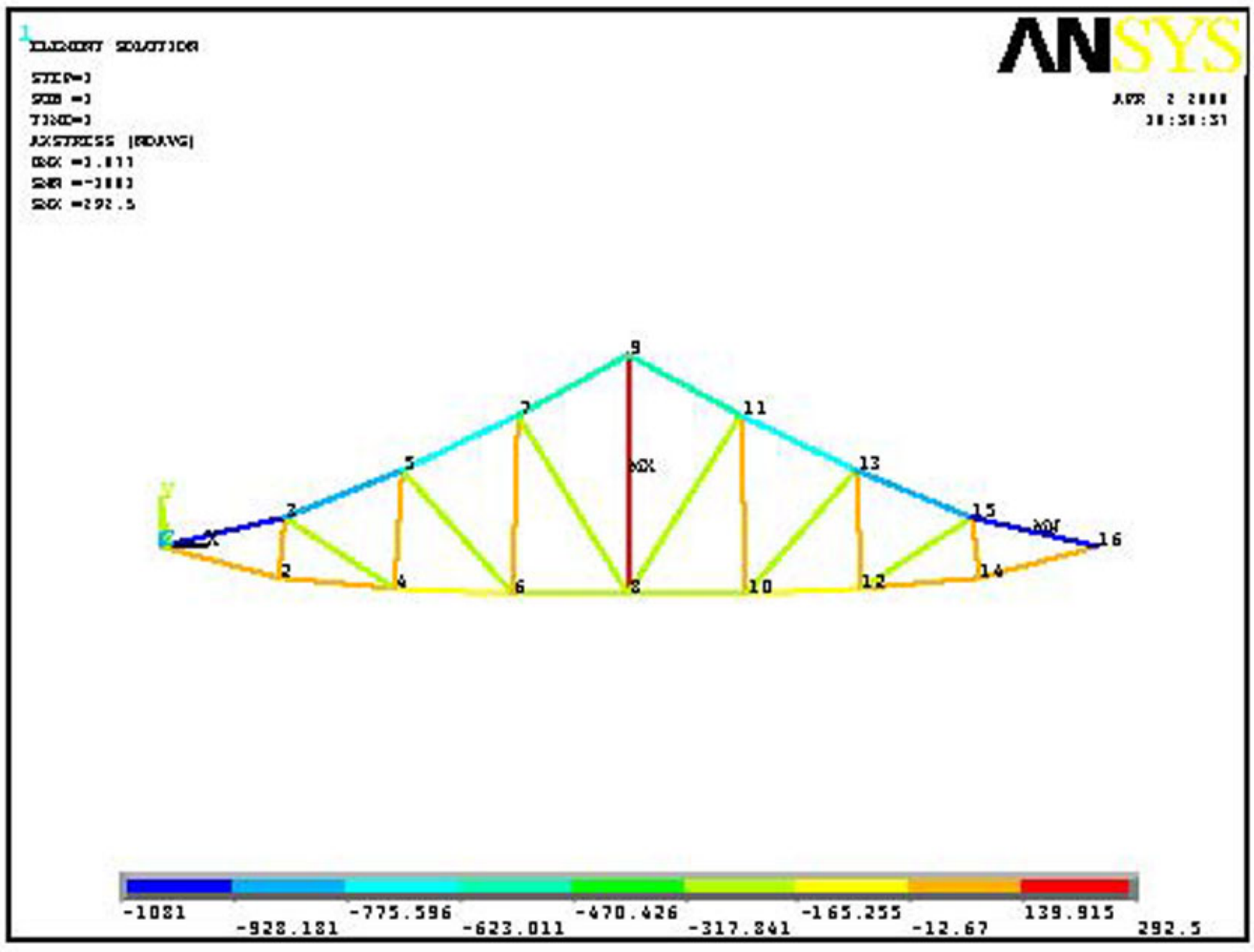

ELEMENTS
ANSYS
1
9
25
26
2
11
24
27
5
15
13
23
13
14
16
17
28
3
11
12
18
19
15
22
9
10
20
21
29
X1
2
2
4
3
6
4
8
5
10
6
12
7
14
8
16

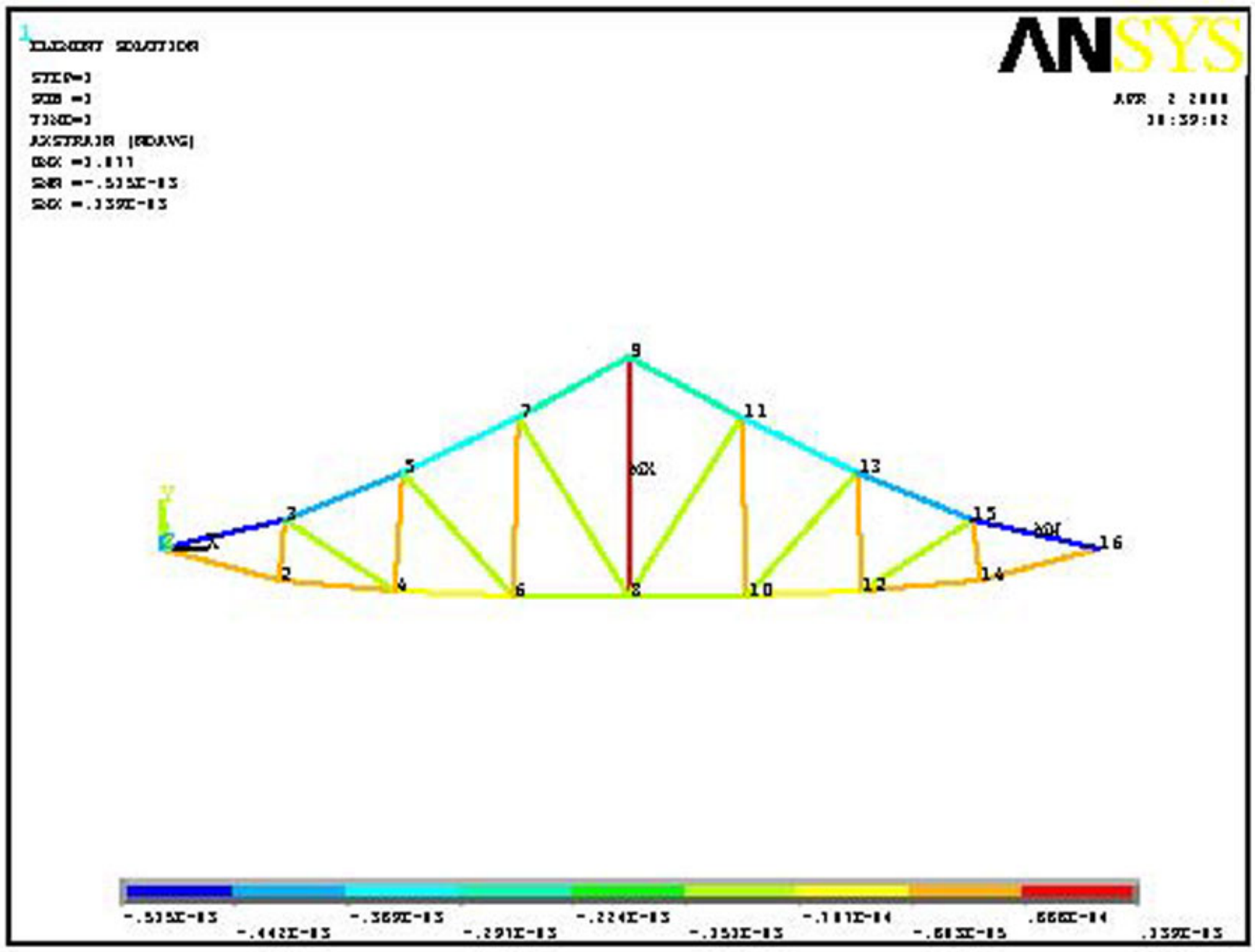

ANSYS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
16


ANSYS
1
2
4
6
8
9
10
11
12
13
14
16
X
-.187066
-.145496
-.103925
-.062355
-.020785
.020785
.062355
.103925
.145496
.187066

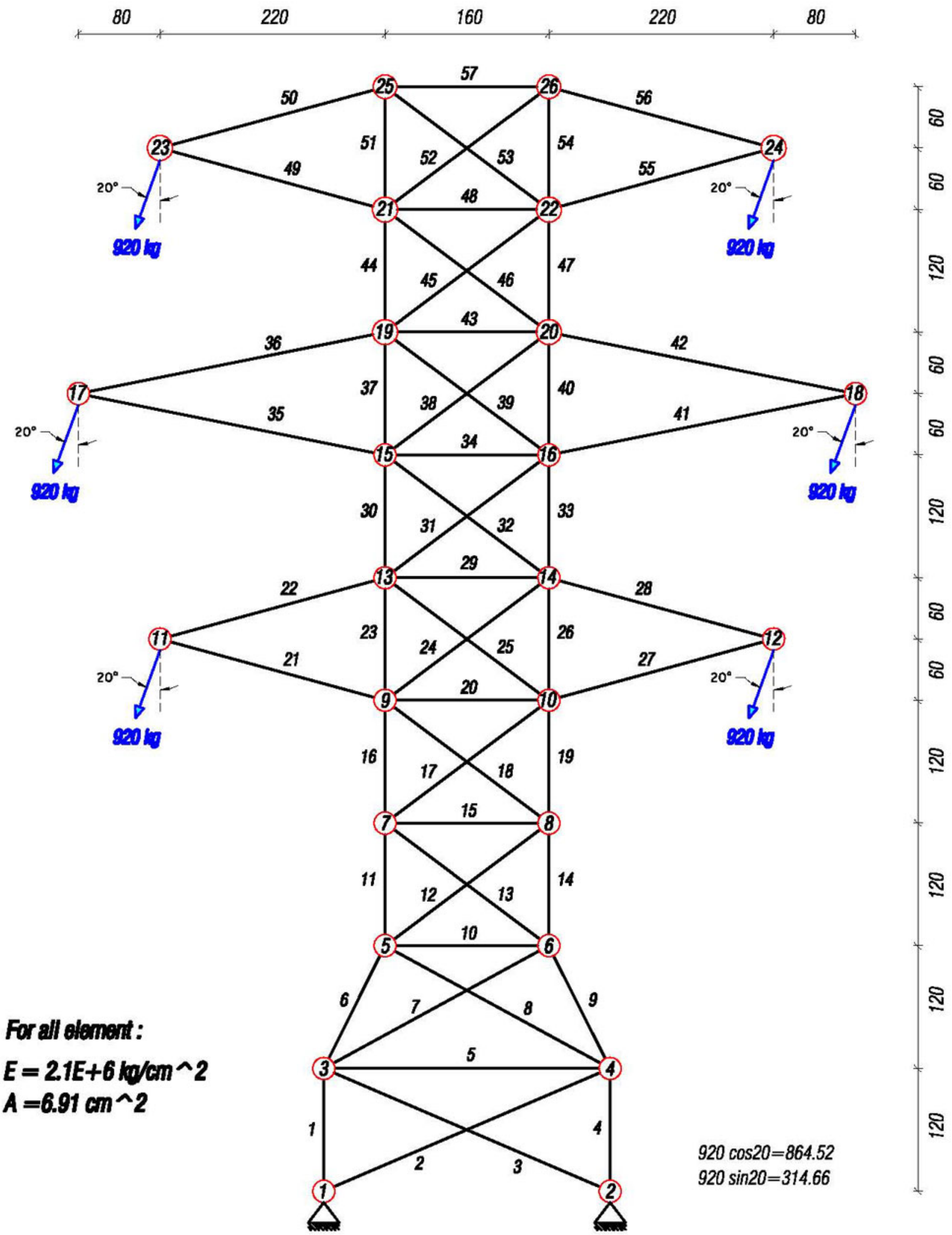

NODAL SOLUTION
ANSYS
-1.076
-.956872
-.837263
-.717654
-.598045
-.478436
-.358827
-.239218
-.119609
0


ELEMENT SOLUTION
ANSYS
-16211
-13760
-11309
-8858
-6406
-3955
-1504
947.446
3399
5850


ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
AXSTRESS (AVG)
DMX =1.811
SMN =-1081
SMX =292.5
ANSYS
APR 2 2008
18:38:31
MX
MN
-1081
-928.181
-775.596
-623.011
-470.426
-317.841
-165.255
-12.67
139.915
292.5


ELEMENT SOLUTION
STEP=1
SUB =1
TIME=1
AXSTRAIN (AVG)
DMX =1.811
SMN =-.535E-03
SMX =.133E-03
ANSYS
APR 2 2008
18:39:02
MX
MN
-.535E-03
-.442E-03
-.369E-03
-.291E-03
-.224E-03
-.153E-03
-.811E-04
-.68E-05
.666E-04
.133E-03

Example 2 : Determine the reactions, nodal displacements,elements forces, elements stresses and straines for 2-D truss which is given then check the results with ANSYS software. (force unit is Kg and distance unit is Cm)



For all element :

E = 2.1E+6 kg/cm^2

A =6.91 cm^2

920 cos20=864.52

920 sin20=314.66

2D truss *analysis using stiffness method (matrix analysis)* *Page1/3*

Written by : " ***Sobhan Rostami & Ali Moeinadini*** "

M.Sc. students of structural engineering of Azad university of Kerman-Iran

E-mail : info@newcivil.com

" Input Data in Excel "

% *Enter number of nodes :* 26

% *Enter number of elements :* 57

% *Please insert coordinates of the nodes,respect to nodes ID :*

ID	*X*	*Y*
1	220	0
2	540	0
3	220	120
4	540	120
5	300	240
6	460	240
7	300	360
8	460	360
9	300	480
10	460	480
11	80	540
12	680	540
13	300	600
14	460	600
15	300	720
16	460	720
17	0	780
18	760	780
19	300	840
20	460	840
21	300	960
22	460	960
23	80	1020
24	680	1020
25	300	1080
26	460	1080

X : *horizontal coordinate*

Y : *vertical coordinate*

2D truss *analysis using stiffness method (matrix analysis)* *Page2/3*

Written by : " ***Sobhan Rostami & Ali Moeinadini*** "

M.Sc. students of structural engineering of Azad university of Kerman-Iran

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" Input Data in Excel "

% *Please insert properties of the elements,respect to elements ID :*

ID	E	A	Start	End
1	2.10E+06	6.91	1	3
2	2.10E+06	6.91	1	4
3	2.10E+06	6.91	2	3
4	2.10E+06	6.91	2	4
5	2.10E+06	6.91	3	4
6	2.10E+06	6.91	3	5
7	2.10E+06	6.91	3	6
8	2.10E+06	6.91	4	5
9	2.10E+06	6.91	4	6
10	2.10E+06	6.91	5	6
11	2.10E+06	6.91	5	7
12	2.10E+06	6.91	5	8
13	2.10E+06	6.91	6	7
14	2.10E+06	6.91	6	8
15	2.10E+06	6.91	7	8
16	2.10E+06	6.91	7	9
17	2.10E+06	6.91	7	10
18	2.10E+06	6.91	8	9
19	2.10E+06	6.91	8	10
20	2.10E+06	6.91	9	10
21	2.10E+06	6.91	9	11
22	2.10E+06	6.91	11	13
23	2.10E+06	6.91	9	13
24	2.10E+06	6.91	9	14
25	2.10E+06	6.91	10	13
26	2.10E+06	6.91	10	14
27	2.10E+06	6.91	10	12
28	2.10E+06	6.91	12	14
29	2.10E+06	6.91	13	14
30	2.10E+06	6.91	13	15
31	2.10E+06	6.91	13	16
32	2.10E+06	6.91	14	15
33	2.10E+06	6.91	14	16
34	2.10E+06	6.91	15	16
35	2.10E+06	6.91	15	17
36	2.10E+06	6.91	17	19
37	2.10E+06	6.91	15	19
38	2.10E+06	6.91	15	20
39	2.10E+06	6.91	16	19
40	2.10E+06	6.91	16	20
41	2.10E+06	6.91	16	18
42	2.10E+06	6.91	18	20

E : *Modulus of elasticity*

A : *Area cross section*

Start : *start node of element*

End : *end node of element*

2D truss analysis using stiffness method (matrix analysis) — *Page3/3*

*Written by : " **Sobhan Rostami & Ali Moeinadini** "*
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" Input Data in Excel "

% Enter number of constrained nodes (number ofsupports) : *2*

ATTENTION :
< the code for constrained in X direction is '1' and in Y is '2' and for costrained in both directions is '0'>

ID	***Relative Code***
1	*0*
2	*0*

% Enter number of nodes that loaded : *6*

ID	***X-force***	***Y-force***
11	*-314.66*	*-864.52*
12	*-314.66*	*-864.52*
17	*-314.66*	*-864.52*
18	*-314.66*	*-864.52*
23	*-314.66*	*-864.52*
24	*-314.66*	*-864.52*

X-force : *amount of concentrated force in X direction*
Y-force : *amount of concentrated force in Y direction*

Node displacement :			Elements force :			Elements stress :			Elements strain :		
dx1	=	0	P1	=	-6977.02	Stress1	=	-1009.7	Strain1	=	-4.80809E-04
dy1	=	0	P2	=	-622.132	Stress2	=	-90.0336	Strain2	=	-4.28731E-05
dx2	=	0	P3	=	1394.21	Stress3	=	201.767	Strain3	=	9.60795E-05
dy2	=	0	P4	=	1518.8	Stress4	=	219.798	Strain4	=	1.04666E-04
dx3	=	-0.0567054	P5	=	1648.21	Stress5	=	238.526	Strain5	=	1.13584E-04
dy3	=	-0.0576971	P6	=	-9033.08	Stress6	=	-1307.25	Strain6	=	-6.22499E-04
dx4	=	-0.0203586	P7	=	2299.79	Stress7	=	332.821	Strain7	=	1.58486E-04
dy4	=	0.0125599	P8	=	-3241.06	Stress8	=	-469.04	Strain8	=	-2.23352E-04
dx5	=	-0.0459999	P9	=	3304.85	Stress9	=	478.271	Strain9	=	2.27748E-04
dy5	=	-0.172734	P10	=	-644.781	Stress10	=	-93.3113	Strain10	=	-4.44339E-05
dx6	=	-0.0531093	P11	=	-7865.19	Stress11	=	-1138.23	Strain11	=	-5.42016E-04
dy6	=	0.0302025	P12	=	-1833.72	Stress12	=	-265.372	Strain12	=	-1.26367E-04
dx7	=	-0.263159	P13	=	526.232	Stress13	=	76.1551	Strain13	=	3.62643E-05
dy7	=	-0.237776	P14	=	3462.57	Stress14	=	501.095	Strain14	=	2.38617E-04
dx8	=	-0.25127	P15	=	1078.31	Stress15	=	156.051	Strain15	=	7.43099E-05
dy8	=	0.0588365	P16	=	-6424.98	Stress16	=	-929.809	Strain16	=	-4.42766E-04
dx9	=	-0.521948	P17	=	-1874.12	Stress17	=	-271.219	Strain17	=	-1.29152E-04
dy9	=	-0.290908	P18	=	485.829	Stress18	=	70.3081	Strain18	=	3.34800E-05
dx10	=	-0.53075	P19	=	2070.84	Stress19	=	299.687	Strain19	=	1.42708E-04
dy10	=	0.0759614	P20	=	-798.311	Stress20	=	-115.53	Strain20	=	-5.50142E-05
dx11	=	-0.693623	P21	=	-1479.76	Stress21	=	-214.148	Strain21	=	-1.01975E-04
dy11	=	-1.00876	P22	=	1805.92	Stress22	=	261.348	Strain22	=	1.24452E-04
dx12	=	-0.681792	P23	=	-4980.65	Stress23	=	-720.789	Strain23	=	-3.43233E-04
dy12	=	0.521926	P24	=	-1272.47	Stress24	=	-184.149	Strain24	=	-8.76899E-05
dx13	=	-0.848752	P25	=	694.156	Stress25	=	100.457	Strain25	=	4.78365E-05
dy13	=	-0.332096	P26	=	1005.04	Stress26	=	145.447	Strain26	=	6.92605E-05
dx14	=	-0.825256	P27	=	-1805.92	Stress27	=	-261.348	Strain27	=	-1.24452E-04
dy14	=	0.0842727	P28	=	1479.76	Stress28	=	214.148	Strain28	=	1.01975E-04
dx15	=	-1.16528	P29	=	2130.98	Stress29	=	308.391	Strain29	=	1.46853E-04
dy15	=	-0.360055	P30	=	-3380.97	Stress30	=	-489.287	Strain30	=	-2.32994E-04
dx16	=	-1.18381	P31	=	-1180.03	Stress31	=	-170.771	Strain31	=	-8.13195E-05
dy16	=	0.0875387	P32	=	393.273	Stress32	=	56.9136	Strain32	=	2.71017E-05
dx17	=	-1.35803	P33	=	394.946	Stress33	=	57.1557	Strain33	=	2.72170E-05
dy17	=	-1.54355	P34	=	-1680.64	Stress34	=	-243.219	Strain34	=	-1.15818E-04
dx18	=	-1.3524	P35	=	-2043.66	Stress35	=	-295.753	Strain35	=	-1.40835E-04
dy18	=	0.676295	P36	=	2364.55	Stress36	=	342.192	Strain36	=	1.62949E-04
dx19	=	-1.54015	P37	=	-2265.76	Stress37	=	-327.895	Strain37	=	-1.56141E-04
dy19	=	-0.378792	P38	=	-797.433	Stress38	=	-115.403	Strain38	=	-5.49537E-05
dx20	=	-1.51422	P39	=	382.542	Stress39	=	55.3606	Strain39	=	2.63622E-05
dy20	=	0.0868865	P40	=	-78.869	Stress40	=	-11.4138	Strain40	=	-5.43512E-06
dx21	=	-1.87792	P41	=	-2364.55	Stress41	=	-342.192	Strain41	=	-1.62949E-04
dy21	=	-0.389696	P42	=	2043.66	Stress42	=	295.753	Strain42	=	1.40835E-04
dx22	=	-1.89437	P43	=	2351.23	Stress43	=	340.264	Strain43	=	1.62031E-04
dy22	=	0.0837891	P44	=	-1318.53	Stress44	=	-190.815	Strain44	=	-9.08644E-05
dx23	=	-2.06961	P45	=	-423.286	Stress45	=	-61.257	Strain45	=	-2.91700E-05
dy23	=	-1.18093	P46	=	363.364	Stress46	=	52.5852	Strain46	=	2.50406E-05
dx24	=	-2.06786	P47	=	-374.553	Stress47	=	-54.2045	Strain47	=	-2.58117E-05
dy24	=	0.612047	P48	=	-1492.49	Stress48	=	-215.99	Strain48	=	-1.02852E-04

PRINT U NODAL SOLUTION PER NODE

***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

LOAD STEP= 0 SUBSTEP= 1
TIME= 2.0000 LOAD CASE= 0

THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN THE GLOBAL COORDINATE SYSTEM

NODE	UX	UY	UZ	USUM
1	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000
3	-0.56705E-01	-0.57697E-01	0.0000	0.80898E-01
4	-0.20359E-01	0.12560E-01	0.0000	0.23921E-01
5	-0.46000E-01	-0.17273	0.0000	0.17875
6	-0.53109E-01	0.30202E-01	0.0000	0.61097E-01
7	-0.26316	-0.23778	0.0000	0.35467
8	-0.25127	0.58836E-01	0.0000	0.25807
9	-0.52195	-0.29091	0.0000	0.59754
10	-0.53075	0.75961E-01	0.0000	0.53616
11	-0.69362	-1.0088	0.0000	1.2242
12	-0.68179	0.52193	0.0000	0.85863
13	-0.84875	-0.33210	0.0000	0.91141
14	-0.82526	0.84273E-01	0.0000	0.82955
15	-1.1653	-0.36005	0.0000	1.2196
16	-1.1838	0.87539E-01	0.0000	1.1870
17	-1.3580	-1.5435	0.0000	2.0559
18	-1.3524	0.67630	0.0000	1.5121
19	-1.5401	-0.37879	0.0000	1.5860
20	-1.5142	0.86887E-01	0.0000	1.5167
21	-1.8779	-0.38970	0.0000	1.9179
22	-1.8944	0.83789E-01	0.0000	1.8962
23	-2.0696	-1.1809	0.0000	2.3828
24	-2.0679	0.61205	0.0000	2.1565
25	-2.2548	-0.39418	0.0000	2.2890
26	-2.2365	0.81970E-01	0.0000	2.2380

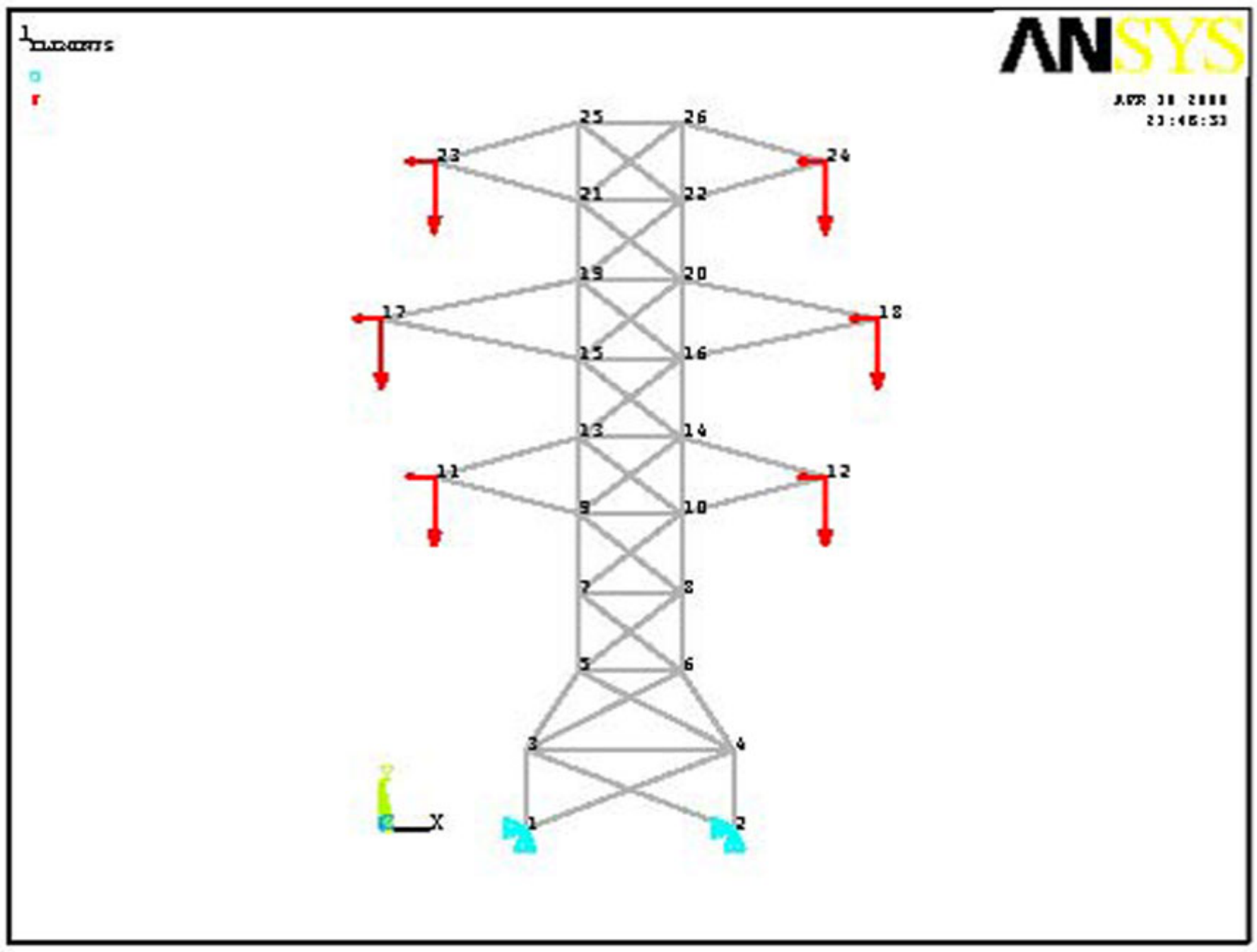
MAXIMUM ABSOLUTE VALUES

NODE	25	17	0	23
VALUE	-2.2548	-1.5435	0.0000	2.3828

PRINT ELEMENT TABLE ITEMS PER ELEMENT

***** POST1 ELEMENT TABLE LISTING *****

STAT ELEM	CURRENT AXFORCE	CURRENT AXSTRESS	CURRENT AXSTRAIN
1	-6977.0	-1009.7	-0.48081E-03
2	-622.13	-90.034	-0.42873E-04
3	1394.2	201.77	0.96080E-04
4	1518.8	219.80	0.10467E-03
5	1648.2	238.53	0.11358E-03
6	-9033.1	-1307.2	-0.62250E-03
7	2299.8	332.82	0.15849E-03
8	-3241.1	-469.04	-0.22335E-03
9	3304.9	478.27	0.22775E-03
10	-644.78	-93.311	-0.44434E-04
11	-7865.2	-1138.2	-0.54202E-03
12	-1833.7	-265.37	-0.12637E-03
13	526.23	76.155	0.36264E-04
14	3462.6	501.09	0.23862E-03
15	1078.3	156.05	0.74310E-04
16	-6425.0	-929.81	-0.44277E-03
17	-1874.1	-271.22	-0.12915E-03
18	485.83	70.308	0.33480E-04
19	2070.8	299.69	0.14271E-03
20	-798.31	-115.53	-0.55014E-04
21	-1479.8	-214.15	-0.10198E-03
22	1805.9	261.35	0.12445E-03
23	-4980.7	-720.79	-0.34323E-03
24	-1272.5	-184.15	-0.87690E-04
25	694.16	100.46	0.47837E-04
26	1005.0	145.45	0.69261E-04
27	-1805.9	-261.35	-0.12445E-03
28	1479.8	214.15	0.10198E-03
29	2131.0	308.39	0.14685E-03
30	-3381.0	-489.29	-0.23299E-03
31	-1180.0	-170.77	-0.81319E-04
32	393.27	56.914	0.27102E-04
33	394.95	57.156	0.27217E-04
34	-1680.6	-243.22	-0.11582E-03
35	-2043.7	-295.75	-0.14083E-03
36	2364.5	342.19	0.16295E-03
37	-2265.8	-327.90	-0.15614E-03
38	-797.43	-115.40	-0.54954E-04
39	382.54	55.361	0.26362E-04
40	-78.869	-11.414	-0.54351E-05
41	-2364.5	-342.19	-0.16295E-03
42	2043.7	295.75	0.14083E-03
43	2351.2	340.26	0.16203E-03
44	-1318.5	-190.82	-0.90864E-04
45	-423.29	-61.257	-0.29170E-04
46	363.36	52.585	0.25041E-04
47	-374.55	-54.205	-0.25812E-04
48	-1492.5	-215.99	-0.10285E-03
49	-1479.8	-214.15	-0.10198E-03
50	1805.9	261.35	0.12445E-03
51	-541.80	-78.408	-0.37337E-04
52	-282.28	-40.851	-0.19453E-04
53	111.05	16.070	0.76526E-05
54	-219.99	-31.836	-0.15160E-04
55	-1805.9	-261.35	-0.12445E-03
56	1479.8	214.15	0.10198E-03
57	1653.4	239.28	0.11394E-03


ELEMENTS
ANSYS
25
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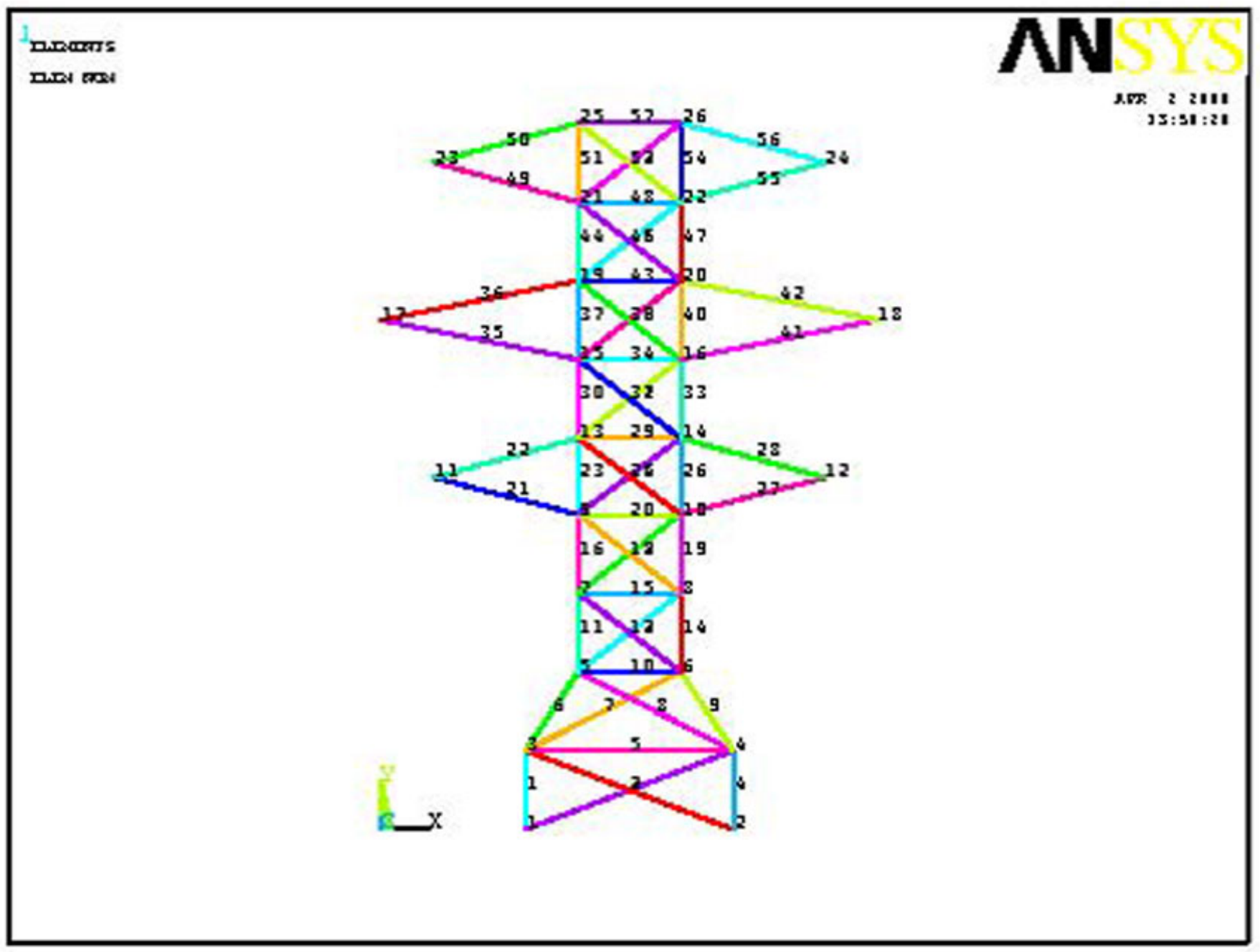
Z
X


ELEMENTS
ELEM NUM
ANSYS
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4
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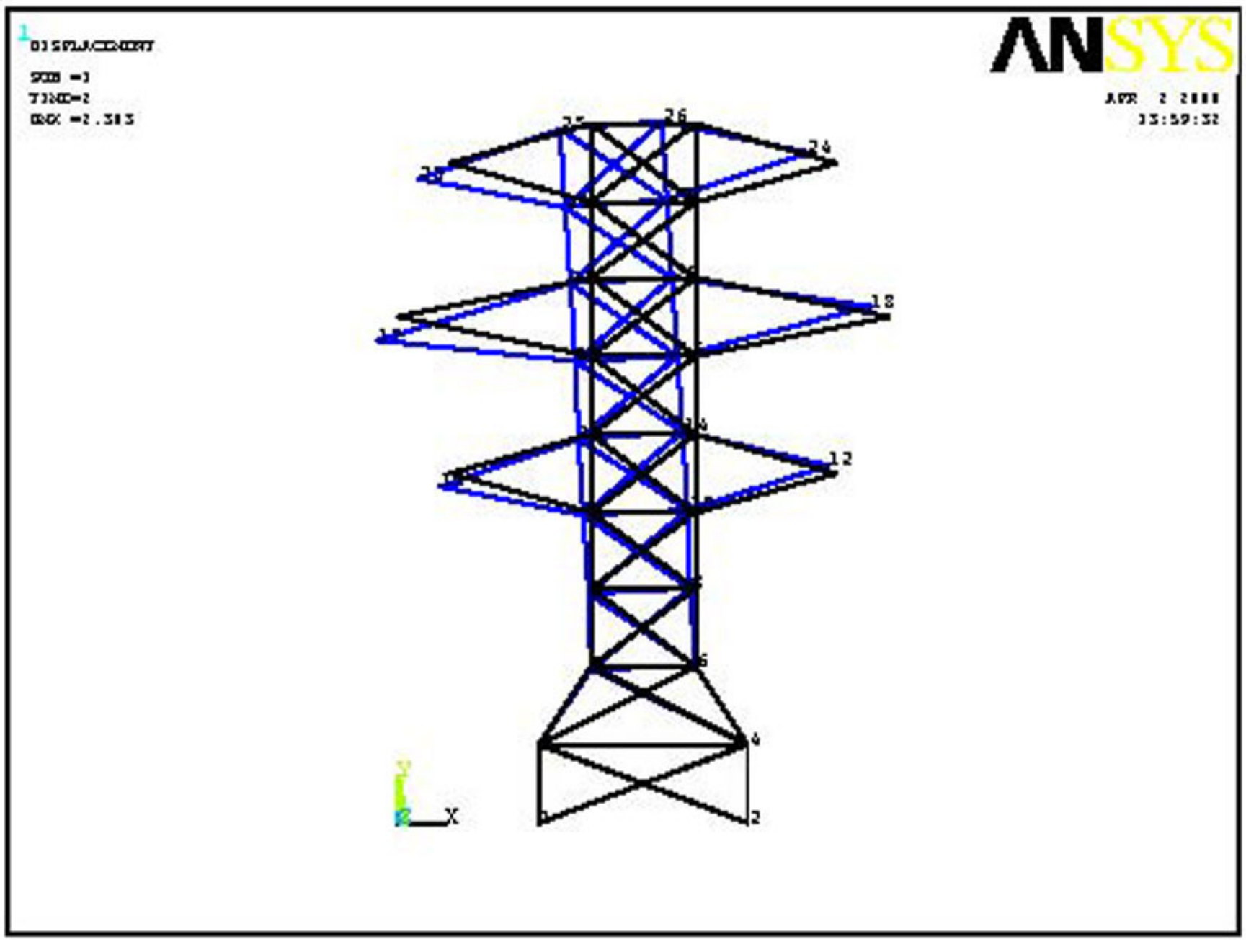
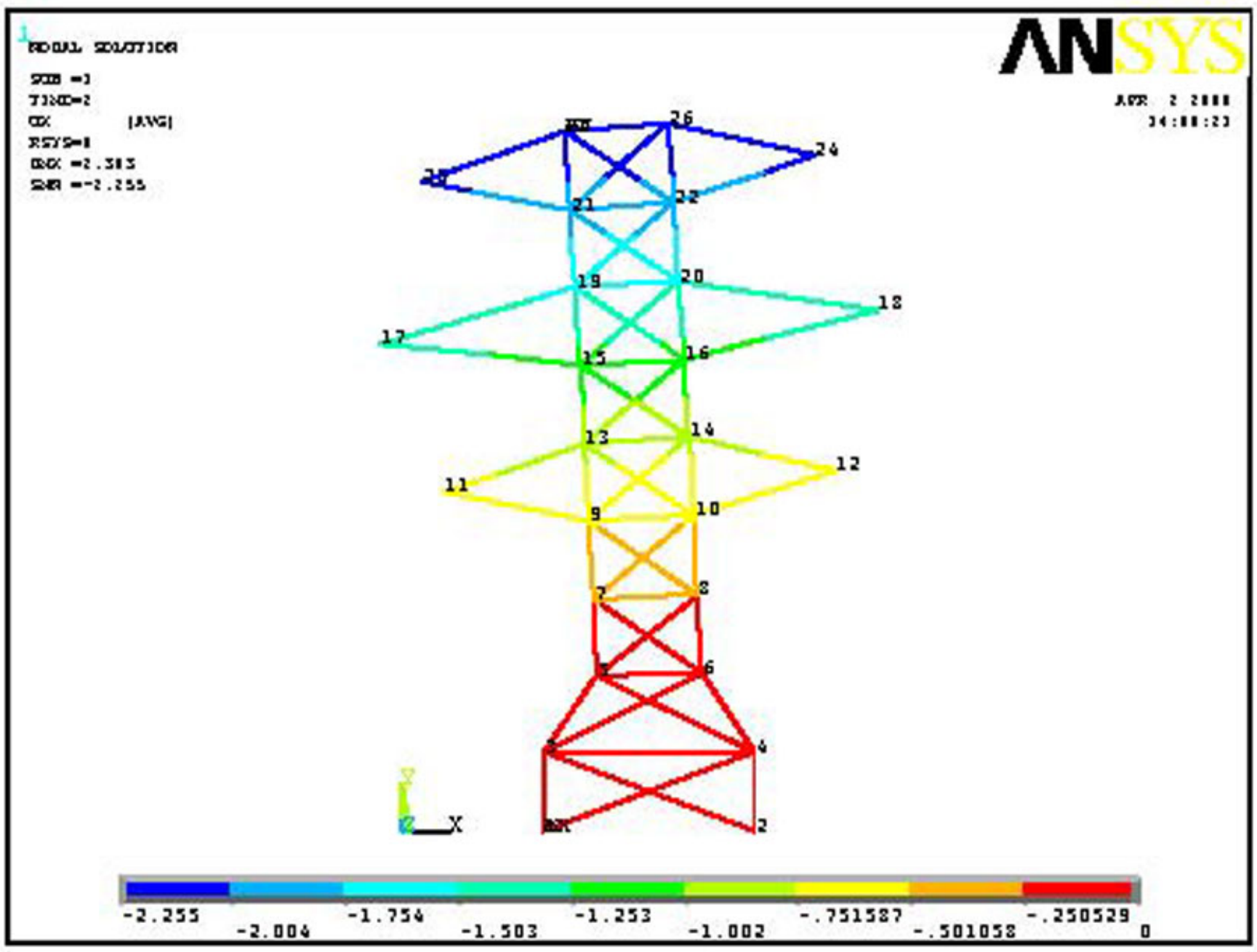
2
Y
X


ANSYS
26
24
18
12
6
4
2
X


ANSYS
26
24
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14
12
11
9
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7
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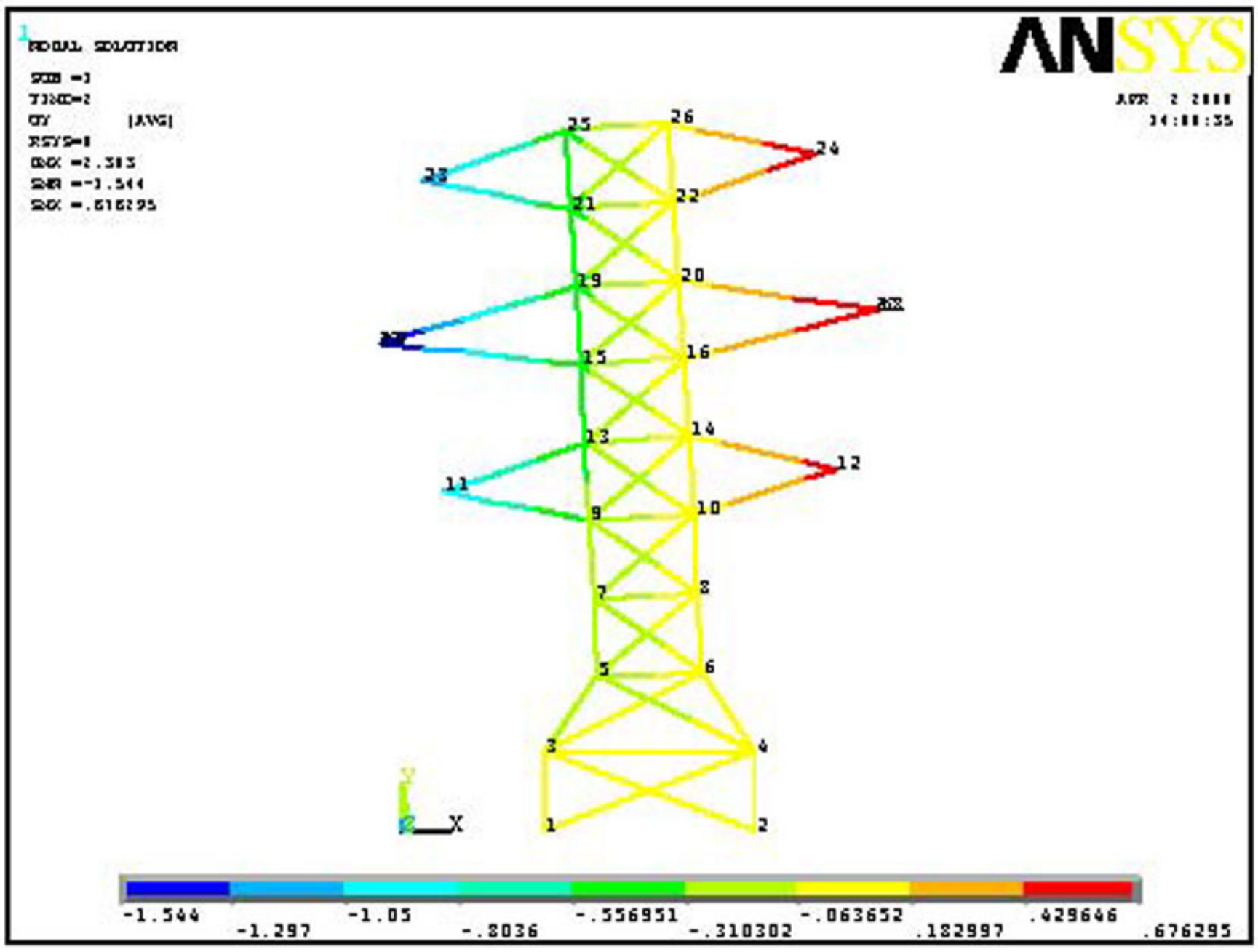
-.501058
-.250529
0


NODAL SOLUTION
ANSYS
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-1.05
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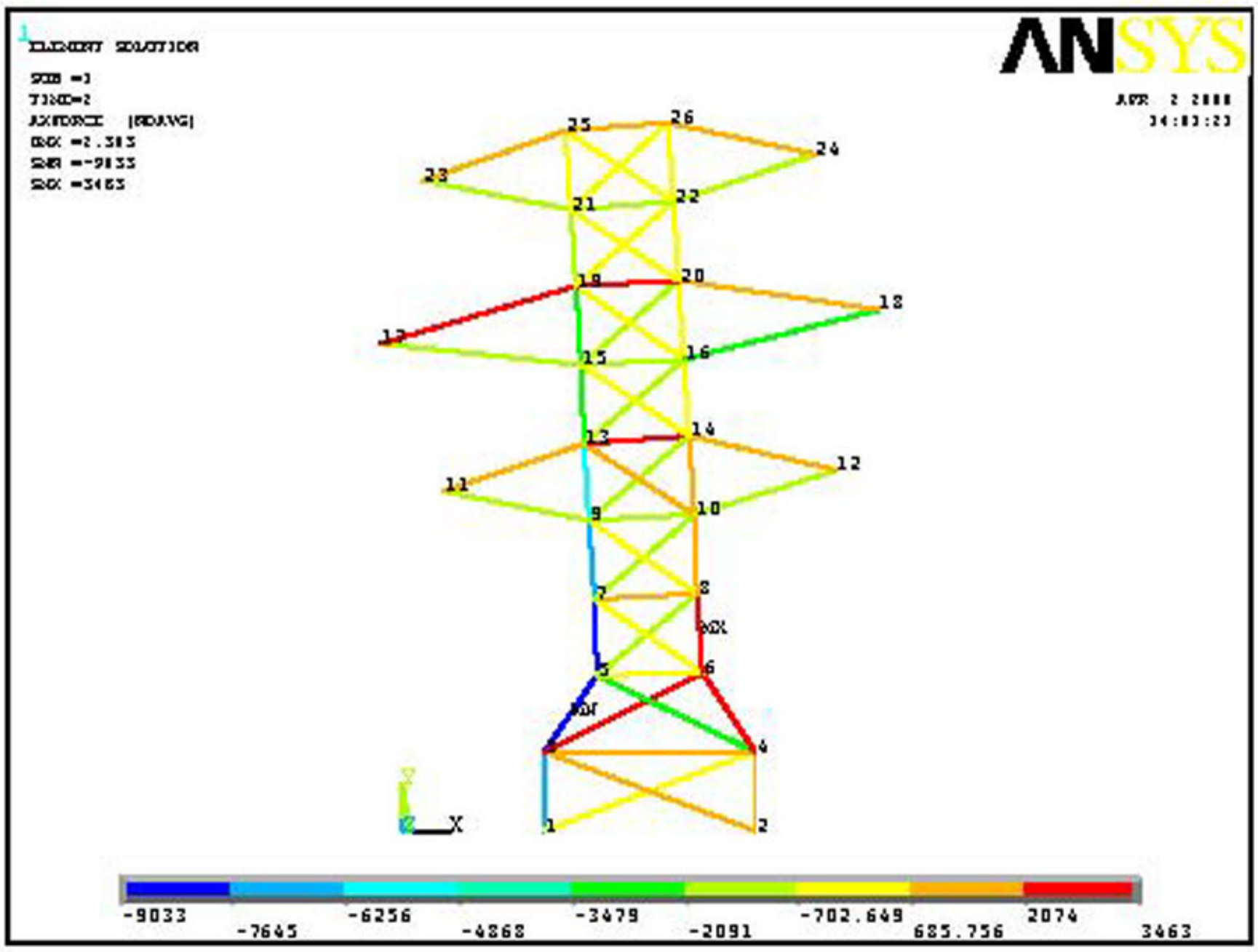
-.310302
-.063652
.182997
.429646
.676295


ELEMENT SOLUTION
ANSYS
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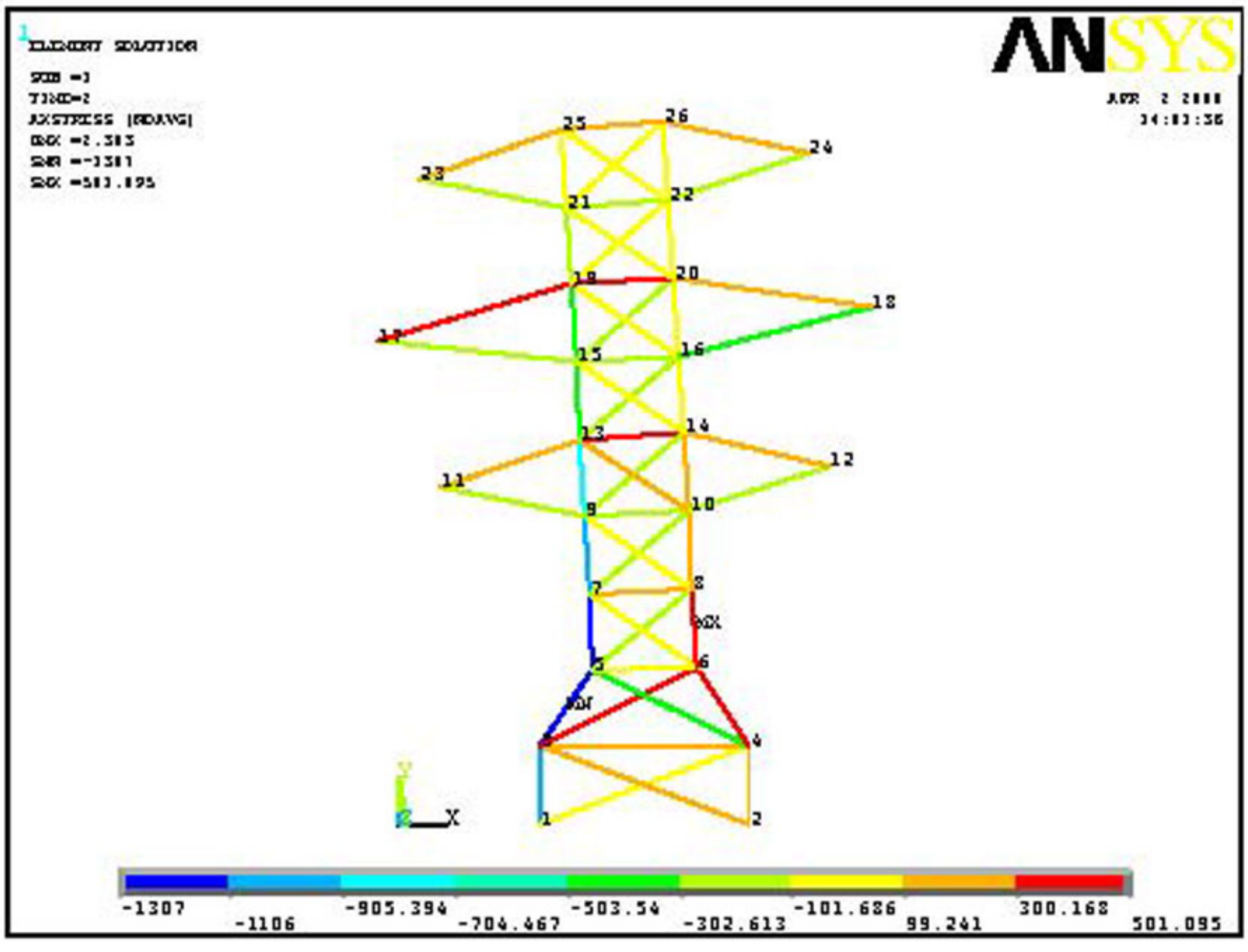
-6256
-4868
-3479
-2091
-702.649
685.756
2074
3463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SMN =-1307
SMX =583.895
ANSYS
AUG 2 2008
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26
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3
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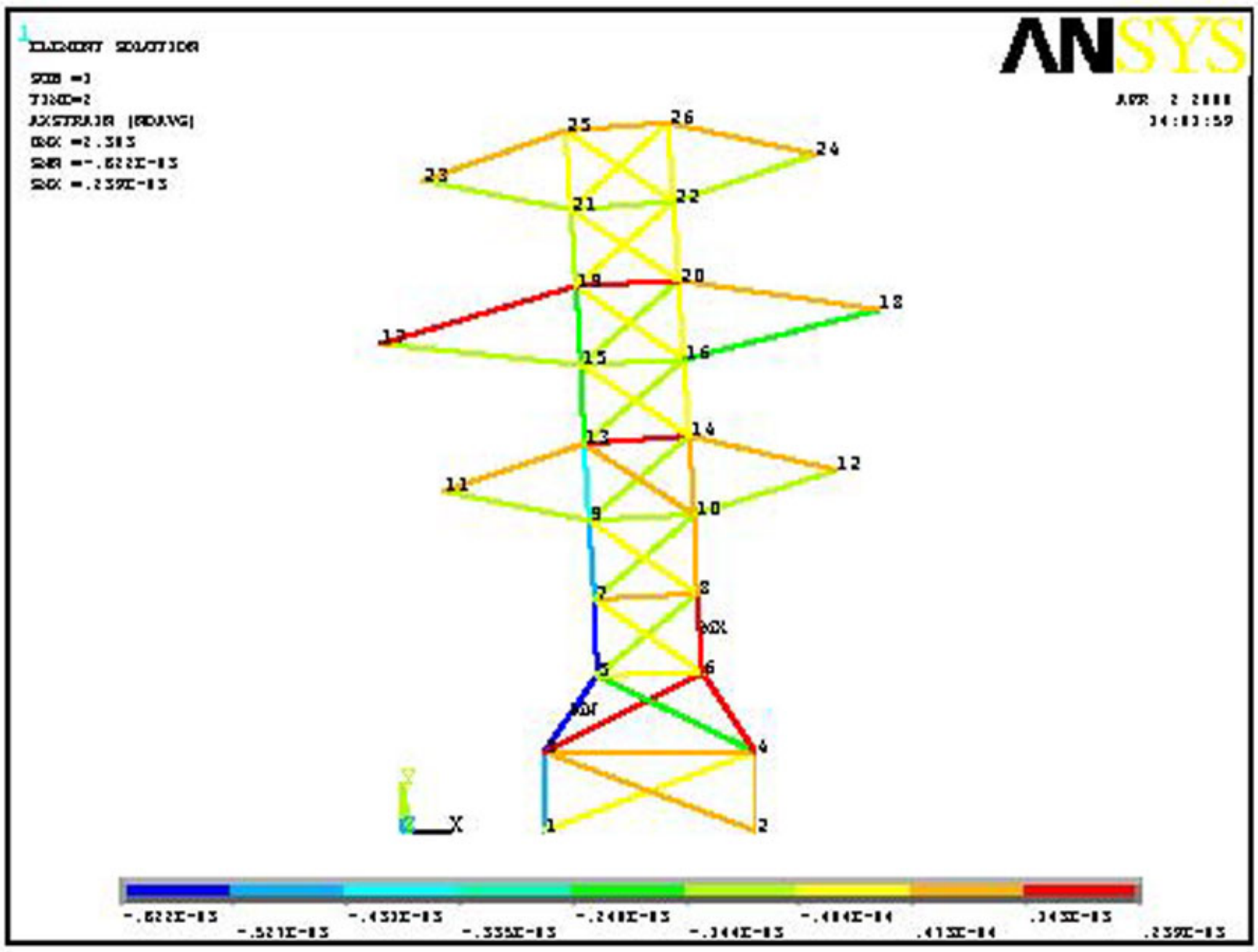
501.095


ELEMENT SOLUTION
SUB =1
TIME=2
AXSTRAIN (AVG)
DMX =2.585
SMN =-.622E-03
SMX =.239E-03
ANSYS
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-.131E-04
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.173E-03
.239E-03

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