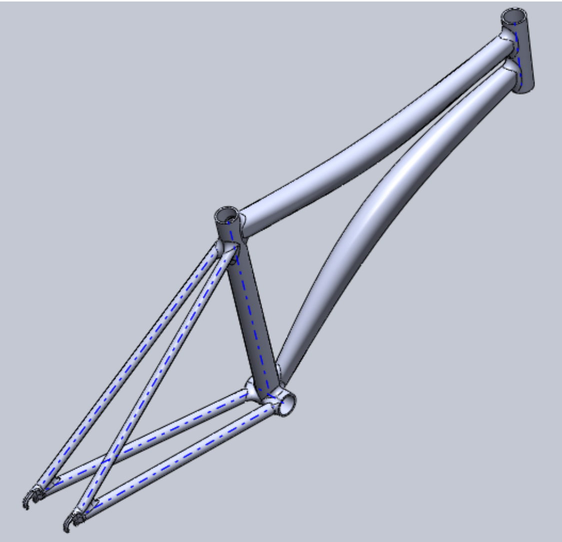
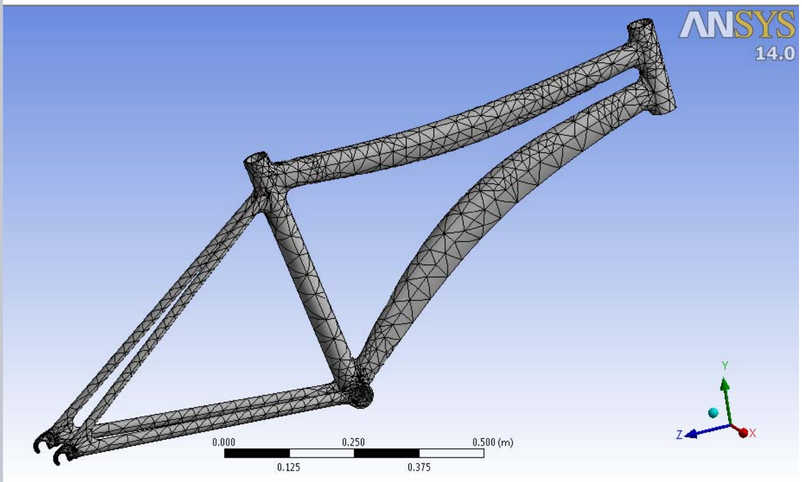
BICYCLE FRAME ANALYSYS

INTRODUCTION

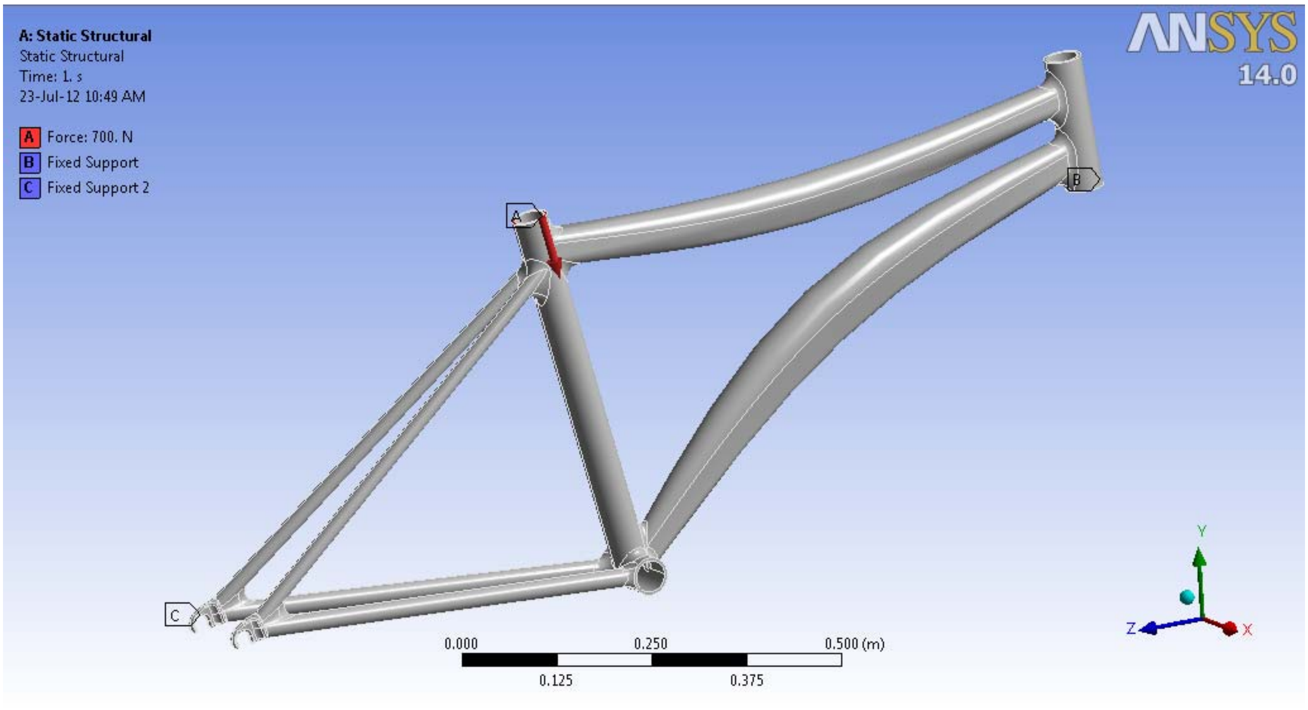
My aim was to analyse a bicycle frame. I used Ansys 14 as the software to analyse the frame that I build in Solidworks 2012. For manual validation programming help was taken. There we used the help of Matlab 2011b. The results both the cases were a near match. Only displacement of each node was verified using the programme. The load applied was in accordance to normal weight of a person which is approximately around 700 N. The reaction forces were observed near the ends where tyres are fixed in the bicycle.



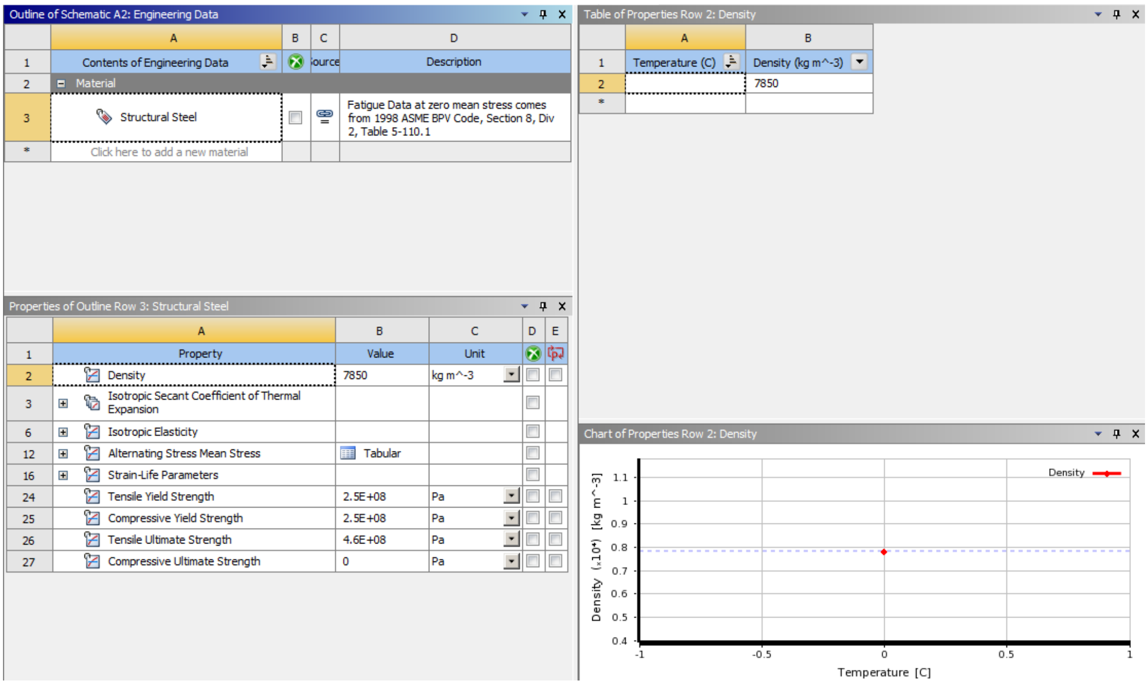
Bicycle Frame Solid model



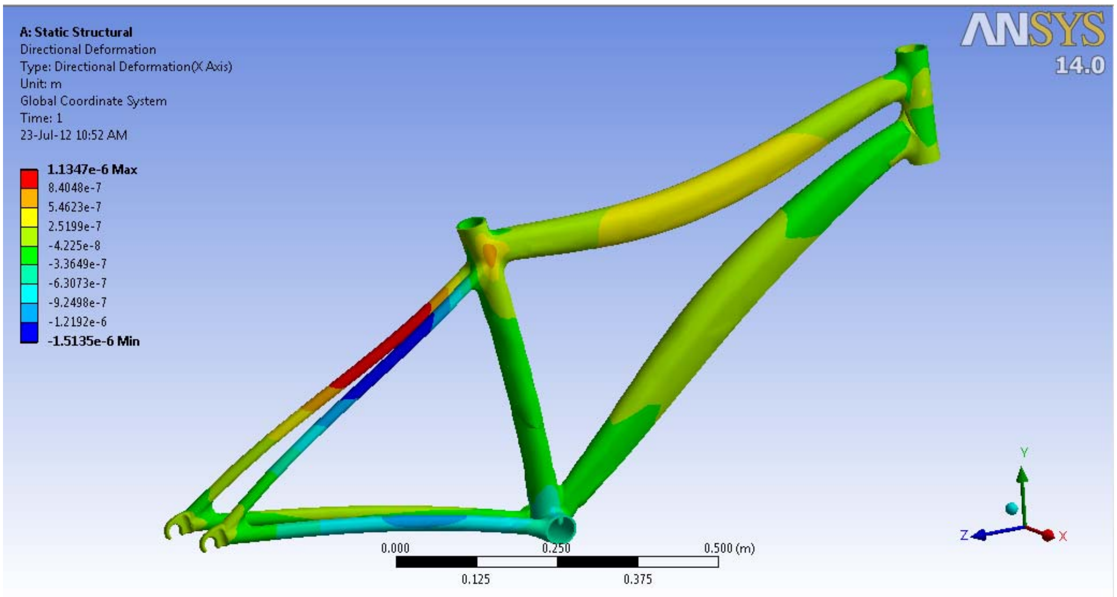
Meshed model (Tetrahedral elements)



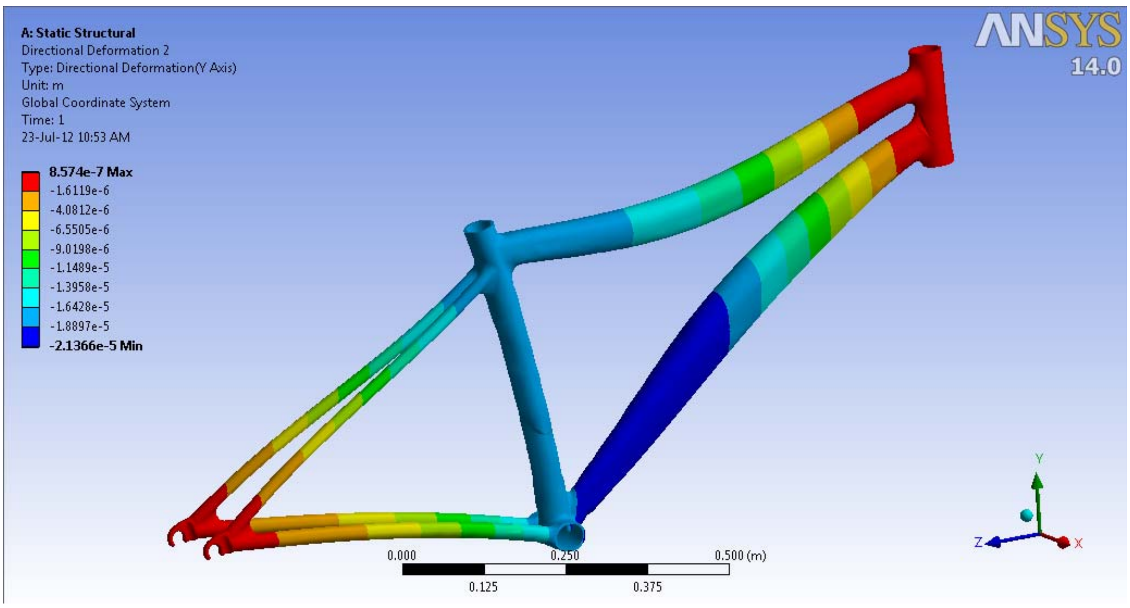
Loads and Constraints applied during Pre-processing



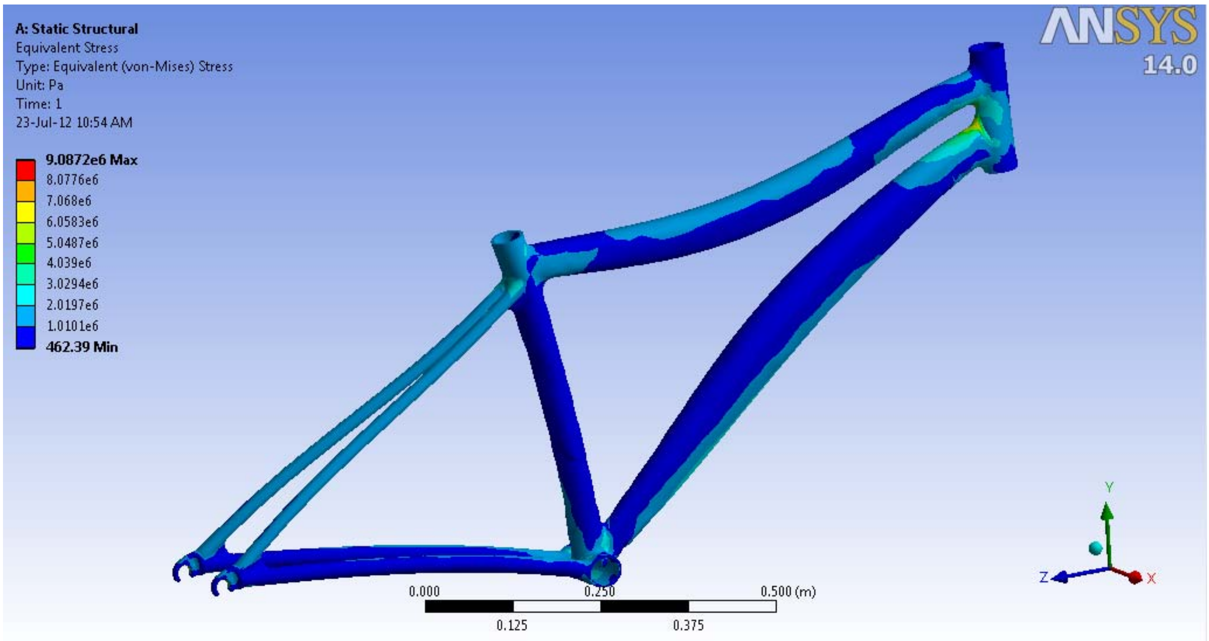
Engineering Data Provided



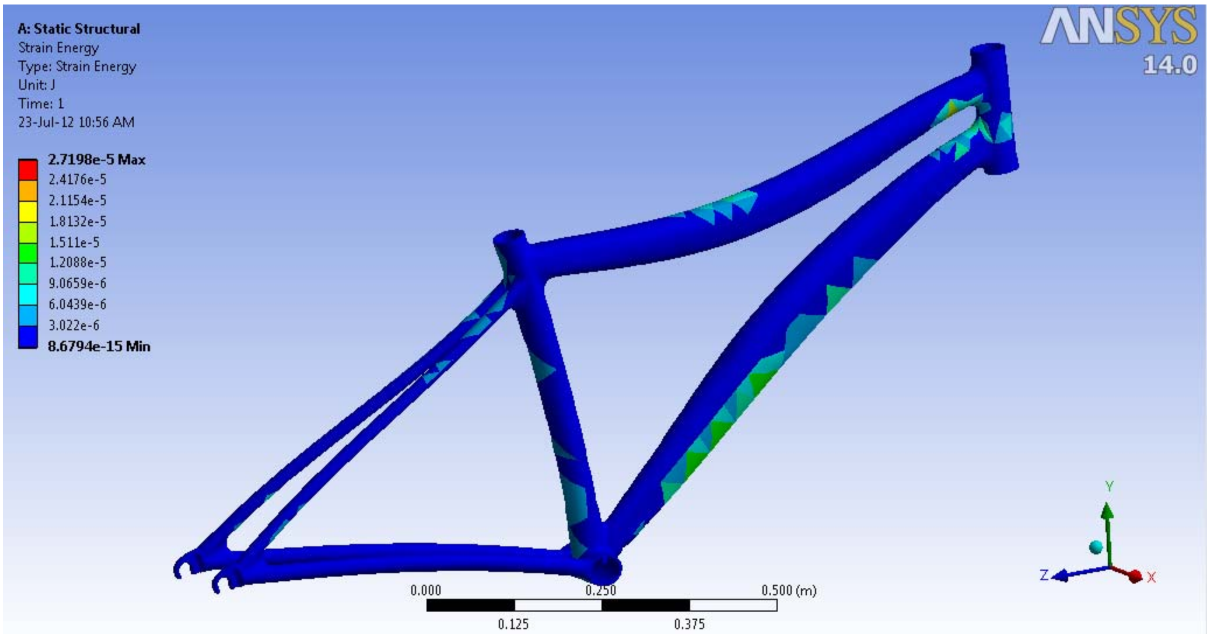
Directional Deformation X-Axis



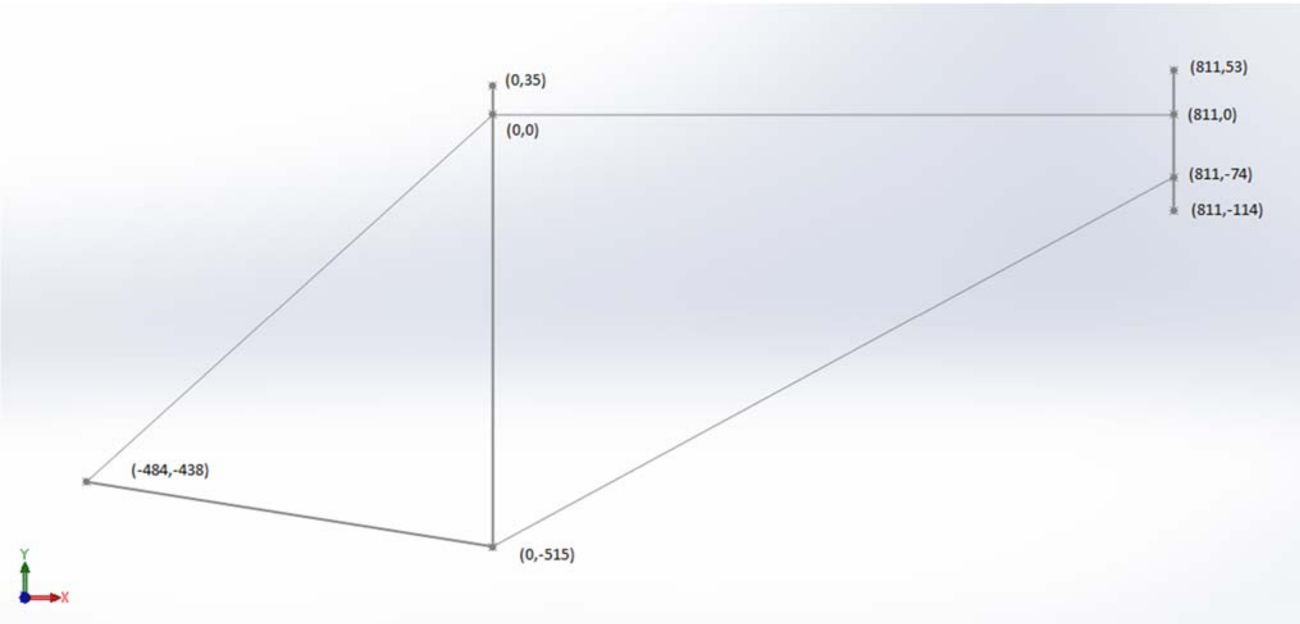
Directional Deformation Y-Axis



Equivalent Von-mises stress



Strain Energy



Approximate model for Validation

Validation MATLAB Code

```
clc
clear all
close all

E=2*10^5;

 Loc=[811 053
      811 0
      811 -74
      811 -114
      0 35
      0 0
      0 -515
      -484 -438];
  [n,dump]=size(Loc);
```

Element Nodes

```
  El=[1 2 50 42
    2 3 50 42
    3 4 50 42
    2 6 44 36
    5 6 48 40
    6 7 48 40
    3 7 44 36
    6 8 20 12
    7 8 20 12];
```

Frame Elements

```
[r,c]=size(El);

K_global=zeros(3*n,3*n);
for(i=1:r)
    L(i)=sqrt((Loc(El(i,1),1)-Loc(El(i,2),1))^2+(Loc(El(i,1),2)-Loc(El(i,2),2))^2);
    A(i)=pi*(El(i,3)^2-El(i,4)^2)/4;
    I(i)=pi*(El(i,3)^4-El(i,4)^4)/64;
    Ang(i)=atan((Loc(El(i,2),2)-Loc(El(i,1),2))/(Loc(El(i,2),1)-Loc(El(i,1),1)));
end

for (i=1:r)
    z=Stiffness_matrix( Ang(i),E,L(i),A(i),I(i) );
    x=El(i,1);
    y=El(i,2);
    for(j=1:3*n)
        for(k=1:3*n)
            if(j==x*3-2 || j==x*3-1 || j==x*3) && (k==x*3-2 || k==x*3-1 || k==x*3)
                K_global(j,k)= K_global(j,k)+z((j-(x-1)*3),(k-(x-1)*3));
            elseif(j==y*3-2 || j==y*3-1 || j==y*3) && (k==y*3-2 || k==y*3-1 || k==y*3)
                K_global(j,k)= K_global(j,k)+z((j-(y-1)*3),(k-(y-1)*3));
            elseif(j==x*3-2 || j==x*3-1 || j==x*3) && (k==y*3-2 || k==y*3-1 || k==y*3)
                K_global(j,k)= K_global(j,k)+z((j-(x-1)*3),(k-(y-1)*3));
            elseif(j==y*3-2 || j==y*3-1 || j==y*3) && (k==x*3-2 || k==x*3-1 || k==x*3)
                K_global(j,k)= K_global(j,k)+z((j-(y-1)*3),(k-(x-1)*3));
            end
        end
    end
end


F_red=transpose([0 0 0 0 0 0 0 0 0 0 700 0 0 0 0 0 0 0]);

K_red=K_global;
K_red(10:12,:)=[];
K_red(:,10:12)=[];
K_red(19:21,:)=[];
K_red(:,19:21)=[];

Def=inv(K_red)*F_red
```

```
function [ K ] = Stiffness_matrix( Ang,E,L,A,I )

l=cos(Ang);
m=sin(Ang);

Ke=[ A*E/L 0 0 -A*E/L 0 0
    0 12*E*I/(L^3) 6*E*I/(L^2) 0 -12*E*I/(L^3) 6*E*I/(L^2)
    0 6*E*I/(L^2) 4*E*I/(L) 0 -6*E*I/(L^2) 2*E*I/(L)
    -A*E/L 0 0 A*E/L 0 0
    0 -12*E*I/(L^3) -6*E*I/(L^2) 0 12*E*I/(L^3) -6*E*I/(L^2)
    0 6*E*I/(L^2) 2*E*I/(L) 0 -6*E*I/(L^2) 4*E*I/(L)];

[T]=[l m 0 0 0 0
    -m l 0 0 0 0
    0 0 1 0 0 0
    0 0 0 l m 0
    0 0 0 -m l 0
    0 0 0 0 0 1];

K= transpose(T)*Ke*T;

end
```

$$
\begin{Bmatrix} \hat{f}_{1x} \\ \hat{f}_{1y} \\ \hat{m}_1 \\ \hat{f}_{2x} \\ \hat{f}_{2y} \\ \hat{m}_2 \end{Bmatrix} = \left[\begin{array}{ccc|ccc} C_1 & 0 & 0 & -C_1 & 0 & 0 \\ 0 & 12C_2 & 6LC_2 & 0 & -12C_2 & 6LC_2 \\ 0 & 6LC_2 & 4C_2L^2 & 0 & -6LC_2 & 2C_2L^2 \\ \hline -C_1 & 0 & 0 & C_1 & 0 & 0 \\ 0 & -12C_2 & -6LC_2 & 0 & 12C_2 & -6LC_2 \\ 0 & 6LC_2 & 2C_2L^2 & 0 & -6LC_2 & 4C_2L^2 \end{array} \right] \begin{Bmatrix} \hat{d}_{1x} \\ \hat{d}_{1x} \\ \hat{\phi}_1 \\ \hat{d}_{2x} \\ \hat{d}_{2y} \\ \hat{\phi}_2 \end{Bmatrix}
$$

Axial effects with the shear force and bending moment effects, in local coordinates

Result Deformation Matrix

	Element 1	Element 2	Element 3	Element 4	Element 5	Element 6	Element 7	Element 8
u (mm)	0.0016	0.0016	0.0001	N.A.	-0.0048	0.0048	-0.0033	N.A.
v (mm)	-0.0001	0.0001	0.0001	N.A.	0.0185	-0.0183	0.0167	N.A.
Theta(rad)	-0.0000	0.0000	0.0000	N.A.	-0.0000	0.0000	-0.0000	N.A.