Analytical solution

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Contents

- define parameters
- calculate analytical solution value
- convert vertex matrix to face matrix
- draw the figures

define parameters

material parameters young modulus

```
E   = 600;
% poisson's ratio
nu  = 1.33;
%鎴€density
rho = 1;
% load mesh model
% x  : coordinates (3* total nnde)
% ix : node number matrix (nnde in cell* cell number)
load('fix comsol.mat')
% Geometric parameters
% length in x,y,z
Lz  = max(x(:,3)) - min(x(:,3));
Ly  = max(x(:,2)) - min(x(:,2));
Lx  = max(x(:,1)) - min(x(:,1));
% physical force
%gravity
g   = 9.8;
```

calculate analytical solution value

stress (x y z)

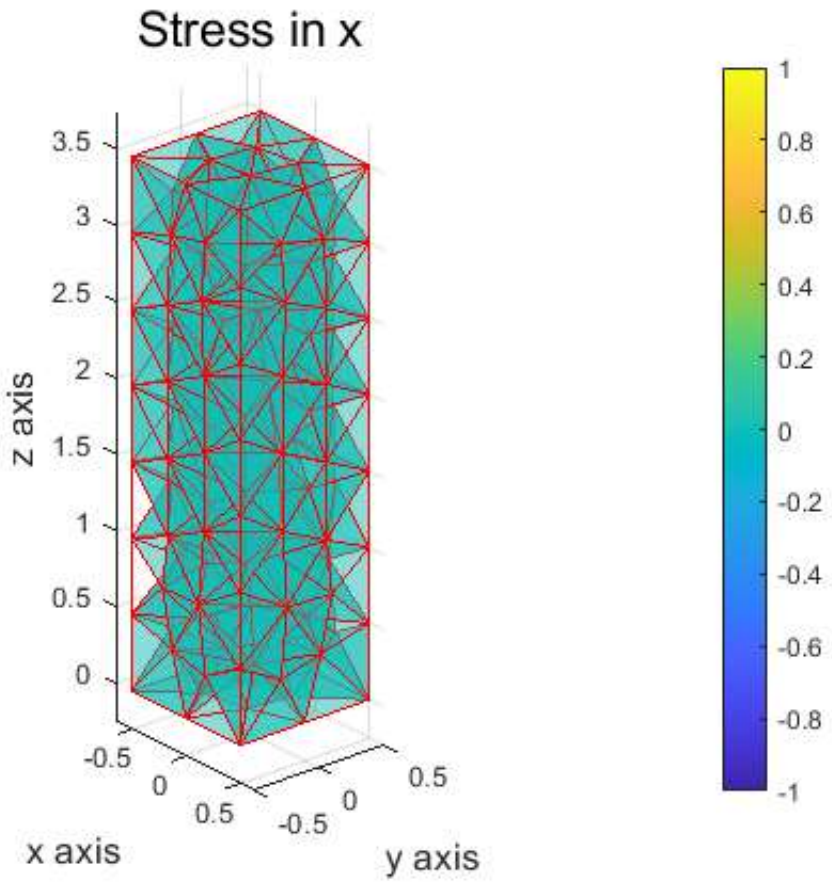
```
sig_z  = rho* g* x(:,3);
sig_x  = zeros(size(sig_z));
sig_y  = zeros(size(sig_z));
% strain (x y z)
eps_xx = -(nu* rho* g* x(:,3))/E;
eps_yy = -(nu* rho* g* x(:,3))/E;
eps_zz = (rho* g* x(:,3))/E;
% displacement (x y z)
u_x = -(nu* rho* g).* x(:,1).* x(:,3) /E;
u_y = -(nu* rho* g).* x(:,2).* x(:,3) /E;
u_z = (rho* g/(2*E)).* (x(:,3).^2- Lz^2+ nu*(x(:,1).^2+x(:,2).^2));
%current configuration's coordinates
xx = x+ [u_x,u_y,u_z];
```

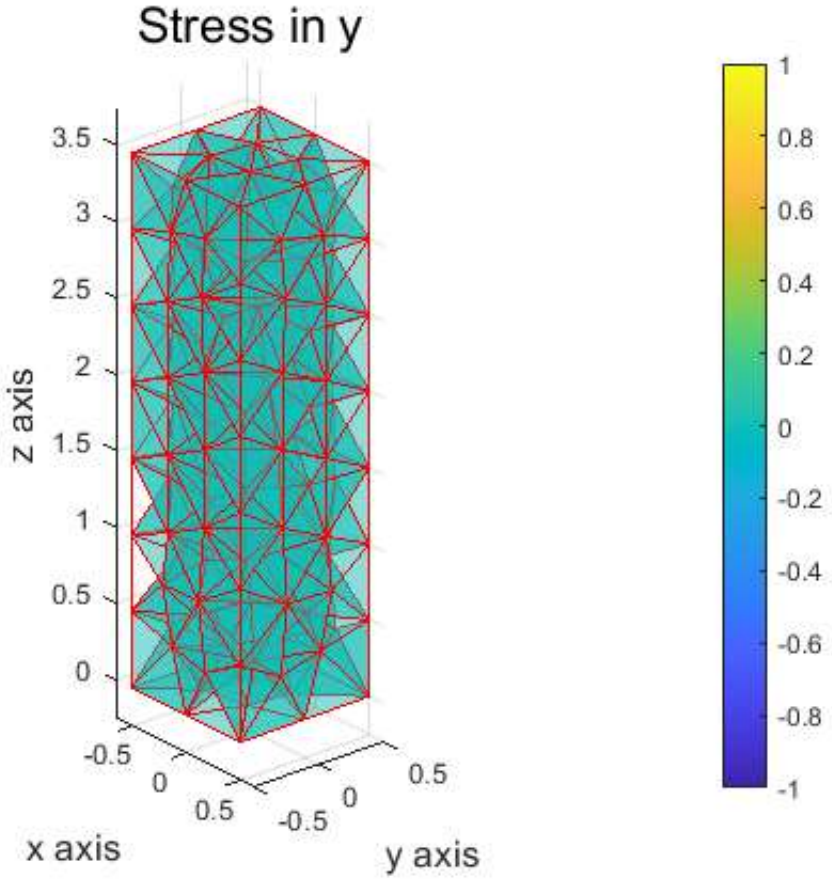
convert vertex matrix to face matrix

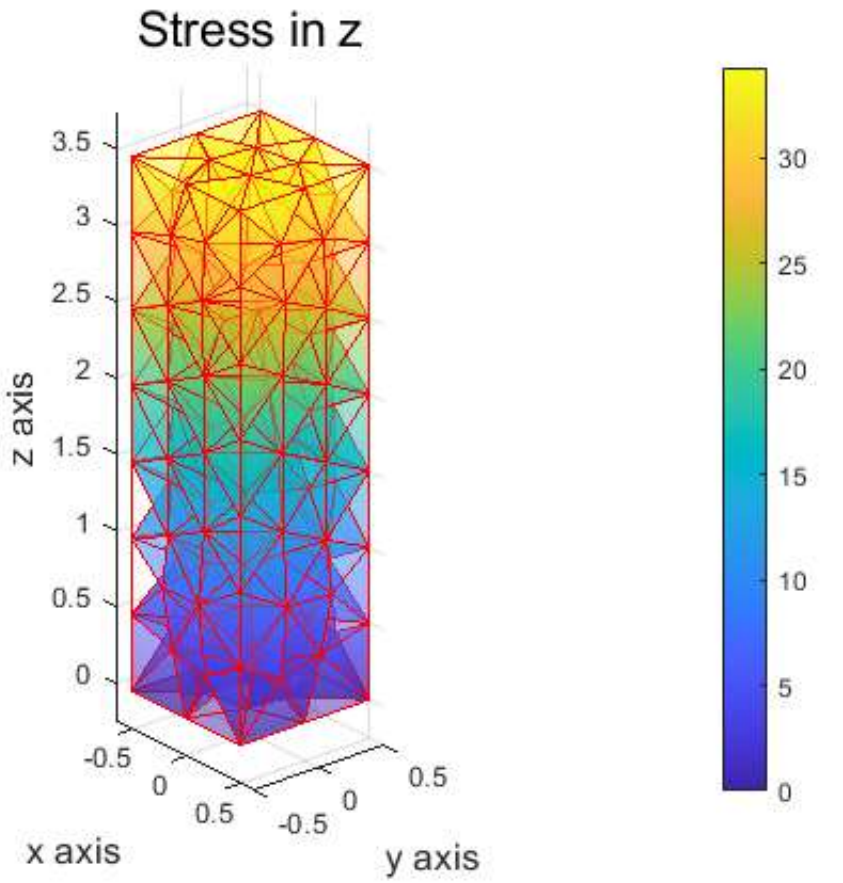
```
for i = 1 : length(ix)
[fx(((4*i-3):(4*i)),:),~] = VerToFace(x(ix(i,:),:),ix(i,:));
end
```

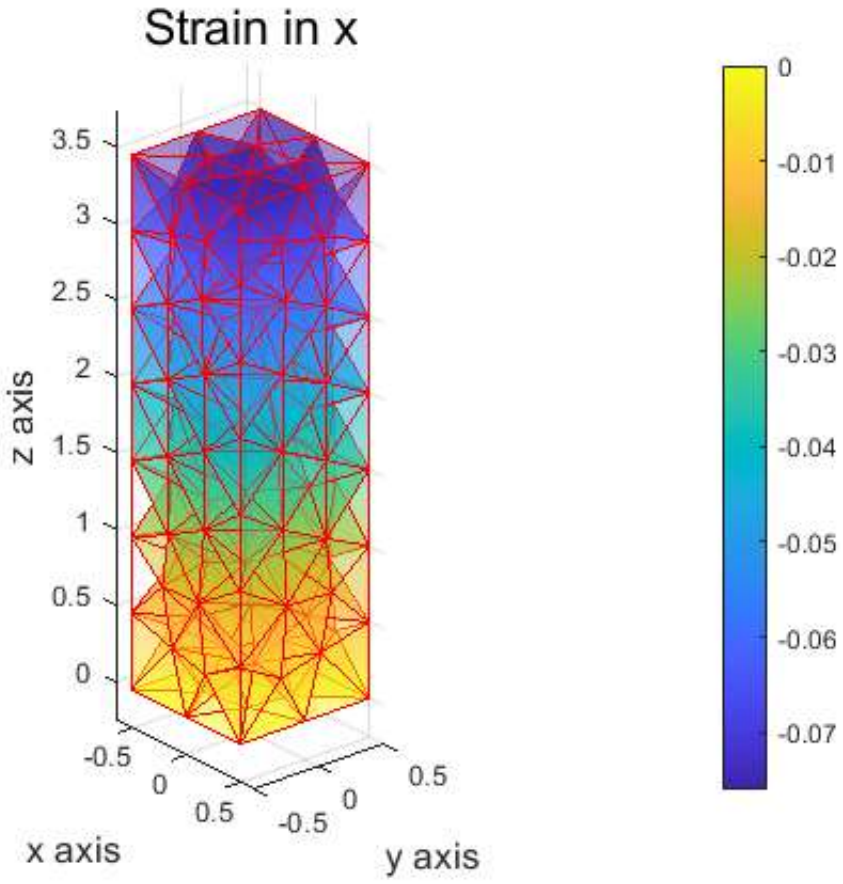
draw the figures

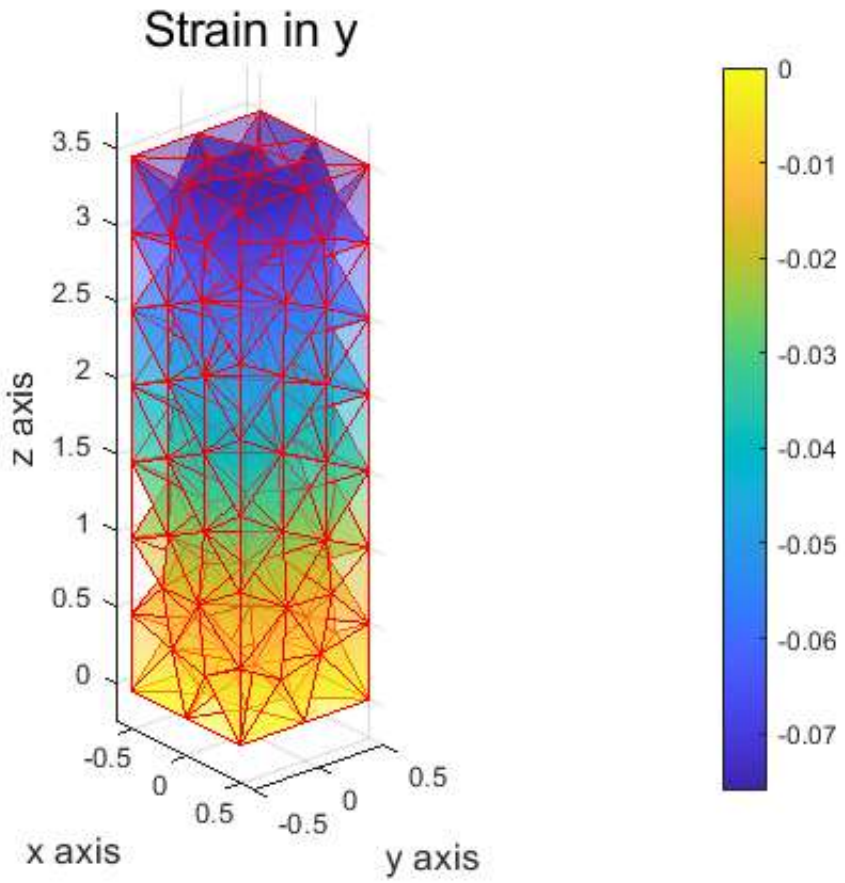
```
% sigma figure
sty  = {'Stress in x', 'Stress in y', 'Stress in z'};
sig=[sig_x,sig_y,sig_z];
for i =1:3
figure
patch('vertices', x, 'faces', fx, ...
'facecolor', 'none', 'edgecolor', 'r');
hold on
axis equal
mypatch(x, ix, 'interp', 'none', sig(:,i), 0.5, 1, sty{i},'x axis','y axis','z axis');
view(50,25)
colorbar
end

% epsilon figure
eps = [eps_xx,eps_yy,eps_zz];
cel = {'Strain in x', 'Strain in y', 'Strain in z'};
for i =1:3
figure
patch('vertices', x, 'faces', fx, ...
'facecolor', 'none', 'edgecolor', 'r');
hold on
axis equal
mypatch(x, ix, 'interp', 'none', eps(:,i), 0.5 , 1 , cel{i} ,'x axis','y axis','z axis');
view(50,25)
colorbar
end

% replacement figure
ctl ={'Displacement in x', 'Displacement in y', 'Displacement in z'};
u = [u_x,u_y,u_z];
for i =1:3
figure
patch('vertices', x, 'faces', fx, ...
'facecolor', 'none', 'edgecolor', 'r');
hold on
axis equal
mypatch(xx, ix, 'interp', 'none', u(:,i), 0.5, 1,ctl{i},'x axis','y axis','z axis');
view(50,25)
colorbar
end
```

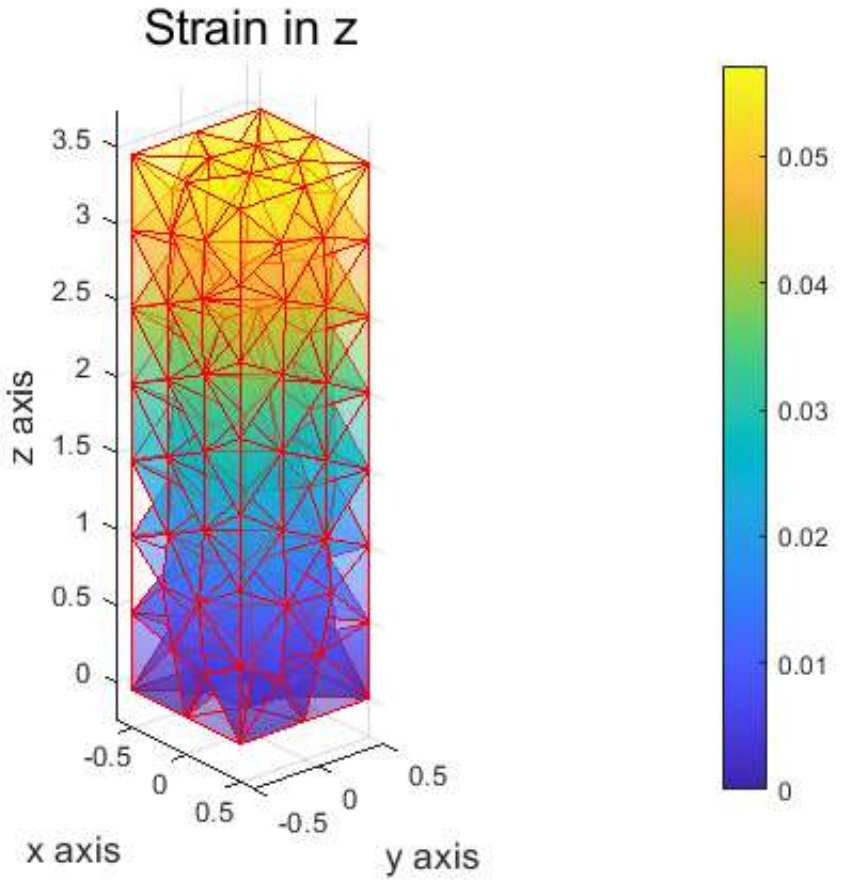

Stress in x
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
-0.5
0
0.5
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

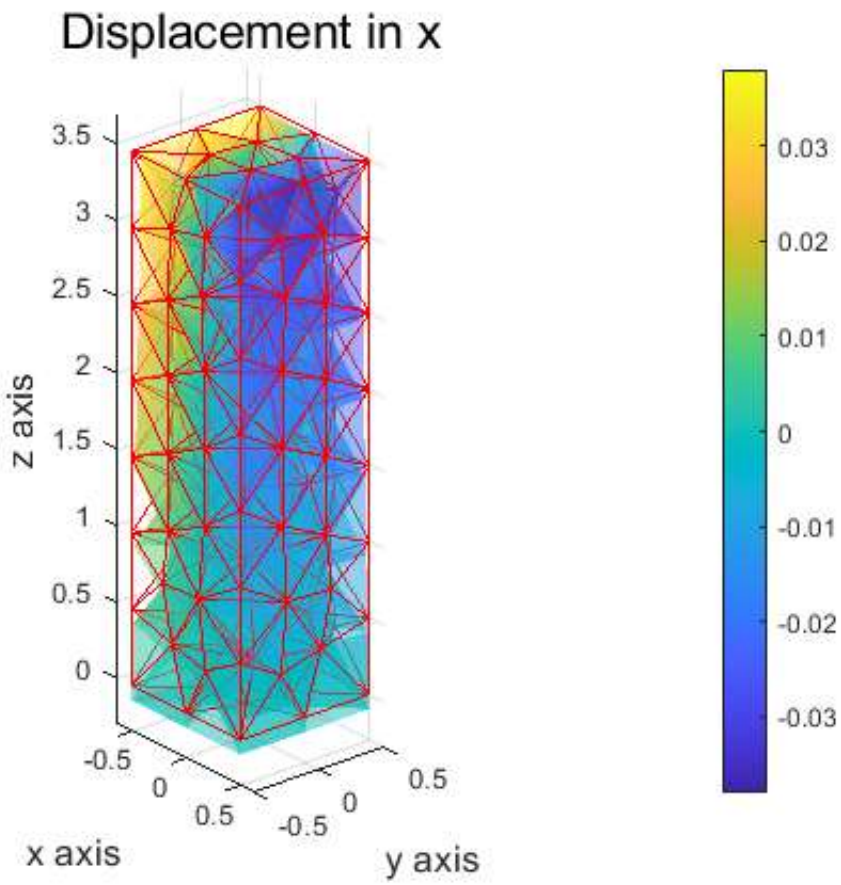

Stress in y
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
-0.5
0
0.5
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

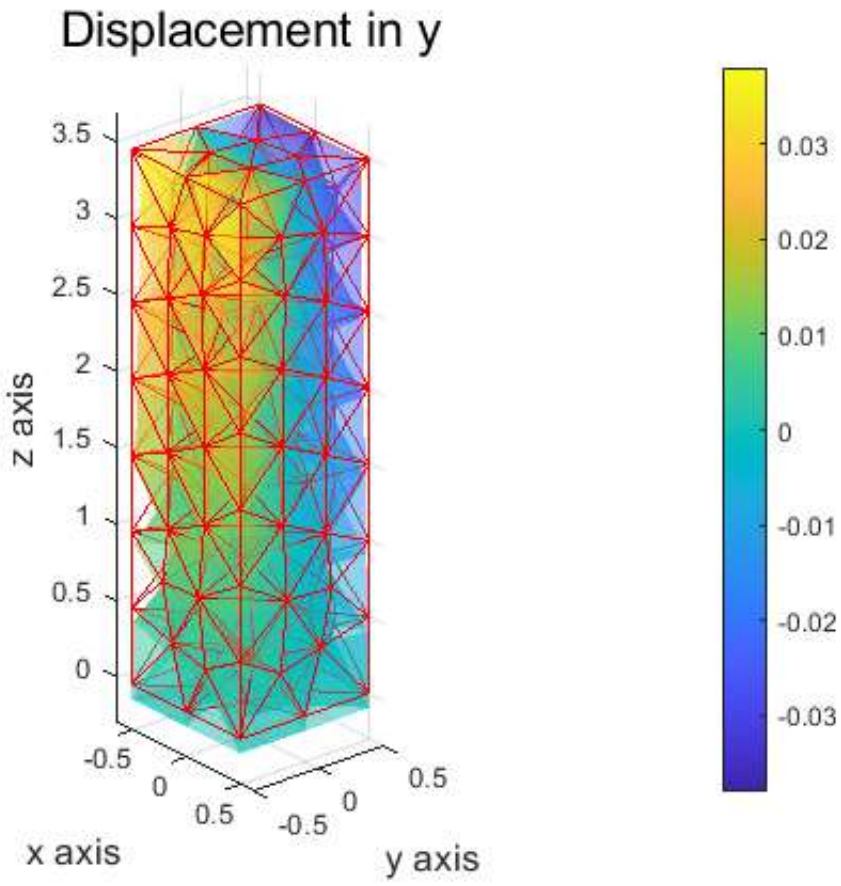

Stress in z
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
-0.5
0
0.5
30
25
20
15
10
5
0

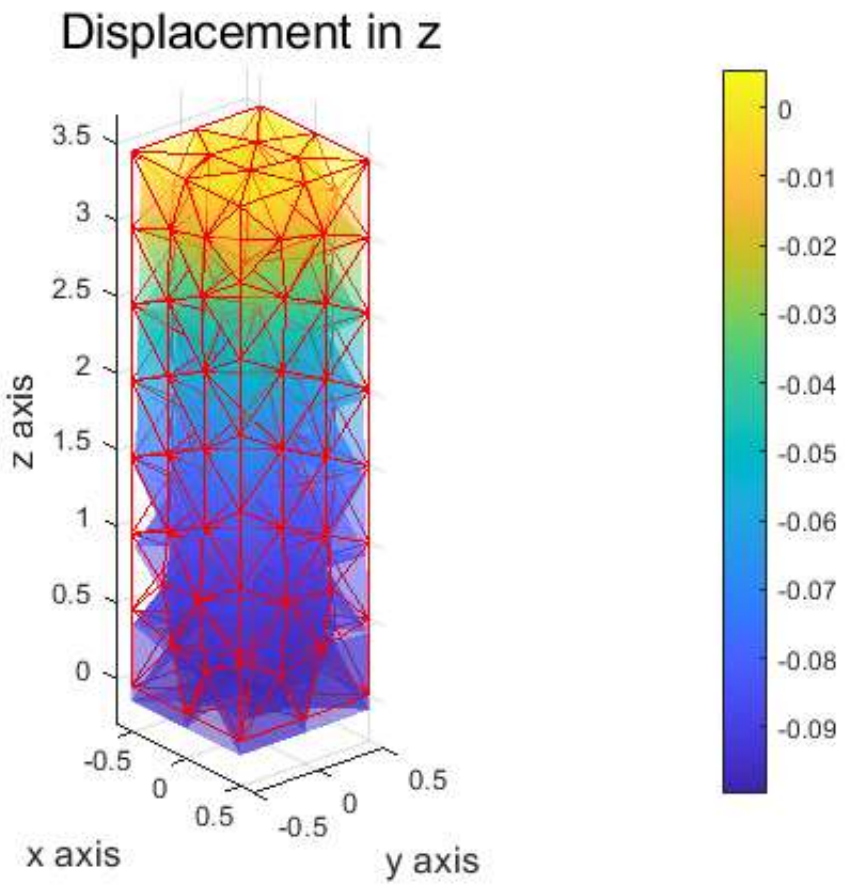

Strain in x
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
-0.5
0
0.5
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07


Strain in y
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07


Strain in z
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
0.05
0.04
0.03
0.02
0.01


Displacement in x
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
0.5
0
-0.5
0.03
0.02
0.01
0
-0.01
-0.02
-0.03


Displacement in y
z axis
x axis
y axis
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
0.5
0.5
0
-0.5
0.03
0.02
0.01
0
-0.01
-0.02
-0.03



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