Appendix

List of symbols

This list of symbols contain some of the most used symbols in this dissertation. The symbols are grouped into three categories: Vector Spaces and Related Concepts, Mathematical Measures and Operations, and Physical Quantities and Parameters. The first appearance of each symbol is also listed.

Other symbols that are section specific or that are contextually evident might not be in this list.

Vector Spaces and Related Co ncepts

Symbol	Description	First Appearance (Page)
$\mathbb{N}$	set of natural numbers j	??
R^n	n-dimensional space of real numbers	??
Ω	subset of R^n, usually representing a body/reference configuration	??
$\partial\Omega$	the boundary of Ω	??
$\bar{\Omega}$	the boundary of Ω	??
C^n	set of n-times continuously differentiable functions	??
C^∞	space of smooth functions	??
C_0^∞	space of smooth functions with compact support	??
L^n	space of n-power Lebesgue integrable functions	??

H^n	space of functions with weak derivatives up to order n (n'th dimensional Sobolev space)	??
X	global space	??
V	inertia space	??
W	energy space	??
$T(\Omega)$	test function space on Ω	??
S^h	finite dimensional subspace	??
$\mathcal{P}_j$	set of all polynomials of degree at most j	??
E_n	space spanned by the orthonormal basis vectors e_i	??

Mathematical Measures and Operations

Symbol	Description	First Appearance (Page)
$a(\cdot,\cdot), b(\cdot,\cdot), c(\cdot,\cdot)$	bilinear forms	??, ??, ??
$(\cdot,\cdot)_X$	innerproduct of X	??
$\|\|\cdot\|\|_X$	norm in the space X	??
$\partial_x^n f$	n-th partial derivative of f with respect to x	??
div$X$	divergence of the matrix X	??
Tr(X)	Trace of the matrix X	??
det(M)	determinant of M	??
span$(\cdot)$	span of a set	??
dV	volume integral measure	??
dS	surface integral measure	??
dA	area integral measure	??
ds	line integral measure	??
$\mathcal{E}(\cdot)$	energy function	??
$R(\cdot)$	Rayleigh quotient	??
Π	interpolation operator	??
$\bar{u}$	another form explicity showing u is a vector	??
RE	abbriviation for the relative error	??

Physical Quantities and Parameters

Symbol	Description	First Appearance (Page)
λ	eigenvalue	??
u or w	displacement vector	??
ϕ	arbitrary vector/rotation of cross-section of Timoshenko beam	??
Q	force per unit volume	??
ρ	density	??
T	stress tensor	??
σ_{ij}	element of the stress tensor T	??
$\mathcal{E}$	infinitesimal strain tensor	??
ε_{ij}	element of the infinitesimal strain tensor $\mathcal{E}$	??
E	Young's modulus	??
ν	Poisson's ratio	??
t	time	??
ℓ	dimension representing length	??
h	dimension representing height	??
b	dimension representing width	??
G	shear modulus of elasticity	??
A	area of a cross-section	??
V	shear force	??
I	area moment of inertia	??
M	moment	??
f^*	dimensionless form of f	??
τ	dimensionless time	??
ξ	dimensionless space	??
α/β	dimensionless constants	??
κ^2	some dimensionless constant/shear correction factor	??
I	identity matrix	??
γ	a dimensionless constant	??
n	a normal vector	??
Σ/Γ	distinct parts of Ω	??
μ	eigenvector	??
e_i	orthonormal basis vector	??

Sobolev spaces

The Space L^2

Consider a measurable space X. The set of square integrable functions is called the L^2 space.

The inner product of L^2 is defined as

$$(f, g) = \int_X fg \qquad \text{for } f, g \in L2.$$

The norm can be defined as $||f|| = (f, f)^{\frac{1}{2}}$ for each $f \in L^2(X)$. For reference, see [Rud53].

The Space L^p

Consider a measurable space X. For a real number $p \geq 1$, the set of p-integrable functions is called the L^p space. A function f belongs to $L^p(X)$ if the p-th power of its absolute value is Lebesgue integrable, that is, if

$$\int_X |f|^p < \infty.$$

The L^p norm (or p-norm) is defined as

$$||f||_p = \left(\int_X |f|^p \right)^{\frac{1}{p}}$$

for each $f \in L^p(X)$.

Continuous function spaces

$C^m(a, b)$ is the space of functions with continuous derivatives up to order m over the open interval (a,b).

$C^m[a, b]$ is the space of functions in $C^m(a, b)$, with existing right derivatives at a and existing left derivatives at b, up to order m.

$C_0^m(a, b)$ contains all functions f in $C^m[a, b]$ with the property that there exists numbers $a < \alpha < \beta < b$ such that f is zero on $[a, \alpha] \cup [\beta, b]$. This property is called compact support.

$C^\infty(a,b)$ contains all functions in $C^m(a,b)$ for all m.

$C^\infty[a,b]$ contains all functions in $C^m[a,b]$ for all m.

$C_0^\infty(a,b)$ contains all functions in $C_0^m(a,b)$ for all m.

First order weak derivative

Suppose $u \in L^2(a,b)$ and there exist a $v \in L^2(a,b)$ such that

$$(u, \phi') = -(v, \phi) \quad \text{for each } \phi \in C_0^\infty(a,b)$$

then v is called the first order weak derivative of u and is denoted by Du.

Higher order weak derivative

Suppose $u \in L^2(a,b)$ and there exist a $v \in L^2(a,b)$ such that

$$(u, \phi^{(m)}) = (-1)^{(m)}(v, \phi) \quad \text{for each } \phi \in C_0^\infty(a,b)$$

then v is called the m'th order weak derivative of u and is denoted by $D^{(m)}u$.

Sobolev spaces

W^n is the space of functions with weak derivatives up to order n. There are also special notation $W^{n,p}$ that indicates that the functions are P-intergrable.

H^n is the space of functions with weak derivatives up to order n and the functions are square integrable. (i.e. $H^n = W^{n,2}$)

MATLAB Code

The following are the main code used in this dissertation to obtain the eigenvalues and eigenvectors of the models. The code and the dissertation is also available on GitHub at `https://github.com/Propagandalf-7/masters`.

The code is optimized for performance, and therefore the presentation of the code is not optimized for readability. The code is also not commented.

Example code for Timoshenko beam model

```
function [u,p,Eig] = TimoshenkoEig(alpha)
syms A;
syms B;
syms C;
syms D;
syms x;
syms m;
syms o;
syms lam;
syms k;
syms a;
syms t;
format long;

%gamma = 0.25;
nu = 0.3;
gamma = 1/(2*(1+nu))*5/6;

delt = 4*gamma/(1+gamma)^2*alpha/lam + (1-gamma)^2/(1+gamma)^2;
omega2 = 1/2*lam*(1+gamma)*(delt^(1/2)+1);
mu2 = 1/2*lam*(1+gamma)*(delt^(1/2)-1);
theta2 = 1/2*lam*(1+gamma)*(1-delt^(1/2));


```

```
u = A*sinh(m*x) + B*cosh(m*x) + C*sin(o*x) + D*cos(o*x);
p = A*((lam+m^2)/m*cosh(m*x)) + B*((lam+m^2)/m*sinh(m*x)) + C
    *(-(lam-o^2)/o*cos(o*x)) + D*((lam-o^2)/o*sin(o*x));

%u = B + C*sin(o*x) + D*cos(o*x);
%p = A + B*a*x + C*(-(lam-o^2)/o)*cos(o*x) + D*((lam-o^2)/o)*
    sin(o*x);

%u = A*sin(t*x) + B*cos(t*x) + C*sin(o*x) + D*cos(o*x);
%p = A*(-(lam-t^2)/t)*cos(t*x) + B*(lam-t^2)/t*sin(t*x) + C*(-(
    lam-o^2)/o)*cos(o*x) + D*(lam-o^2)/o*sin(o*x);


subs((u),x,0);
subs((p),x,0);

u = subs(u,[D,C],[-B,A*(lam+m^2)/m*o/(lam-o^2)]);
p = subs(p,[D,C],[-B,A*(lam+m^2)/m*o/(lam-o^2)]);

%u = subs(u,[B,C],[-D*((lam-o^2)/a),o/lam*(A + k*(-D*((lam-o^2)
    /a) +D))]);
%p = subs(p,[B,C],[-D*((lam-o^2)/a),o/lam*(A + k*(-D*((lam-o^2)
    /a) +D))]);

%u = subs(u,[D,C],[-B,-o/(o^2-lam)*(t^2-lam)/t*A]);
%p = subs(p,[D,C],[-B,-o/(o^2-lam)*(t^2-lam)/t*A]);

M1 = (subs(diff(p),x,1));
M2 = (subs(diff(u) - p,x,1));
M = [subs(M1,[A,B],[1,0]) subs(M1,[A,B],[0,1]);subs(M2,[A,B
    ],[1,0]) subs(M2,[A,B],[0,1])];

%latex(simplify(det(M)))

L = subs(M,k,sqrt(5/6));
L = subs(L,o,(omega2)^(1/2));
L = subs(L,m,(mu2)^(1/2));
L = subs(L,t,(theta2)^(1/2));

Y = det(L);
Y = simplify(subs(Y,lam,x));

%ezplot(Y,[0,300])
%grid on

R = 0;
R = FindRoots(Y,0.001,500,0.1)
%R = FindRoots(Y,100,200,0.1)
```

```
RF = zeros(1,size(R,2));
RF2 = zeros(1,size(R,2));
RF3 = zeros(1,size(R,2));
RF4 = zeros(1,size(R,2));
for i = 1:size(R,2)
    if(R(i)-0.1>0)
        RF(i) = FindRoots(Y,R(i)-0.1,R(i)+0.1,0.0001);
    else
        RF(i) = FindRoots(Y,0.0001,R(i)+0.1,0.0001);
    end
end
for i = 1:size(R,2)
    if(RF(i)-0.0001>0)
        RF2(i) = FindRoots(Y,RF(i)-0.0001,RF(i)+0.0001,0.00001)
    ;
    else
        RF2(i) = FindRoots(Y,0.0001,RF(i)+0.0001,0.00001);
    end
end
for i = 1:size(R,2)
    if(RF2(i)-0.00001>0)
        RF3(i) = FindRoots(Y,RF2(i)-0.00001,RF2(i)
    +0.00001,0.000001);
    else
        RF3(i) = FindRoots(Y,0.00001,RF2(i)+0.00001,0.000001);
    end
end
%for i = 1:size(R,2)
 %   if(RF3(i)-0.00001>0)
 %       RF4(i) = FindRoots(Y,RF3(i)-0.000001,RF3(i)
    +0.000001,0.0000001);
 %   else
%        RF4(i) = FindRoots(Y,0.000001,RF3(i)
    +0.000001,0.0000001);
%    end
%end

Eig = RF3';
%ModeNum = 1;
Eig
%{
imageDir = fullfile(cd, 'images');
if ~exist(imageDir, 'dir')
   mkdir(imageDir);
end

for i = 1:size(Eig,1)
    % Get values
```

```
    LS = subs(L,lam,RF(i));
    [a,L1] = gauss(LS,[0;0]);
    B1 = double(-L1(1,1)/L1(1,2))
    us = subs(u,[o,m],[(omega2)^(1/2),(mu2)^(1/2)]);
    ps = subs(p,[o,m],[(omega2)^(1/2),(mu2)^(1/2)]);
    us = simplify(subs(us,[lam,A,B,k],[RF(i),1,B1,sqrt(5/6)]));
    ps = simplify(subs(ps,[lam,A,B,k],[RF(i),1,B1,sqrt(5/6)]));

    xd = 0:0.01:1;
    uss = subs(us,x,xd);
    max = norm(uss,Inf);
    us = us/max;

    pss = subs(ps,x,xd);
    maxp = norm(pss,Inf);
    ps = ps/maxp;

    % Displacement
    f1 = figure('Name', ['Mode ' num2str(i) ' Displacement']);
    clf(f1)
    ezplot(us,[0,1])
    title(['Mode ' num2str(i) ' Displacement'])
    xlabel('x (Position)')
    ylabel('Displacement (Normalized)')
    legend('Displacement', 'Location', 'best')

    % Stress
    f2 = figure('Name', ['Mode ' num2str(i) ' Stress']);
    clf(f2)
    ezplot(ps,[0,1])
    title(['Mode ' num2str(i) ' Stress Distribution'])
    xlabel('x (Position)')
    ylabel('Stress (Normalized)')
    legend('Stress Distribution', 'Location', 'best')

    % Both
    f3 = figure('Name', ['Mode ' num2str(i) ' Displacement and
   Stress']);
    clf(f3)
    hold on
    ezplot(us,[0,1])
    ezplot(ps,[0,1])
    title(['Mode ' num2str(i) ' Displacement and Stress'])
    xlabel('x (Position)')
    legend('Displacement', 'Stress Distribution', 'Location', '
   best')
    hold off

```

```
    saveas(f1, fullfile(imageDir, ['Mode_' num2str(i) '_Displacement.png']));
    saveas(f2, fullfile(imageDir, ['Mode_' num2str(i) '_Stress.png']));
    saveas(f3, fullfile(imageDir, ['Mode_' num2str(i) '_Displacement_and_Stress.png']));
end
writeToExcel(Eig, imageDir);
%}
return;

function writeToExcel(Eig, imageDir)
    % Define the name of the Excel file
    excelFileName = 'TimoshenkoResults.xlsx';

    % Initialize COM server
    Excel = actxserver('Excel.Application');
    Excel.Workbooks.Add;

    % Get active sheet
    WorkSheets = Excel.ActiveWorkBook.Sheets;
    sheet1 = WorkSheets.get('Item', 1);
    sheet1.Activate;

    % Start writing data to Excel
    sheet1.Range('A1').Value = 'Mode Number';
    sheet1.Range('B1').Value = 'Eigen Value';

    for i = 1:size(Eig, 1)
        sheet1.Range(['A' num2str(i + 1)]).Value = i; % Mode Number
        sheet1.Range(['B' num2str(i + 1)]).Value = Eig(i); % Eigen Value

        % Insert images
        pic_path = fullfile(imageDir, ['Mode_' num2str(i) '_Displacement.png']);
        disp(['Image path: ', pic_path]);
        Excel.ActiveSheet.Shapes.AddPicture(pic_path, 0, 1, 100, i*100, 200, 200);
        pic_path = fullfile(imageDir, ['Mode_' num2str(i) '_Stress.png']);
        disp(['Image path: ', pic_path]);
        Excel.ActiveSheet.Shapes.AddPicture(pic_path, 0, 1, 100, i*100, 200, 200);
        pic_path = fullfile(imageDir, ['Mode_' num2str(i) '_Displacement_and_Stress.png']);
        disp(['Image path: ', pic_path]);
```

```
        Excel.ActiveSheet.Shapes.AddPicture(pic_path, 0, 1,
    100, i*100, 200, 200);
     end

     % Save and close the Excel file
     Excel.ActiveWorkBook.SaveAs(excelFileName);
     pause(1); % waits for 1 second

     Excel.ActiveWorkbook.Close;
     Excel.Quit;
     Excel.delete;
     clear Excel;

function I = IntervalDivision(a,b,TOL)
if abs(b-a)>=TOL
   m = abs(b-a)/2;
   I = [IntervalDivision(a,a+m,TOL); IntervalDivision(a+m,b,TOL
    )];
   return;
else
    I = [a b];
end
return

function R = FindRoots(Y,a,b,TOL)
syms x;
I = IntervalDivision(a,b,TOL);
n = size(I,1);
SubsI = zeros(size(I));
for i = 1:n
    SubsI(i,1) = subs(Y,x,I(i,1));
    SubsI(i,2) = subs(Y,x,I(i,2));
end

icount = 1;
for i = 1:n
   if SubsI(i,1) == 0
       R(icount) = I(i,1);
       icount = icount+1;
   elseif SubsI(i,1) == 0
       R(icount) = I(i,1);
       icount = icount+1;
   elseif SubsI(i,1)*SubsI(i,2) < 0
       R(icount) = (I(i,2)+I(i,1))/2;
       icount = icount+1;
   end
end
return
```

Example code for two-dimensional elastic body using bi-cubics

```
function [E, n, m] = TwoDimensionalCantileverCubic(n,alpha,
    graph)
format long g
%gpuDevice(2)
beta = 1;
%alpha = 300;
gamma = 0.3205;
nu = 0.3;
iA = 1/(1-nu^2);
iB = 1/(2*gamma*(1+nu));

ex = sqrt(12/alpha);
h=ex
%ex = h
m = ceil(n*ex);

if(m <= 1)
    m = 2;
end
%if(m >= 15)
%    m = 15;
%end
%n
%m = 2

a = 0;
b = 1;
c = 0;

%d = sqrt(12/alpha);
d =h
deltx = (b-a)/n;
delty = (d-c)/m;

[MM,Kxx,Kxy,Kyy,D0] = CalMatrix(n,m,deltx,delty);
Kyx = Kxy';%CHECKED
All = (n+1)*(m+1);

K1 = Kxx + (1-nu)/2*Kyy;
K2 = nu*Kyx + (1-nu)/2*Kxy;
```

```
K3 = nu*Kxy + (1-nu)/2*Kyx;
K4 = Kyy + (1-nu)/2*Kxx;
O = sparse(size(MM,1),size(MM,2));%CHECKED
MMu = [MM O;%CHECKED
       O MM];%CHECKED
Mf = MMu;
K = 1/(gamma*(1-nu^2))*[K1 K2; K3 K4];%CHECKED
x = [7*All:-1:7*All-(m+1)+1 5*All:-1:5*All-(m+1)+1 3*All:-1:3*
    All-(m+1)+1 1*All:-1:1*All-(m+1)+1];
K(x,:) = [];
K(:,x) = [];
MMu(x,:) = [];
MMu(:,x) = [];
Mf(x,:) = [];
%CHECKED
%eig(Mu,K)
[V,D] = eigs(K,MMu,20,'sm');
E = diag(D);
size(K)

if (graph == 1)
    for i = 1:10
        w = V(:,i);

        f = -1/200;
        F1 = zeros((n+1)*(m+1),1);
        F1(ceil((1+(m+1))/2)) = f;
        F = zeros(8*(n+1)*(m+1),1);
        F(4*(n+1)*(m+1)+1:5*(n+1)*(m+1)) = F1;


        %ueq = K\MMu*(-w);
        tic
        %Kg = gpuArray(K);
        %Mfg = gpuArray(Mf);
        %Fg = gpuArray(F);
        toc

        %b =Mf*(-F);
        %tic
        %ueq = K\Mf*(-F);
        %toc
        b = MMu*(-w);
        tic
        tol = 0.00001;
        maxit = 30000;
        alpha1 = max(sum(abs(K),2)./diag(K))-2;
```

```
86          L = ichol(K,struct('type','ict','droptol',1e-3,'
    diagcomp',alpha1));
87          ueq = pcg(K,b,tol,maxit,L,L');
88          toc
89
90          Ep = Positions(m,n,deltx,delty);
91          %ux = 0;
92          %uy = 0;
93          ux = [ueq(1:(n+1)*(m+1)-(m+1),1);zeros(m+1,1)] + Ep
    (:,1);
94          dxux = [ueq((n+1)*(m+1)-(m+1)+1:2*(n+1)*(m+1)-(m+1),1)
    ];
95          dyux = [ueq(2*(n+1)*(m+1)-(m+1)+1:3*(n+1)*(m+1)-2*(m+1)
    ,1);zeros(m+1,1)];
96          dxyux = [ueq(3*(n+1)*(m+1)-2*(m+1)+1:4*(n+1)*(m+1)-2*(m
    +1),1)];
97          uy = [ueq(4*(n+1)*(m+1)-2*(m+1)+1:5*(n+1)*(m+1)-3*(m+1)
    ,1);zeros(m+1,1)] + Ep(:,2);
98          dxuy = [ueq(5*(n+1)*(m+1)-3*(m+1)+1:6*(n+1)*(m+1)-3*(m
    +1),1)];
99          dyuy = [ueq(6*(n+1)*(m+1)-3*(m+1)+1:7*(n+1)*(m+1)-4*(m
    +1),1);zeros(m+1,1)];
100         dxyuy = [ueq(7*(n+1)*(m+1)-4*(m+1)+1:8*(n+1)*(m+1)-4*(m
    +1),1)];
101
102         ux = flip(ux);
103         dxux = flip(dxux);
104         dyux = flip(dyux);
105         dxyux = flip(dxyux);
106         uy = flip(uy);
107         dxuy = flip(dxuy);
108         dyuy = flip(dyuy);
109         dxyuy = flip(dxyuy);
110
111         uxB = ux(D0(ceil((m+1)/2),:));
112         uyB = uy(D0(ceil((m+1)/2),:));
113         dxuxB = dxux(D0(ceil((m+1)/2),:));
114         dxuyB = dxuy(D0(ceil((m+1)/2),:));
115         dyuxB = dyux(D0(ceil((m+1)/2),:));
116         dyuyB = dyuy(D0(ceil((m+1)/2),:));
117         dxyuxB = dxyux(D0(ceil((m+1)/2),:));
118         dxyuyB = dxyuy(D0(ceil((m+1)/2),:));
119
120         maxs = norm(uy,Inf);
121         uy = uy/maxs;
122         stress = ceil((n+1)/2);
123         figure(i);
124
```

```
125         scatter(ux,uy, 'b', 'filled'); % blue filled circles
126         hold on;
127 
128         middleIndex = ceil(size(D0,1)/2);  % Find the middle
    row of D0
129         ux1 = ux(D0(middleIndex,:));
130         uy1 = uy(D0(middleIndex,:));
131         maxs2 =  norm(uy1,Inf);
132 
133         plot(ux1,uy1, 'r', 'LineWidth', 2); % red line with
    thicker width
134 
135         % Add titles, labels, and legends
136         title(['Eigenfunction ' num2str(i)]);
137         xlabel('Ux');
138         ylabel('Uy');
139         legend('Ux vs. Uy', 'Transformed Ux vs. Uy', 'Location'
    , 'best');
140 
141         grid on; % Add a grid for better readability
142         sigma11 = 1/(gamma*(1-nu^2))*(dxuxB + nu*dyuyB);
143         sigma22 = 1/(gamma*(1-nu^2))*(dyuyB + nu*dxuxB);
144         sigma12 = 1/(2*gamma*(1+nu))*(dyuxB + dxuyB);
145 
146         T = [sigma11(stress) sigma12(stress);sigma12(stress)
    sigma22(stress)]
147     end
148 end
149 return;
150 
151 function [Mq,Kxxq,Kxyq,Kyyq] = matrix(deltx,delty)%CHECKED
152 syms x;
153 syms y;
154 
155 Q = [1 x x^2 x^3 y x*y x^2*y x^3*y y^2 x*y^2 x^2*y^2 x^3*y^2 y
    ^3 x*y^3 x^2*y^3 x^3*y^3];
156 
157 size_num = size(Q,2)/4;
158 T = MATRIX_T(Q);
159 
160 Mq = zeros(size(Q,2))*x*y;
161 Kxxq = zeros(size(Q,2))*x*y;
162 Kxyq = zeros(size(Q,2))*x*y;
163 Kyyq = zeros(size(Q,2))*x*y;
164 
165 for i = 1:size(Q,2)
166     for j = 1:size(Q,2)
167         Mq(j,i) = Q(j)*Q(i);
```

```
        Kxxq(j,i) = diff(Q(j),x)*diff(Q(i),x);
        Kxyq(j,i) = diff(Q(j),y)*diff(Q(i),x);
        Kyyq(j,i) = diff(Q(j),y)*diff(Q(i),y);
    end
end

Mq = int(int(Mq,x,0,1),y,0,1);
Kxxq = int(int(Kxxq,x,0,1),y,0,1);
Kxyq = int(int(Kxyq,x,0,1),y,0,1);
Kyyq = int(int(Kyyq,x,0,1),y,0,1);

IT = inv(T);

Mq = (IT)'*Mq*IT;
Kxxq = (IT)'*Kxxq*IT;
Kxyq = (IT)'*Kxyq*IT;
Kyyq = (IT)'*Kyyq*IT;

Mq = double(Mq*deltx*delty);
Kxxq = double(Kxxq*delty/deltx);
Kyyq = double(Kyyq*deltx/delty);
Kxyq = double(Kxyq);
return;

function [Adj, Type, D] = Domain(n,m)
D = zeros(m+1,n+1);
icount = 1;
for i = n+1:-1:1
   for j = 1:m+1
       D(j,i) = icount;
       icount = icount + 1;
   end
end
D0 = [zeros(1,n+3);zeros(m+1,1) D zeros(m+1,1);zeros(1,n+3)];
icount = 1;
Adj = zeros((n+1)*(m+1),9);
for i = n+2:-1:2
   for j = 2:m+2
   Adj(icount,1) = D0(j,i); %middel
   Adj(icount,2) = D0(j-1,i); %bo
   Adj(icount,3) = D0(j-1,i+1); %regsbo
   Adj(icount,4) = D0(j,i+1); %regs
   Adj(icount,5) = D0(j+1,i+1); %regs onder
   Adj(icount,6) = D0(j+1,i); %onder
   Adj(icount,7) = D0(j+1,i-1); %links onder
   Adj(icount,8) = D0(j,i-1); %links
   Adj(icount,9) = D0(j-1,i-1); %linksbo
   icount = icount +1;
```

```
    end
end
Type= zeros((n+1)*(m+1),2);
T = [1     0     0     0     0     2     5     4     0;
     2     1     0     0     0     3     6     5     4;
     3     2     0     0     0     0     0     6     5;
     4     0     0     1     2     5     8     7     0;
     5     4     1     2     3     6     9     8     7;
     6     5     2     3     0     0     0     9     8;
     7     0     0     4     5     8     0     0     0;
     8     7     4     5     6     9     0     0     0;
     9     8     5     6     0     0     0     0     0];
 nnz(T);

for i = 1:(n+1)*(m+1)
    Type(i,1) = Adj(i,1);
    for j = 1:9
        bflag = true;
        for k = 1:9
            if(any(T(j,k)) ~= any(Adj(i,k)))
                bflag = false;
            end
        end
        if(bflag == true)
           Type(i,2) = j;
        end
    end
end
return

function [M,Kxx,Kxy,Kyy,D0] = CalMatrix(n,m,deltx,delty)
[Adj, Type, D0] = Domain(n,m);
[Mq,Kxxq,Kxyq,Kyyq] = matrix(deltx,delty);

ns = nnz(Adj);
Ms = zeros(16*ns,1);
Kxxs = zeros(16*ns,1);
Kxys = zeros(16*ns,1);
Kyys = zeros(16*ns,1);

x = [1:(n+1)*(m+1)]';
c = sum(Adj~=0,2);

ix = repelem(x,c);
x = [ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);
     ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);
     ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);
     ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);];
```

```
264
265 iy = nonzeros(Adj');
266 y = [iy;iy;iy;iy;
267     iy+(n+1)*(m+1);iy+(n+1)*(m+1);iy+(n+1)*(m+1);iy+(n+1)*(m+1)
    ;
268     iy+2*(n+1)*(m+1);iy+2*(n+1)*(m+1);iy+2*(n+1)*(m+1);iy+2*(n
    +1)*(m+1);
269     iy+3*(n+1)*(m+1);iy+3*(n+1)*(m+1);iy+3*(n+1)*(m+1);iy+3*(n
    +1)*(m+1)];
270 B = BMatrix();
271
272 Adj(Adj == 0) = nan;
273 NanAdj = ~isnan(Adj);
274 NanAdj = NanAdj';
275
276 a = 1:9;
277 b = repelem(a,size(Adj,1),1);
278 b = b';
279 iz = b(NanAdj);
280
281 for i = 1:ns
282   k = 1;
283   while(B(Type(ix(i),2),iz(i),k) ~= 0)
284     Ms(i)   = Ms(i) + Mq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i)
    ,2),iz(i),k+1));
285     Kxxs(i) = Kxxs(i) + Kxxq(B(Type(ix(i),2),iz(i),k),B(Type(ix
    (i),2),iz(i),k+1));
286     Kxys(i) = Kxys(i) + Kxyq(B(Type(ix(i),2),iz(i),k),B(Type(ix
    (i),2),iz(i),k+1));
287     Kyys(i) = Kyys(i) + Kyyq(B(Type(ix(i),2),iz(i),k),B(Type(ix
    (i),2),iz(i),k+1));
288
289     Ms(ns+i)   = Ms(ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+4,B(
    Type(ix(i),2),iz(i),k+1));
290     Kxxs(ns+i) = Kxxs(ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1));
291     Kxys(ns+i) = Kxys(ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1));
292     Kyys(ns+i) = Kyys(ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1));
293
294     Ms(2*ns+i)   = Ms(2*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+8,B
    (Type(ix(i),2),iz(i),k+1));
295     Kxxs(2*ns+i) = Kxxs(2*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1));
296     Kxys(2*ns+i) = Kxys(2*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1));
```

```
297     Kyys(2*ns+i) = Kyys(2*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
        +8,B(Type(ix(i),2),iz(i),k+1));
298
299     Ms(3*ns+i)   = Ms(3*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+12,
        B(Type(ix(i),2),iz(i),k+1));
300     Kxxs(3*ns+i) = Kxxs(3*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
        +12,B(Type(ix(i),2),iz(i),k+1));
301     Kxys(3*ns+i) = Kxys(3*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
        +12,B(Type(ix(i),2),iz(i),k+1));
302     Kyys(3*ns+i) = Kyys(3*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
        +12,B(Type(ix(i),2),iz(i),k+1));
303
304   %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
305     Ms(4*ns+i)   = Ms(4*ns+i) + Mq(B(Type(ix(i),2),iz(i),k),B(
        Type(ix(i),2),iz(i),k+1)+4);
306     Kxxs(4*ns+i) = Kxxs(4*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
        ,B(Type(ix(i),2),iz(i),k+1)+4);
307     Kxys(4*ns+i) = Kxys(4*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
        ,B(Type(ix(i),2),iz(i),k+1)+4);
308     Kyys(4*ns+i) = Kyys(4*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
        ,B(Type(ix(i),2),iz(i),k+1)+4);
309
310     Ms(5*ns+i)   = Ms(5*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+4,B
        (Type(ix(i),2),iz(i),k+1)+4);
311     Kxxs(5*ns+i) = Kxxs(5*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
        +4,B(Type(ix(i),2),iz(i),k+1)+4);
312     Kxys(5*ns+i) = Kxys(5*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
        +4,B(Type(ix(i),2),iz(i),k+1)+4);
313     Kyys(5*ns+i) = Kyys(5*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
        +4,B(Type(ix(i),2),iz(i),k+1)+4);
314
315     Ms(6*ns+i)   = Ms(6*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+8,B
        (Type(ix(i),2),iz(i),k+1)+4);
316     Kxxs(6*ns+i) = Kxxs(6*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
        +8,B(Type(ix(i),2),iz(i),k+1)+4);
317     Kxys(6*ns+i) = Kxys(6*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
        +8,B(Type(ix(i),2),iz(i),k+1)+4);
318     Kyys(6*ns+i) = Kyys(6*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
        +8,B(Type(ix(i),2),iz(i),k+1)+4);
319
320     Ms(7*ns+i)   = Ms(7*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+12,
        B(Type(ix(i),2),iz(i),k+1)+4);
321     Kxxs(7*ns+i) = Kxxs(7*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
        +12,B(Type(ix(i),2),iz(i),k+1)+4);
322     Kxys(7*ns+i) = Kxys(7*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
        +12,B(Type(ix(i),2),iz(i),k+1)+4);
323     Kyys(7*ns+i) = Kyys(7*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
        +12,B(Type(ix(i),2),iz(i),k+1)+4);
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    Ms(8*ns+i)   = Ms(8*ns+i) + Mq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+8);
    Kxxs(8*ns+i) = Kxxs(8*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+8);
    Kxys(8*ns+i) = Kxys(8*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+8);
    Kyys(8*ns+i) = Kyys(8*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+8);

    Ms(9*ns+i)   = Ms(9*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+4,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxxs(9*ns+i) = Kxxs(9*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)+4,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxys(9*ns+i) = Kxys(9*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)+4,B(Type(ix(i),2),iz(i),k+1)+8);
    Kyys(9*ns+i) = Kyys(9*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)+4,B(Type(ix(i),2),iz(i),k+1)+8);

    Ms(10*ns+i)   = Ms(10*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+8,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxxs(10*ns+i) = Kxxs(10*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)+8,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxys(10*ns+i) = Kxys(10*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)+8,B(Type(ix(i),2),iz(i),k+1)+8);
    Kyys(10*ns+i) = Kyys(10*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)+8,B(Type(ix(i),2),iz(i),k+1)+8);

    Ms(11*ns+i)   = Ms(11*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+12,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxxs(11*ns+i) = Kxxs(11*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)+12,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxys(11*ns+i) = Kxys(11*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)+12,B(Type(ix(i),2),iz(i),k+1)+8);
    Kyys(11*ns+i) = Kyys(11*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)+12,B(Type(ix(i),2),iz(i),k+1)+8);
      %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    Ms(12*ns+i)   = Ms(12*ns+i) + Mq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+12);
    Kxxs(12*ns+i) = Kxxs(12*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+12);
    Kxys(12*ns+i) = Kxys(12*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+12);
    Kyys(12*ns+i) = Kyys(12*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i),2),iz(i),k+1)+12);

```

```
351      Ms(13*ns+i)    = Ms(13*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+12);
352      Kxxs(13*ns+i) = Kxxs(13*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
    k)+4,B(Type(ix(i),2),iz(i),k+1)+12);
353      Kxys(13*ns+i) = Kxys(13*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
    k)+4,B(Type(ix(i),2),iz(i),k+1)+12);
354      Kyys(13*ns+i) = Kyys(13*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
    k)+4,B(Type(ix(i),2),iz(i),k+1)+12);
355
356      Ms(14*ns+i)    = Ms(14*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1)+12);
357      Kxxs(14*ns+i) = Kxxs(14*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
    k)+8,B(Type(ix(i),2),iz(i),k+1)+12);
358      Kxys(14*ns+i) = Kxys(14*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
    k)+8,B(Type(ix(i),2),iz(i),k+1)+12);
359      Kyys(14*ns+i) = Kyys(14*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
    k)+8,B(Type(ix(i),2),iz(i),k+1)+12);
360
361      Ms(15*ns+i)    = Ms(15*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+12);
362      Kxxs(15*ns+i) = Kxxs(15*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
    k)+12,B(Type(ix(i),2),iz(i),k+1)+12);
363      Kxys(15*ns+i) = Kxys(15*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
    k)+12,B(Type(ix(i),2),iz(i),k+1)+12);
364      Kyys(15*ns+i) = Kyys(15*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
    k)+12,B(Type(ix(i),2),iz(i),k+1)+12);
365
366      k = k + 2;
367      if(k > 8)
368         break;
369      end
370    end
371 end
372 M   = sparse(x,y,Ms,4*(n+1)*(m+1),4*(n+1)*(m+1));
373 Kxx = sparse(x,y,Kxxs,4*(n+1)*(m+1),4*(n+1)*(m+1));
374 Kxy = sparse(x,y,Kxys,4*(n+1)*(m+1),4*(n+1)*(m+1));
375 Kyy = sparse(x,y,Kyys,4*(n+1)*(m+1),4*(n+1)*(m+1));
376 return;
377
378 function B = BMatrix()
379 B = zeros(9,9,8);
380 B(3,1,:) = [2 2 0 0 0 0 0 0];
381 B(3,2,:) = [2 3 0 0 0 0 0 0];
382 B(3,3,:) = [0 0 0 0 0 0 0 0];
383 B(3,4,:) = [0 0 0 0 0 0 0 0];
384 B(3,5,:) = [0 0 0 0 0 0 0 0];
385 B(3,6,:) = [0 0 0 0 0 0 0 0];
386 B(3,7,:) = [0 0 0 0 0 0 0 0];
```

```
B(3,8,:) = [2 1 0 0 0 0 0 0];
B(3,9,:) = [2 4 0 0 0 0 0 0];

B(2,1,:) = [2 2 3 3 0 0 0 0];
B(2,2,:) = [2 3 0 0 0 0 0 0];
B(2,3,:) = [0 0 0 0 0 0 0 0];
B(2,4,:) = [0 0 0 0 0 0 0 0];
B(2,5,:) = [0 0 0 0 0 0 0 0];
B(2,6,:) = [3 2 0 0 0 0 0 0];
B(2,7,:) = [3 1 0 0 0 0 0 0];
B(2,8,:) = [2 1 3 4 0 0 0 0];
B(2,9,:) = [2 4 0 0 0 0 0 0];

B(1,1,:) = [3 3 0 0 0 0 0 0];
B(1,2,:) = [0 0 0 0 0 0 0 0];
B(1,3,:) = [0 0 0 0 0 0 0 0];
B(1,4,:) = [0 0 0 0 0 0 0 0];
B(1,5,:) = [0 0 0 0 0 0 0 0];
B(1,6,:) = [3 2 0 0 0 0 0 0];
B(1,7,:) = [3 1 0 0 0 0 0 0];
B(1,8,:) = [3 4 0 0 0 0 0 0];
B(1,9,:) = [0 0 0 0 0 0 0 0];

B(6,1,:) = [1 1 2 2 0 0 0 0];
B(6,2,:) = [1 4 2 3 0 0 0 0];
B(6,3,:) = [1 3 0 0 0 0 0 0];
B(6,4,:) = [1 2 0 0 0 0 0 0];
B(6,5,:) = [0 0 0 0 0 0 0 0];
B(6,6,:) = [0 0 0 0 0 0 0 0];
B(6,7,:) = [0 0 0 0 0 0 0 0];
B(6,8,:) = [2 1 0 0 0 0 0 0];
B(6,9,:) = [2 4 0 0 0 0 0 0];

B(5,1,:) = [1 1 2 2 3 3 4 4];
B(5,2,:) = [1 4 2 3 0 0 0 0];
B(5,3,:) = [1 3 0 0 0 0 0 0];
B(5,4,:) = [1 2 4 3 0 0 0 0];
B(5,5,:) = [4 2 0 0 0 0 0 0];
B(5,6,:) = [4 1 3 2 0 0 0 0];
B(5,7,:) = [3 1 0 0 0 0 0 0];
B(5,8,:) = [3 4 2 1 0 0 0 0];
B(5,9,:) = [2 4 0 0 0 0 0 0];

B(4,1,:) = [3 3 4 4 0 0 0 0];
B(4,2,:) = [0 0 0 0 0 0 0 0];
B(4,3,:) = [0 0 0 0 0 0 0 0];
B(4,4,:) = [4 3 0 0 0 0 0 0];
B(4,5,:) = [4 2 0 0 0 0 0 0];
```

```
B(4,6,:) = [4 1 3 2 0 0 0 0];
B(4,7,:) = [3 1 0 0 0 0 0 0];
B(4,8,:) = [3 4 0 0 0 0 0 0];
B(4,9,:) = [0 0 0 0 0 0 0 0];

B(9,1,:) = [1 1 0 0 0 0 0 0];
B(9,2,:) = [1 4 0 0 0 0 0 0];
B(9,3,:) = [1 3 0 0 0 0 0 0];
B(9,4,:) = [1 2 0 0 0 0 0 0];
B(9,5,:) = [0 0 0 0 0 0 0 0];
B(9,6,:) = [0 0 0 0 0 0 0 0];
B(9,7,:) = [0 0 0 0 0 0 0 0];
B(9,8,:) = [0 0 0 0 0 0 0 0];
B(9,9,:) = [0 0 0 0 0 0 0 0];

B(8,1,:) = [1 1 4 4 0 0 0 0];
B(8,2,:) = [1 4 0 0 0 0 0 0];
B(8,3,:) = [1 3 0 0 0 0 0 0];
B(8,4,:) = [1 2 4 3 0 0 0 0];
B(8,5,:) = [4 2 0 0 0 0 0 0];
B(8,6,:) = [4 1 0 0 0 0 0 0];
B(8,7,:) = [0 0 0 0 0 0 0 0];
B(8,8,:) = [0 0 0 0 0 0 0 0];
B(8,9,:) = [0 0 0 0 0 0 0 0];

B(7,1,:) = [4 4 0 0 0 0 0 0];
B(7,2,:) = [0 0 0 0 0 0 0 0];
B(7,3,:) = [0 0 0 0 0 0 0 0];
B(7,4,:) = [4 3 0 0 0 0 0 0];
B(7,5,:) = [4 2 0 0 0 0 0 0];
B(7,6,:) = [4 1 0 0 0 0 0 0];
B(7,7,:) = [0 0 0 0 0 0 0 0];
B(7,8,:) = [0 0 0 0 0 0 0 0];
B(7,9,:) = [0 0 0 0 0 0 0 0];
return;

function T = MATRIX_T(Q)
syms x;
syms y;

n = size(Q,2);

T = zeros(n);
for j = 1:n
   T(j,1) = subs(Q(j),[x,y],[0,0]);
   T(j,2) = subs(Q(j),[x,y],[1,0]);
   T(j,3) = subs(Q(j),[x,y],[1,1]);
   T(j,4) = subs(Q(j),[x,y],[0,1]);
```

```
    if(n > 4)
    T(j,5) = subs(diff(Q(j),x),[x,y],[0,0]);
    T(j,6) = subs(diff(Q(j),x),[x,y],[1,0]);
    T(j,7) = subs(diff(Q(j),x),[x,y],[1,1]);
    T(j,8) = subs(diff(Q(j),x),[x,y],[0,1]);
    end
    if(n > 8)
    T(j,9) = subs(diff(Q(j),y),[x,y],[0,0]);
    T(j,10) = subs(diff(Q(j),y),[x,y],[1,0]);
    T(j,11) = subs(diff(Q(j),y),[x,y],[1,1]);
    T(j,12) = subs(diff(Q(j),y),[x,y],[0,1]);
    end
    if(n > 12)
    T(j,13) = subs(diff(diff(Q(j),y),x),[x,y],[0,0]);
    T(j,14) = subs(diff(diff(Q(j),y),x),[x,y],[1,0]);
    T(j,15) = subs(diff(diff(Q(j),y),x),[x,y],[1,1]);
    T(j,16) = subs(diff(diff(Q(j),y),x),[x,y],[0,1]);
    end
end
T = T';
return

function E = Positions(m,n,dx,dy)
    E = zeros((n+1)*(m+1),2);
    ix = n+1;
    iy = m+1;
    for i = 1:(n+1)*(m+1)
        E(i,:) = [dx*(ix-1),dy*(iy-1)];

        iy = iy-1;
        if(iy == 0)
            iy = m+1;
            ix = ix -1;
        end
    end
    %[Cubes,CubeNumbers] = CreateCubes(E,N);
    %Plot(E,N,Cubes)
return
```

Example code for Reissner-Mindlin plate model using bi-cubics

```
%function [E,wP,xP,yP,size_c] = PlateCantileverCubic(d,n,h,inum
    ,numEig)
function [E,n,m] = PlateCantileverCubic(d,n,h,inum,numEig)
```

```
format long g
m = ceil(n*d);
a = 0;
b = 1;
c = 0;

%h = sqrt(12/alpha);
%d = 1;
deltx = (b-a)/n;
delty = (d-c)/m;

size_c = (n+1)*(m+1);

nu = 0.3;

kappa_b = (5/6);
kappa_p = 0.9554;%0.29738*nu + 0.763932;

I = (h^3)/12;
beta = kappa_b/((2*(1+nu))*I);%*alpha;%0.3846*kappa_p/I
A = 1/(beta*(1-nu^2));
B = 1/(2*beta*(1+nu));

[MM,Kxx,Kxy,Kyy,Lx,Ly,Edge] = CalMatrix(n,m,deltx,delty);
LxT = Lx';
LyT = Ly';
Kyx = Kxy';%CHECKED
O = sparse(size(MM,1),size(MM,2));
Mu = [MM O O; O I*MM O; O O I*MM];
Ku = [Kxx+Kyy LxT LyT; h*Lx A*Kxx+B*Kyy+h*MM A*nu*Kyx+B*Kxy; h*
    Ly A*nu*Kxy+B*Kyx A*Kyy+B*Kxx+h*MM];%The correct one!
%Ku = [Kxx+Kyy Lx Ly; h*LxT A*Kxx+B*Kyy+h*MM A*nu*Kxy+B*Kyx; h*
    LyT A*nu*Kyx+B*Kxy A*Kyy+B*Kxx+h*MM];%The not correct one!
%Ku = [h*(Kxx+Kyy) h*Lx h*Ly; h*LxT A*Kxx+B*Kyy+h*MM A*nu*Kxy+B
    *Kyx; h*LyT A*nu*Kyx+B*Kxy A*Kyy+B*Kxx+h*MM];
Mq = [MM O O; O O O; O O O];
F = zeros(size(Mu,1),1);
F(1:(m+1),1) = 0.01;
x = [];

for i = [0 2 4 6 8 10]
    x = [x; Edge+(i)*(m+1)*(n+1)];
end
Mu(x,:) = [];
Mu(:,x) = [];
Ku(x,:) = [];
Ku(:,x) = [];
Mq(x,:) = [];
```

```
48
49 [R,p,s] = chol(Mu,'vector');
50 [V,DE,flag] = eigs(Ku,R,numEig,'smallestabs','IsCholesky',true,
       'CholeskyPermutation',s,'Tolerance',1e-4);
51 E = diag(DE);
52
53 %[V,D] = eigs(Ku,Mu,numEig,'sm');
54 %E = diag(D);
55 %V = V(:,E>=0);
56 %E = E(E>=0);
57
58 %tic
59 %Kug = gpuArray(Ku);
60 %bg = gpuArray(Mq*(F));
61 %u = gmres(Kug,bg,30,1e-4,30);
62 %ueq = gather(u);
63
64 %toc
65 %wP = [ueq(1:(m+1)*(n+1)-(m+1),1); zeros(m+1,1)];
66
67 %inum = 1
68 wP = zeros(inum,(m+1)*(n+1));
69 %wP(1,:) = [ueq(1:(m+1)*(n+1)-(m+1),1); zeros(m+1,1)];
70 for i = inum:-1:1
71 w = V(:,i);
72 tic
73 Kug = gpuArray(Ku);
74 bg = gpuArray(Mu*(w));
75 u = gmres(Kug,bg,30,1e-4,30);
76 ueq = gather(u);
77
78 %bg = Mu*(w);
79 %ueq = gmres(Ku,bg,30,1e-4,30);
80
81 toc
82 wP(i,:) = [ueq(1:(m+1)*(n+1)-(m+1),1); zeros(m+1,1)];
83 end
84
85 icx = b;
86 icy = d;
87 icount = 1;
88 xP = zeros(1,(n+1)*(m+1));
89 yP = zeros(1,(n+1)*(m+1));
90 for i = 1:n+1
91    for j = 1:m+1
92       xP(1,icount) = icx;
93       yP(1,icount) = icy;
94       icy = icy - delty;
```

```
95          icount = icount + 1;
96      end
97      icx = icx - deltx;
98      icy = d;
99  end
100
101 %for i = inum:-1:1
102 %figure();
103 %scatter3(xP(1,:),yP(1,:),wP(i,:));
104 %end
105
106
107 %}
108 %w = V(:,8);
109
110 %Kyx = Kxy';%CHECKED
111 %All = (n+1)*(m+1);
112
113 %K1 = Kxx + (1-nu)/2*Kyy;
114 %K2 = nu*Kyx + (1-nu)/2*Kxy;
115 %K3 = nu*Kxy + (1-nu)/2*Kyx;
116 %K4 = Kyy + (1-nu)/2*Kxx;
117 %O = sparse(size(MM,1),size(MM,2));%CHECKED
118 %MMu = [MM O;%CHECKED
119 %        O MM];%CHECKED
120 %Mf = MMu;
121 %K = 1/(gamma*(1-nu^2))*[K1 K2; K3 K4];%CHECKED
122 %x = [7*All:-1:7*All-(m+1)+1 5*All:-1:5*All-(m+1)+1 3*All:-1:3*
        All-(m+1)+1 1*All:-1:1*All-(m+1)+1];
123 %K(x,:) = [];
124 %K(:,x) = [];
125 %MMu(x,:) = [];
126 %MMu(:,x) = [];
127 %Mf(x,:) = [];
128 %CHECKED
129 %eig(Mu,K)
130 %[V,D] = eigs(K,MMu,10,'sm');
131 %E = diag(D);
132 %w = V(:,8);
133
134
135
136
137 %ueq = Ku\Mu*(-w)
138
139 %b =Mf*(-F);
140 %tic
141 %ueq = K\Mf*(-F);
```

```
%toc

%{
tic
tol = 0.0001;
maxit = 300000;
alpha1 = max(sum(abs(K),2)./diag(K))-2;
L = ichol(K,struct('type','ict','droptol',1e-3,'diagcomp',
    alpha1));
%ueq = pcg(K,b,tol,maxit,L,L');
toc

Ep = Positions(m,n,deltx,delty);
%ux = 0;
%uy = 0;
ux = [ueq(1:(n+1)*(m+1)-(m+1),1);zeros(m+1,1)] + Ep(:,1);
dxux = [ueq((n+1)*(m+1)-(m+1)+1:2*(n+1)*(m+1)-(m+1),1)];
dyux = [ueq(2*(n+1)*(m+1)-(m+1)+1:3*(n+1)*(m+1)-2*(m+1),1);
    zeros(m+1,1)];
dxyux = [ueq(3*(n+1)*(m+1)-2*(m+1)+1:4*(n+1)*(m+1)-2*(m+1),1)];
uy = [ueq(4*(n+1)*(m+1)-2*(m+1)+1:5*(n+1)*(m+1)-3*(m+1),1);
    zeros(m+1,1)] + Ep(:,2);
dxuy = [ueq(5*(n+1)*(m+1)-3*(m+1)+1:6*(n+1)*(m+1)-3*(m+1),1)];
dyuy = [ueq(6*(n+1)*(m+1)-3*(m+1)+1:7*(n+1)*(m+1)-4*(m+1),1);
    zeros(m+1,1)];
dxyuy = [ueq(7*(n+1)*(m+1)-4*(m+1)+1:8*(n+1)*(m+1)-4*(m+1),1)];

ux = flip(ux);
dxux = flip(dxux);
dyux = flip(dyux);
dxyux = flip(dxyux);
uy = flip(uy);
dxuy = flip(dxuy);
dyuy = flip(dyuy);
dxyuy = flip(dxyuy);

stress = ceil((n+1)/2);
figure();
scatter(ux,uy);
sigma11 = 1/(gamma*(1-nu^2))*(dxux + nu*dyuy);
sigma22 = 1/(gamma*(1-nu^2))*(dyuy + nu*dxux);
sigma12 = 1/(2*gamma*(1+nu))*(dyux + dyux);

T = [sigma11(stress) sigma12(stress);sigma12(stress) sigma22(
    stress)];
%}
return;

```

```
function [Mq,Kxxq,Kxyq,Kyyq,Lxq,Lyq] = matrix(deltx,delty)% CHECKED
syms x;
syms y;

Q = [1 x x^2 x^3 y x*y x^2*y x^3*y y^2 x*y^2 x^2*y^2 x^3*y^2 y^3 x*y^3 x^2*y^3 x^3*y^3];

%size_num = size(Q,2)/4;
T = MATRIX_T(Q);

Mq   = zeros(size(Q,2))*x*y;
Kxxq = zeros(size(Q,2))*x*y;
Kxyq = zeros(size(Q,2))*x*y;
Kyyq = zeros(size(Q,2))*x*y;
Lxq  = zeros(size(Q,2))*x*y;
Lyq  = zeros(size(Q,2))*x*y;

for i = 1:size(Q,2)
    for j = 1:size(Q,2)
        Mq(j,i)   = Q(j)*Q(i);
        Kxxq(j,i) = diff(Q(j),x)*diff(Q(i),x);
        Kxyq(j,i) = diff(Q(j),y)*diff(Q(i),x);
        Kyyq(j,i) = diff(Q(j),y)*diff(Q(i),y);
        Lxq(j,i)  = Q(j)*diff(Q(i),x);
        Lyq(j,i)  = Q(j)*diff(Q(i),y);
    end
end
Mq = int(int(Mq,x,0,1),y,0,1);
Kxxq = int(int(Kxxq,x,0,1),y,0,1);
Kxyq = int(int(Kxyq,x,0,1),y,0,1);
Kyyq = int(int(Kyyq,x,0,1),y,0,1);
Lxq = int(int(Lxq,x,0,1),y,0,1);
Lyq = int(int(Lyq,x,0,1),y,0,1);

IT = inv(T);

Mq = (IT)'*Mq*IT;
Kxxq = (IT)'*Kxxq*IT;
Kxyq = (IT)'*Kxyq*IT;
Kyyq = (IT)'*Kyyq*IT;
Lxq = (IT)'*Lxq*IT;
Lyq = (IT)'*Lyq*IT;

Mq = double(Mq*deltx*delty);
Kxxq = double(Kxxq*delty/deltx);
Kyyq = double(Kyyq*deltx/delty);
Kxyq = double(Kxyq);
```

```
Lxq = double(Lxq*delty);
Lyq = double(Lyq*deltx);
return;

function [Adj,Type,Edge] = Domain(n,m)
D = zeros(m+1,n+1);
icount = 1;
for i = n+1:-1:1
   for j = 1:m+1
       D(j,i) = icount;
       icount = icount + 1;
   end
end
%D
Edge1 = [];
Edge2 = [];
Edge3 = [];
Edge4 = [];
Edge1 = (D(:,1));
%Edge2 = (D(m+1,:)');
%Edge3 = (D(:,n+1));
%Edge4 = (D(1,:)');

Edge = sort(unique([Edge1; Edge2; Edge3; Edge4]));
%Edge

D0 = [zeros(1,n+3);zeros(m+1,1) D zeros(m+1,1);zeros(1,n+3)];

icount = 1;
Adj = zeros((n+1)*(m+1),9);
for i = n+2:-1:2
   for j = 2:m+2
   Adj(icount,1) = D0(j,i); %middel
   Adj(icount,2) = D0(j-1,i); %bo
   Adj(icount,3) = D0(j-1,i+1); %regsbo
   Adj(icount,4) = D0(j,i+1); %regs
   Adj(icount,5) = D0(j+1,i+1); %regs onder
   Adj(icount,6) = D0(j+1,i); %onder
   Adj(icount,7) = D0(j+1,i-1); %links onder
   Adj(icount,8) = D0(j,i-1); %links
   Adj(icount,9) = D0(j-1,i-1); %linksbo
   icount = icount +1;
   end
end
Type= zeros((n+1)*(m+1),2);
T = [1     0     0     0     0     2     5     4     0;
     2     1     0     0     0     3     6     5     4;
     3     2     0     0     0     0     0     6     5;
```

```
     4     0     0     1     2     5     8     7     0;
     5     4     1     2     3     6     9     8     7;
     6     5     2     3     0     0     0     9     8;
     7     0     0     4     5     8     0     0     0;
     8     7     4     5     6     9     0     0     0;
     9     8     5     6     0     0     0     0     0];
 nnz(T);

for i = 1:(n+1)*(m+1)
   Type(i,1) = Adj(i,1);
   for j = 1:9
       bflag = true;
       for k = 1:9
           if(any(T(j,k)) ~= any(Adj(i,k)))
               bflag = false;
           end
       end
       if(bflag == true)
          Type(i,2) = j;
       end
   end
end
return

function [M,Kxx,Kxy,Kyy,Lx,Ly,Edge] = CalMatrix(n,m,deltx,delty
   )
[Adj, Type, Edge] = Domain(n,m);
[Mq,Kxxq,Kxyq,Kyyq,Lxq,Lyq] = matrix(deltx,delty);

ns = nnz(Adj);
Ms = zeros(16*ns,1);
Kxxs = zeros(16*ns,1);
Kxys = zeros(16*ns,1);
Kyys = zeros(16*ns,1);
Lxs = zeros(16*ns,1);
Lys = zeros(16*ns,1);

x = [1:(n+1)*(m+1)]';
c = sum(Adj~=0,2);

ix = repelem(x,c);
x = [ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);
    ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);
    ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);
    ix;ix+(n+1)*(m+1);ix+2*(n+1)*(m+1);ix+3*(n+1)*(m+1);];

iy = nonzeros(Adj');
y = [iy;iy;iy;iy;
```

```
326     iy+(n+1)*(m+1);iy+(n+1)*(m+1);iy+(n+1)*(m+1);iy+(n+1)*(m+1)
    ;
327     iy+2*(n+1)*(m+1);iy+2*(n+1)*(m+1);iy+2*(n+1)*(m+1);iy+2*(n
    +1)*(m+1);
328     iy+3*(n+1)*(m+1);iy+3*(n+1)*(m+1);iy+3*(n+1)*(m+1);iy+3*(n
    +1)*(m+1)];
329 B = BMatrix();
330
331 Adj(Adj == 0) = nan;
332 NanAdj = ~isnan(Adj);
333 NanAdj = NanAdj';
334
335 a = 1:9;
336 b = repelem(a,size(Adj,1),1);
337 b = b';
338 iz = b(NanAdj);
339
340 for i = 1:ns
341   k = 1;
342   while(B(Type(ix(i),2),iz(i),k) ~= 0)
343     Ms(i)   = Ms(i) + Mq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i)
    ,2),iz(i),k+1));
344     Kxxs(i) = Kxxs(i) + Kxxq(B(Type(ix(i),2),iz(i),k),B(Type(ix
    (i),2),iz(i),k+1));
345     Kxys(i) = Kxys(i) + Kxyq(B(Type(ix(i),2),iz(i),k),B(Type(ix
    (i),2),iz(i),k+1));
346     Kyys(i) = Kyys(i) + Kyyq(B(Type(ix(i),2),iz(i),k),B(Type(ix
    (i),2),iz(i),k+1));
347     Lxs(i) = Lxs(i) + Lxq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i)
    ,2),iz(i),k+1));
348     Lys(i) = Lys(i) + Lyq(B(Type(ix(i),2),iz(i),k),B(Type(ix(i)
    ,2),iz(i),k+1));
349
350     Ms(ns+i)   = Ms(ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+4,B(
    Type(ix(i),2),iz(i),k+1));
351     Kxxs(ns+i) = Kxxs(ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1));
352     Kxys(ns+i) = Kxys(ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1));
353     Kyys(ns+i) = Kyys(ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1));
354     Lxs(ns+i) = Lxs(ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)+4,B(
    Type(ix(i),2),iz(i),k+1));
355     Lys(ns+i) = Lys(ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)+4,B(
    Type(ix(i),2),iz(i),k+1));
356
357     Ms(2*ns+i)   = Ms(2*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+8,B
    (Type(ix(i),2),iz(i),k+1));
```

```
358     Kxxs(2*ns+i) = Kxxs(2*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1));
359     Kxys(2*ns+i) = Kxys(2*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1));
360     Kyys(2*ns+i) = Kyys(2*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1));
361     Lxs(2*ns+i) = Lxs(2*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)+8,
    B(Type(ix(i),2),iz(i),k+1));
362     Lys(2*ns+i) = Lys(2*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)+8,
    B(Type(ix(i),2),iz(i),k+1));
363
364     Ms(3*ns+i)   = Ms(3*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+12,
    B(Type(ix(i),2),iz(i),k+1));
365     Kxxs(3*ns+i) = Kxxs(3*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1));
366     Kxys(3*ns+i) = Kxys(3*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1));
367     Kyys(3*ns+i) = Kyys(3*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1));
368     Lxs(3*ns+i) = Lxs(3*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1));
369     Lys(3*ns+i) = Lys(3*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1));
370
371 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
372     Ms(4*ns+i)   = Ms(4*ns+i) + Mq(B(Type(ix(i),2),iz(i),k),B(
    Type(ix(i),2),iz(i),k+1)+4);
373     Kxxs(4*ns+i) = Kxxs(4*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    ,B(Type(ix(i),2),iz(i),k+1)+4);
374     Kxys(4*ns+i) = Kxys(4*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    ,B(Type(ix(i),2),iz(i),k+1)+4);
375     Kyys(4*ns+i) = Kyys(4*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
    ,B(Type(ix(i),2),iz(i),k+1)+4);
376     Lxs(4*ns+i) = Lxs(4*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k),B(
    Type(ix(i),2),iz(i),k+1)+4);
377     Lys(4*ns+i) = Lys(4*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k),B(
    Type(ix(i),2),iz(i),k+1)+4);
378
379     Ms(5*ns+i)   = Ms(5*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1)+4);
380     Kxxs(5*ns+i) = Kxxs(5*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+4);
381     Kxys(5*ns+i) = Kxys(5*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+4);
382     Kyys(5*ns+i) = Kyys(5*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+4);
383     Lxs(5*ns+i) = Lxs(5*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)+4,
    B(Type(ix(i),2),iz(i),k+1)+4);
```

```
384     Lys(5*ns+i) = Lys(5*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)+4,
    B(Type(ix(i),2),iz(i),k+1)+4);
385
386     Ms(6*ns+i)   = Ms(6*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+8,B
    (Type(ix(i),2),iz(i),k+1)+4);
387     Kxxs(6*ns+i) = Kxxs(6*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1)+4);
388     Kxys(6*ns+i) = Kxys(6*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1)+4);
389     Kyys(6*ns+i) = Kyys(6*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1)+4);
390     Lxs(6*ns+i) = Lxs(6*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)+8,
    B(Type(ix(i),2),iz(i),k+1)+4);
391     Lys(6*ns+i) = Lys(6*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)+8,
    B(Type(ix(i),2),iz(i),k+1)+4);
392
393     Ms(7*ns+i)   = Ms(7*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+12,
    B(Type(ix(i),2),iz(i),k+1)+4);
394     Kxxs(7*ns+i) = Kxxs(7*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+4);
395     Kxys(7*ns+i) = Kxys(7*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+4);
396     Kyys(7*ns+i) = Kyys(7*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+4);
397     Lxs(7*ns+i) = Lxs(7*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+4);
398     Lys(7*ns+i) = Lys(7*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+4);
399
400 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
401     Ms(8*ns+i)   = Ms(8*ns+i) + Mq(B(Type(ix(i),2),iz(i),k),B(
    Type(ix(i),2),iz(i),k+1)+8);
402     Kxxs(8*ns+i) = Kxxs(8*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    ,B(Type(ix(i),2),iz(i),k+1)+8);
403     Kxys(8*ns+i) = Kxys(8*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
    ,B(Type(ix(i),2),iz(i),k+1)+8);
404     Kyys(8*ns+i) = Kyys(8*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
    ,B(Type(ix(i),2),iz(i),k+1)+8);
405     Lxs(8*ns+i) = Lxs(8*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k),B(
    Type(ix(i),2),iz(i),k+1)+8);
406     Lys(8*ns+i) = Lys(8*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k),B(
    Type(ix(i),2),iz(i),k+1)+8);
407
408     Ms(9*ns+i)   = Ms(9*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)+4,B
    (Type(ix(i),2),iz(i),k+1)+8);
409     Kxxs(9*ns+i) = Kxxs(9*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+8);
```

```
    Kxys(9*ns+i) = Kxys(9*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),k)
   +4,B(Type(ix(i),2),iz(i),k+1)+8);
    Kyys(9*ns+i) = Kyys(9*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),k)
   +4,B(Type(ix(i),2),iz(i),k+1)+8);
    Lxs(9*ns+i) = Lxs(9*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)+4,
   B(Type(ix(i),2),iz(i),k+1)+8);
    Lys(9*ns+i) = Lys(9*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)+4,
   B(Type(ix(i),2),iz(i),k+1)+8);

    Ms(10*ns+i)   = Ms(10*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
   +8,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxxs(10*ns+i) = Kxxs(10*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
   k)+8,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxys(10*ns+i) = Kxys(10*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
   k)+8,B(Type(ix(i),2),iz(i),k+1)+8);
    Kyys(10*ns+i) = Kyys(10*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
   k)+8,B(Type(ix(i),2),iz(i),k+1)+8);
    Lxs(10*ns+i) = Lxs(10*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)
   +8,B(Type(ix(i),2),iz(i),k+1)+8);
    Lys(10*ns+i) = Lys(10*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)
   +8,B(Type(ix(i),2),iz(i),k+1)+8);

    Ms(11*ns+i)   = Ms(11*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
   +12,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxxs(11*ns+i) = Kxxs(11*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
   k)+12,B(Type(ix(i),2),iz(i),k+1)+8);
    Kxys(11*ns+i) = Kxys(11*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
   k)+12,B(Type(ix(i),2),iz(i),k+1)+8);
    Kyys(11*ns+i) = Kyys(11*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
   k)+12,B(Type(ix(i),2),iz(i),k+1)+8);
    Lxs(11*ns+i) = Lxs(11*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)
   +12,B(Type(ix(i),2),iz(i),k+1)+8);
    Lys(11*ns+i) = Lys(11*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)
   +12,B(Type(ix(i),2),iz(i),k+1)+8);
      %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    Ms(12*ns+i)   = Ms(12*ns+i) + Mq(B(Type(ix(i),2),iz(i),k),B
   (Type(ix(i),2),iz(i),k+1)+12);
    Kxxs(12*ns+i) = Kxxs(12*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
   k),B(Type(ix(i),2),iz(i),k+1)+12);
    Kxys(12*ns+i) = Kxys(12*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
   k),B(Type(ix(i),2),iz(i),k+1)+12);
    Kyys(12*ns+i) = Kyys(12*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
   k),B(Type(ix(i),2),iz(i),k+1)+12);
    Lxs(12*ns+i) = Lxs(12*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k),
   B(Type(ix(i),2),iz(i),k+1)+12);
    Lys(12*ns+i) = Lys(12*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k),
   B(Type(ix(i),2),iz(i),k+1)+12);

```

```
436      Ms(13*ns+i)    = Ms(13*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+12);
437      Kxxs(13*ns+i) = Kxxs(13*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
    k)+4,B(Type(ix(i),2),iz(i),k+1)+12);
438      Kxys(13*ns+i) = Kxys(13*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
    k)+4,B(Type(ix(i),2),iz(i),k+1)+12);
439      Kyys(13*ns+i) = Kyys(13*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
    k)+4,B(Type(ix(i),2),iz(i),k+1)+12);
440      Lxs(13*ns+i) = Lxs(13*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+12);
441      Lys(13*ns+i) = Lys(13*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)
    +4,B(Type(ix(i),2),iz(i),k+1)+12);
442
443      Ms(14*ns+i)    = Ms(14*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1)+12);
444      Kxxs(14*ns+i) = Kxxs(14*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
    k)+8,B(Type(ix(i),2),iz(i),k+1)+12);
445      Kxys(14*ns+i) = Kxys(14*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
    k)+8,B(Type(ix(i),2),iz(i),k+1)+12);
446      Kyys(14*ns+i) = Kyys(14*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
    k)+8,B(Type(ix(i),2),iz(i),k+1)+12);
447      Lxs(14*ns+i) = Lxs(14*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1)+12);
448      Lys(14*ns+i) = Lys(14*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)
    +8,B(Type(ix(i),2),iz(i),k+1)+12);
449
450      Ms(15*ns+i)    = Ms(15*ns+i) + Mq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+12);
451      Kxxs(15*ns+i) = Kxxs(15*ns+i) + Kxxq(B(Type(ix(i),2),iz(i),
    k)+12,B(Type(ix(i),2),iz(i),k+1)+12);
452      Kxys(15*ns+i) = Kxys(15*ns+i) + Kxyq(B(Type(ix(i),2),iz(i),
    k)+12,B(Type(ix(i),2),iz(i),k+1)+12);
453      Kyys(15*ns+i) = Kyys(15*ns+i) + Kyyq(B(Type(ix(i),2),iz(i),
    k)+12,B(Type(ix(i),2),iz(i),k+1)+12);
454      Lxs(15*ns+i) = Lxs(15*ns+i) + Lxq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+12);
455      Lys(15*ns+i) = Lys(15*ns+i) + Lyq(B(Type(ix(i),2),iz(i),k)
    +12,B(Type(ix(i),2),iz(i),k+1)+12);
456
457      k = k + 2;
458      if(k > 8)
459         break;
460      end
461    end
462 end
463 M   = sparse(x,y,Ms,4*(n+1)*(m+1),4*(n+1)*(m+1));
464 Kxx = sparse(x,y,Kxxs,4*(n+1)*(m+1),4*(n+1)*(m+1));
465 Kxy = sparse(x,y,Kxys,4*(n+1)*(m+1),4*(n+1)*(m+1));
```

```
Kyy = sparse(x,y,Kyys,4*(n+1)*(m+1),4*(n+1)*(m+1));
Lx = sparse(x,y,Lxs,4*(n+1)*(m+1),4*(n+1)*(m+1));
Ly = sparse(x,y,Lys,4*(n+1)*(m+1),4*(n+1)*(m+1));
return;

function B = BMatrix()
B = zeros(9,9,8);
B(3,1,:) = [2 2 0 0 0 0 0 0];
B(3,2,:) = [2 3 0 0 0 0 0 0];
B(3,3,:) = [0 0 0 0 0 0 0 0];
B(3,4,:) = [0 0 0 0 0 0 0 0];
B(3,5,:) = [0 0 0 0 0 0 0 0];
B(3,6,:) = [0 0 0 0 0 0 0 0];
B(3,7,:) = [0 0 0 0 0 0 0 0];
B(3,8,:) = [2 1 0 0 0 0 0 0];
B(3,9,:) = [2 4 0 0 0 0 0 0];

B(2,1,:) = [2 2 3 3 0 0 0 0];
B(2,2,:) = [2 3 0 0 0 0 0 0];
B(2,3,:) = [0 0 0 0 0 0 0 0];
B(2,4,:) = [0 0 0 0 0 0 0 0];
B(2,5,:) = [0 0 0 0 0 0 0 0];
B(2,6,:) = [3 2 0 0 0 0 0 0];
B(2,7,:) = [3 1 0 0 0 0 0 0];
B(2,8,:) = [2 1 3 4 0 0 0 0];
B(2,9,:) = [2 4 0 0 0 0 0 0];

B(1,1,:) = [3 3 0 0 0 0 0 0];
B(1,2,:) = [0 0 0 0 0 0 0 0];
B(1,3,:) = [0 0 0 0 0 0 0 0];
B(1,4,:) = [0 0 0 0 0 0 0 0];
B(1,5,:) = [0 0 0 0 0 0 0 0];
B(1,6,:) = [3 2 0 0 0 0 0 0];
B(1,7,:) = [3 1 0 0 0 0 0 0];
B(1,8,:) = [3 4 0 0 0 0 0 0];
B(1,9,:) = [0 0 0 0 0 0 0 0];

B(6,1,:) = [1 1 2 2 0 0 0 0];
B(6,2,:) = [1 4 2 3 0 0 0 0];
B(6,3,:) = [1 3 0 0 0 0 0 0];
B(6,4,:) = [1 2 0 0 0 0 0 0];
B(6,5,:) = [0 0 0 0 0 0 0 0];
B(6,6,:) = [0 0 0 0 0 0 0 0];
B(6,7,:) = [0 0 0 0 0 0 0 0];
B(6,8,:) = [2 1 0 0 0 0 0 0];
B(6,9,:) = [2 4 0 0 0 0 0 0];

B(5,1,:) = [1 1 2 2 3 3 4 4];
```

```
B(5,2,:) = [1 4 2 3 0 0 0 0];
B(5,3,:) = [1 3 0 0 0 0 0 0];
B(5,4,:) = [1 2 4 3 0 0 0 0];
B(5,5,:) = [4 2 0 0 0 0 0 0];
B(5,6,:) = [4 1 3 2 0 0 0 0];
B(5,7,:) = [3 1 0 0 0 0 0 0];
B(5,8,:) = [3 4 2 1 0 0 0 0];
B(5,9,:) = [2 4 0 0 0 0 0 0];

B(4,1,:) = [3 3 4 4 0 0 0 0];
B(4,2,:) = [0 0 0 0 0 0 0 0];
B(4,3,:) = [0 0 0 0 0 0 0 0];
B(4,4,:) = [4 3 0 0 0 0 0 0];
B(4,5,:) = [4 2 0 0 0 0 0 0];
B(4,6,:) = [4 1 3 2 0 0 0 0];
B(4,7,:) = [3 1 0 0 0 0 0 0];
B(4,8,:) = [3 4 0 0 0 0 0 0];
B(4,9,:) = [0 0 0 0 0 0 0 0];

B(9,1,:) = [1 1 0 0 0 0 0 0];
B(9,2,:) = [1 4 0 0 0 0 0 0];
B(9,3,:) = [1 3 0 0 0 0 0 0];
B(9,4,:) = [1 2 0 0 0 0 0 0];
B(9,5,:) = [0 0 0 0 0 0 0 0];
B(9,6,:) = [0 0 0 0 0 0 0 0];
B(9,7,:) = [0 0 0 0 0 0 0 0];
B(9,8,:) = [0 0 0 0 0 0 0 0];
B(9,9,:) = [0 0 0 0 0 0 0 0];

B(8,1,:) = [1 1 4 4 0 0 0 0];
B(8,2,:) = [1 4 0 0 0 0 0 0];
B(8,3,:) = [1 3 0 0 0 0 0 0];
B(8,4,:) = [1 2 4 3 0 0 0 0];
B(8,5,:) = [4 2 0 0 0 0 0 0];
B(8,6,:) = [4 1 0 0 0 0 0 0];
B(8,7,:) = [0 0 0 0 0 0 0 0];
B(8,8,:) = [0 0 0 0 0 0 0 0];
B(8,9,:) = [0 0 0 0 0 0 0 0];

B(7,1,:) = [4 4 0 0 0 0 0 0];
B(7,2,:) = [0 0 0 0 0 0 0 0];
B(7,3,:) = [0 0 0 0 0 0 0 0];
B(7,4,:) = [4 3 0 0 0 0 0 0];
B(7,5,:) = [4 2 0 0 0 0 0 0];
B(7,6,:) = [4 1 0 0 0 0 0 0];
B(7,7,:) = [0 0 0 0 0 0 0 0];
B(7,8,:) = [0 0 0 0 0 0 0 0];
B(7,9,:) = [0 0 0 0 0 0 0 0];
```

```
return;

function T = MATRIX_T(Q)
syms x;
syms y;

n = size(Q,2);

T = zeros(n);
for j = 1:n
   T(j,1) = subs(Q(j),[x,y],[0,0]);
   T(j,2) = subs(Q(j),[x,y],[1,0]);
   T(j,3) = subs(Q(j),[x,y],[1,1]);
   T(j,4) = subs(Q(j),[x,y],[0,1]);
   if(n > 4)
   T(j,5) = subs(diff(Q(j),x),[x,y],[0,0]);
   T(j,6) = subs(diff(Q(j),x),[x,y],[1,0]);
   T(j,7) = subs(diff(Q(j),x),[x,y],[1,1]);
   T(j,8) = subs(diff(Q(j),x),[x,y],[0,1]);
   end
   if(n > 8)
   T(j,9) = subs(diff(Q(j),y),[x,y],[0,0]);
   T(j,10) = subs(diff(Q(j),y),[x,y],[1,0]);
   T(j,11) = subs(diff(Q(j),y),[x,y],[1,1]);
   T(j,12) = subs(diff(Q(j),y),[x,y],[0,1]);
   end
   if(n > 12)
   T(j,13) = subs(diff(diff(Q(j),y),x),[x,y],[0,0]);
   T(j,14) = subs(diff(diff(Q(j),y),x),[x,y],[1,0]);
   T(j,15) = subs(diff(diff(Q(j),y),x),[x,y],[1,1]);
   T(j,16) = subs(diff(diff(Q(j),y),x),[x,y],[0,1]);
   end
end
T = T';
return

function E = Positions(m,n,dx,dy)
    E = zeros((n+1)*(m+1),2);
    ix = n+1;
    iy = m+1;
    for i = 1:(n+1)*(m+1)
        E(i,:) = [dx*(ix-1),dy*(iy-1)];

        iy = iy-1;
        if(iy == 0)
            iy = m+1;
            ix = ix -1;
        end
```

```
610     end
611     %[Cubes,CubeNumbers] = CreateCubes(E,N);
612     %Plot(E,N,Cubes)
613 return
```

Example code for three-dimensional elastic body using tri-cubics

```
1  %function [Eig,uxB,uyB,uzB,sz] = Copy_of_CubePC(s,n1,h,inum,
       numEig)
2  function [Eig,n1,n2,n3] = Copy_of_CubePC(s,n1,h,inum,numEig)
3  format long g
4  warning off;
5  method =2;
6
7
8
9  %mkdir(strcat('\Plots\',sprintf('%.6f',s)));
10 %gpuDevice(1);
11     %mwb = MultiWaitBar(3, 1, '3-Dimensional Beam Eigenvalue
       Calculator', 'g');
12     %mwb.Update(1, 1, 0, 'Total Progress - Setting parameters')
       ;
13     %mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(0) '%']);
14     %mwb.Update(3, 1, 0, 'Plot');
15     %alpha = 1200;
16     %d2 = sqrt(s/alpha);
17     %d1 = sqrt((12*s^2)/(alpha*(1+s^2)));
18     %d1 = sqrt(12/(alpha));
19     d1 = h;
20     d2 = s;
21     %d2 = 1;
22
23     n2 = ceil(n1*h);
24     if(n2 <= 10)
25         n2 = 6;
26     end
27     n3 = ceil(n2*s);
28     %n3 = ceil(n1/s);
29     if(n3 <= 10)
30         n3 = 6;
31     end
32     %n2 = 3;
33
34     sz = n1*n2*n3;
```

```
35
36      S = [0 1 0 d1 0 d2]; %Set size of the beam
37      N = [n1 n2 n3]; %Number of elements
38      Delta = [(S(2)-S(1))/N(1) (S(4)-S(3))/N(2) (S(6)-S(5))/N(3)
        ]; %space step size
39      nu = 0.3;
40      gamma = 1/(2*(1+nu))*5/6
41      %A = 1/(gamma*(1+nu)*(1-2*nu));
42      %B = 1/(2*gamma*(1+nu));
43      for i = inum:-1:50
44          h(i) = figure(i);
45          movegui(h(i),'west')
46      end
47      %A = 1/(1-nu^2);
48      %B = 1/(2*gamma*(1+nu));
49      %mwb.Update(1, 1, 0.1, 'Total Progress - Creating Matrices
        ');
50      [K11,K12,K13,K22,K23,K33,M0,Dom,E] = Matrices(Delta,N,
        method);
51      %mwb.Update(1, 1, 0.3, 'Total Progress - Admissible Basis
        functions');
52      %Om = Omega(N,Dom);
53      %F = Initial(N,f);
54      Mf = M0;
55
56    %K11(1:(N(2)+1)*(N(3)+1),:) = [];
57    %K11(:,1:(N(2)+1)*(N(3)+1)) = [];
58    %K12(1:(N(2)+1)*(N(3)+1),:) = [];
59    %K12(:,1:(N(2)+1)*(N(3)+1)) = [];
60    %K13(1:(N(2)+1)*(N(3)+1),:) = [];
61    %K13(:,1:(N(2)+1)*(N(3)+1)) = [];
62    %K22(1:(N(2)+1)*(N(3)+1),:) = [];
63    %K22(:,1:(N(2)+1)*(N(3)+1)) = [];
64    %K23(1:(N(2)+1)*(N(3)+1),:) = [];
65    %K23(:,1:(N(2)+1)*(N(3)+1)) = [];
66    %K33(1:(N(2)+1)*(N(3)+1),:) = [];
67    %K33(:,1:(N(2)+1)*(N(3)+1)) = [];
68
69    %M0(1:(N(2)+1)*(N(3)+1),:) = [];
70    %M0(:,1:(N(2)+1)*(N(3)+1)) = [];
71    %Mf(1:(N(2)+1)*(N(3)+1),:) = [];
72
73      %mwb.Update(1, 1, 0.4, 'Total Progress - Concatinating
        matrices');
74      Of = sparse(size(Mf,1),size(Mf,2));
75      MF = [Mf Of Of; Of Mf Of; Of Of Mf];
76      O = sparse(size(M0,1),size(M0,2));
77      %M = sparse(3*size(M0,1),3*size(M0,2));
```

```
78      M = [M0 0 0; 0 M0 0; 0 0 M0];
79      %M([1:size(M0,1)],[1:size(M0,2)]) = M0;
80      %M(2*[1:size(M0,1)],2*[1:size(M0,2)]) = M0;
81      %M(3*[1:size(M0,1)],3*[1:size(M0,2)]) = M0;
82      Mf = M;
83      FS = size(M);
84      %M = [M0 0; 0 M0];
85      K21 = K12';
86      K31 = K13';
87      K32 = K23';
88
89      a1 = 1/(gamma*(1+nu));
90      a2 = nu/(gamma*(1+nu)*(1-2*nu));
91      a3 = 1/(2*gamma*(1+nu));
92
93      K1 = a1*K11 + a2*K11 + a3*K22 + a3*K33;
94      K2 = a3*K12 + a2*K21;
95      K3 = a3*K13 + a2*K31;
96      K4 = a2*K12 + a3*K21;
97      K5 = a1*K22 + a2*K22 + a3*K11 + a3*K33;
98      K6 = a3*K23 + a2*K32;
99      K7 = a2*K13 + a3*K31;
100     K8 = a2*K23 + a3*K32;
101     K9 = a1*K33 + a2*K33 + a3*K11 + a3*K22;
102
103     %K = sparse(size(K1,1)*3,size(K1,2)*3);
104
105     %K([1:size(K1,1)],[1:size(K1,2)]) = K1;
106     %K([1:size(K1,1)],2*[1:size(K1,2)]) = K2;
107     %K([1:size(K1,1)],3*[1:size(K1,2)]) = K3;
108     %K(2*[1:size(K1,1)],[1:size(K1,2)]) = K4;
109     %K(2*[1:size(K1,1)],2*[1:size(K1,2)]) = K5;
110     %K(2*[1:size(K1,1)],3*[1:size(K1,2)]) = K6;
111     %K(3*[1:size(K1,1)],[1:size(K1,2)]) = K7;
112     %K(3*[1:size(K1,1)],2*[1:size(K1,2)]) = K8;
113     %K(3*[1:size(K1,1)],3*[1:size(K1,2)]) = K9;
114
115     K = [K1 K2 K3; K4 K5 K6; K7 K8 K9];
116
117     All = (N(1)+1)*(N(2)+1)*(N(3)+1);
118     x = [22*All+(N(2)+1)*(N(3)+1):-1:22*All+1
119          19*All+(N(2)+1)*(N(3)+1):-1:19*All+1
120          18*All+(N(2)+1)*(N(3)+1):-1:18*All+1
121          16*All+(N(2)+1)*(N(3)+1):-1:16*All+1
122
123          14*All+(N(2)+1)*(N(3)+1):-1:14*All+1
124          11*All+(N(2)+1)*(N(3)+1):-1:11*All+1
125          10*All+(N(2)+1)*(N(3)+1):-1:10*All+1
```

```
126           8*All+(N(2)+1)*(N(3)+1):-1:8*All+1
127
128           6*All+(N(2)+1)*(N(3)+1):-1:6*All+1
129           3*All+(N(2)+1)*(N(3)+1):-1:3*All+1
130           2*All+(N(2)+1)*(N(3)+1):-1:2*All+1
131           0*All+(N(2)+1)*(N(3)+1):-1:0*All+1];
132
133      K(x,:) = [];
134      K(:,x) = [];
135      M(x,:) = [];
136      M(:,x) = [];
137      Mf(x,:) = [];
138
139     % K = [1/(gamma*(1+nu))*K11+nu/(gamma*(1+nu)*(1-2*nu))*(K11+
     K22+K33)  1/(gamma*(1+nu))*K12 1/(gamma*(1+nu))*K13;
140    %       1/(gamma*(1+nu))*K12 1/(gamma*(1+nu))*K22+nu/(gamma
     *(1+nu)*(1-2*nu))*(K11+K22+K33) 1/(gamma*(1+nu))*K23;
141     %      1/(gamma*(1+nu))*K13 1/(gamma*(1+nu))*K23 1/(gamma
     *(1+nu))*K33+nu/(gamma*(1+nu)*(1-2*nu))*(K11+K22+K33)];
142
143     % K33 = (-nu/((1-2*nu)+nu))*(K11+K22);
144     % K = [1/(gamma*(1+nu))*K11+nu/(gamma*(1+nu)*(1-2*nu))*(K11+
     K22+K33)  1/(gamma*(1+nu))*K12;
145     %      1/(gamma*(1+nu))*K12 1/(gamma*(1+nu))*K22+nu/(gamma
     *(1+nu)*(1-2*nu))*(K11+K22+K33)];
146
147
148      %K = [2*(1-nu)*K11+(1-2*nu)*K22+(1-2*nu)*K33 2*nu*K12+(1-2*
     nu)*K21 2*nu*K13+(1-2*nu)*K31;
149      %    2*nu*K21+(1-2*nu)*K12 (1-2*nu)*K11+2*(1-nu)*K22+(1-2*
     nu)*K33 2*nu*K23+(1-2*nu)*K32;
150      %    2*nu*K31+(1-2*nu)*K13 2*nu*K32+(1-2*nu)*K23 (1-2*nu)*
     K11+(1-2*nu)*K22+2*(1-nu)*K33];
151      %K = 1/(2*gamma*(1+nu)*(1-2*nu))*K;
152
153      %K = [K11+(1-nu)/2*K22+(1-nu)/2*K33 (1-nu)/2*K12+nu*K21 (1-
     nu)/2*K13+nu*K31;
154      %    (1-nu)/2*K21+nu*K12 (1-nu)/2*K11+K22+(1-nu)/2*K33 (1-
     nu)/2*K23+nu*K32;
155      %    (1-nu)/2*K31+nu*K13 (1-nu)/2*K32+nu*K23 (1-nu)/2*K11
     +(1-nu)/2*K22+K33];
156      % K = 1/(gamma*(1-nu^2))*K;
157       whos k
158
159 %numEig = 100;
160 %{
161 alpha = max(sum(abs(K),2)./diag(K))-2;
```

```
L = ichol(K,struct('type','ict','droptol',1e-3,'diagcomp',alpha
    ));
n = size(K,1);
[V,D] = eigs(@(x)pcg(K,x,1e-3,200,L,L'),n,M,numEig,'sm');
%}
 %mwb.Update(1, 1, 0.5, 'Total Progress - Cholsky Decomposition
    ');
[R,p,s] = chol(M,'vector');
p;
 %mwb.Update(1, 1, 0.55, 'Total Progress - Eigs');

%Rand = sprand(K);
%[v, lambda] = lobpcg(Rand, K, M, 1e-5, 20,0)
[V,DE,flag] = eigs(K,R,numEig,'smallestabs','IsCholesky',true,'
    CholeskyPermutation',s,'Tolerance',1e-4);
flag;
%mwb.Update(1, 1, 0.6, 'Total Progress');
Eig = diag(DE);
%%Mg = gpuArray(M);
%%Kg = gpuArray(K);

%{
sV = size(Eig,1);
R = zeros(sV,sV);
for i = 1:sV
   for j = 1:sV
    X = K*V(:,i) - M*V(:,i)*D(j);
    NORMX = norm(X,Inf);
    R(j,i) = NORMX;
   end
end
R = K*V-M*V*D;
xlswrite('CompareEigenValues.xlsx',R)
%}

u1p = 0;
u2p = 0;
u3p = 0;
u1s = 0;
u2s = 0;
u3s = 0;
uplx= 0;
uply = 0;
Psize = 0;
T = 0;
%%{

uxB = zeros(inum,(N(1)+1),(N(2)+1),(N(3)+1));
```

```
uyB = zeros(inum,(N(1)+1),(N(2)+1),(N(3)+1));
uzB = zeros(inum,(N(1)+1),(N(2)+1),(N(3)+1));

f = 0.3;

[D,E] = Domain(N,Delta);
%TD = D(:,ceil((N(2)+1)/2),ceil((N(3)+1)/2));
%TD = D(:,ceil((N(2)+1)/2),:);
TD = D(:,:,ceil((N(3)+1)/2));
TD = TD(:);
TDV = sort(TD(:));
OD = D(:,ceil((N(2)+1)/2),ceil((N(3)+1)/2));

F1 = zeros((N(1)+1)*(N(2)+1)*(N(3)+1),1);

F1(D(N(1)+1,ceil((N(2)+2)/2),ceil((N(3)+2)/2))) = f;
%F1(D(N(1)+1,:,:)) = f;
F = zeros(24*(N(1)+1)*(N(2)+1)*(N(3)+1),1);
F(8*(N(1)+1)*(N(2)+1)*(N(3)+1)+1:9*(N(1)+1)*(N(2)+1)*(N(3)+1))
    = F1;


%Kug = gpuArray(K);
%bg = gpuArray(Mf*(F));
%u = gmres(Kug,bg,30,1e-4,30);
%ueq = gather(u);


for i = inum:-1:1

w = V(:,i);

%Kug = gpuArray(K);
%bg = gpuArray(M*(-w));
%u = gmres(Kug,bg,30,1e-4,30);
%ueq = gather(u);

%ueq = K\(Mf*F);


b = M*(-w);
ueq = gmres(K,b,30,1e-4,30);

ux = [zeros((N(2)+1)*(N(3)+1),1); ueq(1:(N(1)+1)*(N(2)+1)*(N(3)
    +1)-(N(2)+1)*(N(3)+1),1)]+E(:,1);
dxux = [ueq((N(1)+1)*(N(2)+1)*(N(3)+1)-(N(2)+1)*(N(3)+1)+1:2*(N
    (1)+1)*(N(2)+1)*(N(3)+1)-(N(2)+1)*(N(3)+1),1)];
```

```
dyux = [zeros((N(2)+1)*(N(3)+1),1); ueq(2*(N(1)+1)*(N(2)+1)*(N(3)+1)-(N(2)+1)*(N(3)+1)+1:3*(N(1)+1)*(N(2)+1)*(N(3)+1)-2*(N(2)+1)*(N(3)+1),1)];
dzux = [zeros((N(2)+1)*(N(3)+1),1); ueq(3*(N(1)+1)*(N(2)+1)*(N(3)+1)-2*(N(2)+1)*(N(3)+1)+1:4*(N(1)+1)*(N(2)+1)*(N(3)+1)-3*(N(2)+1)*(N(3)+1),1)];
dxyux = [ueq(4*(N(1)+1)*(N(2)+1)*(N(3)+1)-3*(N(2)+1)*(N(3)+1)+1:5*(N(1)+1)*(N(2)+1)*(N(3)+1)-3*(N(2)+1)*(N(3)+1),1)];
dxzux = [ueq(5*(N(1)+1)*(N(2)+1)*(N(3)+1)-3*(N(2)+1)*(N(3)+1)+1:6*(N(1)+1)*(N(2)+1)*(N(3)+1)-3*(N(2)+1)*(N(3)+1),1)];
dyzux = [zeros((N(2)+1)*(N(3)+1),1); ueq(6*(N(1)+1)*(N(2)+1)*(N(3)+1)-3*(N(2)+1)*(N(3)+1)+1:7*(N(1)+1)*(N(2)+1)*(N(3)+1)-4*(N(2)+1)*(N(3)+1),1)];
dxyzux = [ueq(7*(N(1)+1)*(N(2)+1)*(N(3)+1)-4*(N(2)+1)*(N(3)+1)+1:8*(N(1)+1)*(N(2)+1)*(N(3)+1)-4*(N(2)+1)*(N(3)+1),1)];
uy = [zeros((N(2)+1)*(N(3)+1),1); ueq(8*(N(1)+1)*(N(2)+1)*(N(3)+1)-4*(N(2)+1)*(N(3)+1)+1:9*(N(1)+1)*(N(2)+1)*(N(3)+1)-5*(N(2)+1)*(N(3)+1),1)]+E(:,2);
dxuy = [ueq(9*(N(1)+1)*(N(2)+1)*(N(3)+1)-5*(N(2)+1)*(N(3)+1)+1:10*(N(1)+1)*(N(2)+1)*(N(3)+1)-5*(N(2)+1)*(N(3)+1),1)];
dyuy = [zeros((N(2)+1)*(N(3)+1),1); ueq(10*(N(1)+1)*(N(2)+1)*(N(3)+1)-5*(N(2)+1)*(N(3)+1)+1:11*(N(1)+1)*(N(2)+1)*(N(3)+1)-6*(N(2)+1)*(N(3)+1),1)];
dzuy = [zeros((N(2)+1)*(N(3)+1),1); ueq(11*(N(1)+1)*(N(2)+1)*(N(3)+1)-6*(N(2)+1)*(N(3)+1)+1:12*(N(1)+1)*(N(2)+1)*(N(3)+1)-7*(N(2)+1)*(N(3)+1),1)];
dxyuy = [ueq(12*(N(1)+1)*(N(2)+1)*(N(3)+1)-7*(N(2)+1)*(N(3)+1)+1:13*(N(1)+1)*(N(2)+1)*(N(3)+1)-7*(N(2)+1)*(N(3)+1),1)];
dxzuy = [ueq(13*(N(1)+1)*(N(2)+1)*(N(3)+1)-7*(N(2)+1)*(N(3)+1)+1:14*(N(1)+1)*(N(2)+1)*(N(3)+1)-7*(N(2)+1)*(N(3)+1),1)];
dyzuy = [zeros((N(2)+1)*(N(3)+1),1); ueq(14*(N(1)+1)*(N(2)+1)*(N(3)+1)-7*(N(2)+1)*(N(3)+1)+1:15*(N(1)+1)*(N(2)+1)*(N(3)+1)-8*(N(2)+1)*(N(3)+1),1)];
dxyzuy = [ueq(15*(N(1)+1)*(N(2)+1)*(N(3)+1)-8*(N(2)+1)*(N(3)+1)+1:16*(N(1)+1)*(N(2)+1)*(N(3)+1)-8*(N(2)+1)*(N(3)+1),1)];
uz = [zeros((N(2)+1)*(N(3)+1),1); ueq(16*(N(1)+1)*(N(2)+1)*(N(3)+1)-8*(N(2)+1)*(N(3)+1)+1:17*(N(1)+1)*(N(2)+1)*(N(3)+1)-9*(N(2)+1)*(N(3)+1),1)]+E(:,3);
dxuz = [ueq(17*(N(1)+1)*(N(2)+1)*(N(3)+1)-9*(N(2)+1)*(N(3)+1)+1:18*(N(1)+1)*(N(2)+1)*(N(3)+1)-9*(N(2)+1)*(N(3)+1),1)];
dyuz = [zeros((N(2)+1)*(N(3)+1),1); ueq(18*(N(1)+1)*(N(2)+1)*(N(3)+1)-9*(N(2)+1)*(N(3)+1)+1:19*(N(1)+1)*(N(2)+1)*(N(3)+1)-10*(N(2)+1)*(N(3)+1),1)];
dzuz = [zeros((N(2)+1)*(N(3)+1),1); ueq(19*(N(1)+1)*(N(2)+1)*(N(3)+1)-10*(N(2)+1)*(N(3)+1)+1:20*(N(1)+1)*(N(2)+1)*(N(3)+1)-11*(N(2)+1)*(N(3)+1),1)];
dxyuz = [ueq(20*(N(1)+1)*(N(2)+1)*(N(3)+1)-11*(N(2)+1)*(N(3)+1)+1:21*(N(1)+1)*(N(2)+1)*(N(3)+1)-11*(N(2)+1)*(N(3)+1),1)];
```

```
dxzuz = [ueq(21*(N(1)+1)*(N(2)+1)*(N(3)+1)-11*(N(2)+1)*(N(3)+1)
    +1:22*(N(1)+1)*(N(2)+1)*(N(3)+1)-11*(N(2)+1)*(N(3)+1),1)];
dyzuz = [zeros((N(2)+1)*(N(3)+1),1); ueq(22*(N(1)+1)*(N(2)+1)*(
    N(3)+1)-11*(N(2)+1)*(N(3)+1)+1:23*(N(1)+1)*(N(2)+1)*(N(3)
    +1)-12*(N(2)+1)*(N(3)+1),1)];
dxyzuz = [ueq(23*(N(1)+1)*(N(2)+1)*(N(3)+1)-12*(N(2)+1)*(N(3)
    +1)+1:24*(N(1)+1)*(N(2)+1)*(N(3)+1)-12*(N(2)+1)*(N(3)+1),1)
    ];


f = figure(i);
movegui(f,'west')
scatter3(ux(TD),uy(TD),uz(TD),5,uz(TD))
title(Eig(i));


%uxB(i,1:N(1)+1,1,1:N(3)+1) = ux(TD);
%uyB(i,1:N(1)+1,1,1:N(3)+1) = uy(TD);
%uzB(i,1:N(1)+1,1,1:N(3)+1) = uz(TD);


%dxuxB(i,1:N(1)+1,1,1) = dxux(TD);
%dxuyB(i,1:N(1)+1,1,1) = dxuy(TD);
%dxuzB(i,1:N(1)+1,1,1) = dxuz(TD);
%dyuxB(i,1:N(1)+1,1,1) = dyux(TD);
%dyuyB(i,1:N(1)+1,1,1) = dyuy(TD);
%dyuzB(i,1:N(1)+1,1,1) = dyuz(TD);
%dzuxB(i,1:N(1)+1,1,1) = dzux(TD);
%dzuyB(i,1:N(1)+1,1,1) = dzuy(TD);
%dzuzB(i,1:N(1)+1,1,1) = dzuz(TD);
%dxyuxB(i,1:N(1)+1,1,1) = dxyux(TD);
%dxyuyB(i,1:N(1)+1,1,1) = dxyuy(TD);
%dxyuzB(i,1:N(1)+1,1,1) = dxyuz(TD);
%dxzuxB(i,1:N(1)+1,1,1) = dxzux(TD);
%dxzuyB(i,1:N(1)+1,1,1) = dxzuy(TD);
%dxzuzB(i,1:N(1)+1,1,1) = dxzuz(TD);
%dyzuxB(i,1:N(1)+1,1,1) = dyzux(TD);
%dyzuyB(i,1:N(1)+1,1,1) = dyzuy(TD);
%dyzuzB(i,1:N(1)+1,1,1) = dyzuz(TD);
%dxyzuxB(i,1:N(1)+1,1,1) = dxyzux(TD);
%dxyzuyB(i,1:N(1)+1,1,1) = dxyzuy(TD);
%dxyzuzB(i,1:N(1)+1,1,1) = dxyzuz(TD);
%set(0,'CurrentFigure',h(i));
%scatter3(ux,uy,uz)
%title(Eig(i));
%scatter3(ux,uy,uz,5,uz)

%scatter3(uxB,uyB,uzB,5,uzB)
```

```
%hold on
%scatter3(ux,uy,zeros(size(uz)));

%hold on
%ux2 = ux(D(:,1,1));
%uy2 = uy(D(:,1,1));
%uz2 = uz(D(:,1,1));

%max2 = norm(uy2,Inf);
%uy2 = uy2/max2*0.8;
%scatter3(ux2,uy2,uz2)

hold off
%axis([0 1.1 -0.025 0.05 -0.025 0.025])
%dxux2 = dxux(TDV);
%dxuy2 = dxuy(TDV);
%dxuz2 = dxuz(TDV);
%dyux2 = dyux(TDV);
%dyuy2 = dyuy(TDV);
%dyuz2 = dyuz(TDV);
%dzux2 = dzux(TDV);
%dzuy2 = dzuy(TDV);
%dzuz2 = dzuz(TDV);


%sigma11 = 1/(gamma*(1+nu))*dxuxB + nu/(gamma*(1+nu)*(1-2*nu))
    *(dxuxB+dyuyB+dzuzB);
%sigma22 = 1/(gamma*(1+nu))*dyuyB + nu/(gamma*(1+nu)*(1-2*nu))
    *(dxuxB+dyuyB+dzuzB);
%sigma33 = 1/(gamma*(1+nu))*dzuzB + nu/(gamma*(1+nu)*(1-2*nu))
    *(dxuxB+dyuyB+dzuzB);
%sigma23 = 1/(2*gamma*(1+nu))*(dzuyB + dyuzB);
%sigma31 = 1/(2*gamma*(1+nu))*(dzuxB + dxuzB);
%sigma12 = 1/(2*gamma*(1+nu))*(dyuxB + dxuyB);

%stress = ceil((N(1)+1)/2);


%Ty = [0.5*(dxux(stress) + dxux(stress)) 0.5*(dxuy(stress) +
    dyux(stress)); 0.5*(dyux(stress) + dxuy(stress)) 0.5*(dyuy(
    stress) + dyuy(stress))]
%Tz = [0.5*(dxux(stress) + dxux(stress)) 0.5*(dxuz(stress) +
    dzux(stress)); 0.5*(dzux(stress) + dxuz(stress)) 0.5*(dzuz(
    stress) + dzuz(stress))]
%T = [sigma11(stress) sigma12(stress) sigma31(stress); sigma12(
    stress) sigma22(stress) sigma23(stress); sigma31(stress)
    sigma23(stress) sigma33(stress)]

```

```
%ux1 = ux(OD);
%uy1 = uy(OD);
%uz1 = uz(OD);


%f = figure();
%movegui(f,pos);
%scatter3(ux,uy,uz);
%hold on
%grid on
%plot3(ux1,uy1,uz1);
%title(strcat(num2str(i),' - ',num2str(Eig(i))))
%view(2)
end
%}
%{
%[KM, KMPat] = sparseinv(K);
%KM = KM*M;
%smallest = 0;
%bestEig = 0;

for i = 20:-1:1
  %smallest = 100;
  plot_fig = figure('NumberTitle', 'off', 'Name', strcat('
   Eigenvalue: ',int2str(i),' - ',num2str(s)));
  w = V(:,i);

%  for j = 1:numEig
%    X = K*w - M*w*Eig(j);
%    if norm(X) < smallest
%        smallest = norm(X);
%        bestEig = Eig(j);
%    end
%  end
   %plot_fig.suptitle(strcat(int2str(i),' - ',num2str(s)));
%mwb.Update(3, 1, 0.1, 'Plot');
    %wg = gpuArray(w);
    alpha = max(sum(abs(K),2)./diag(K))-2;
    L = ichol(K,struct('type','ict','droptol',1e-3,'diagcomp',
   alpha));
    u = pcg(K,M*w,1e-1,2000000,L,L');


    %normalize = norm(w,Inf);
    %u = normalize*u;
   % u = (K)\MF*F;

    %alpha = max(sum(abs(K),2)./diag(K))-2;
```

```
398     %L = ichol(K,struct('type','ict','droptol',1e-3,'diagcomp',
    alpha));
399     %u = pcg(K,MF*F,1e-3,200000,L,L');
400    % mwb.Update(3, 1, 0.3, 'Plot');
401     u1 = [zeros((N(2)+1)*(N(3)+1),1); u(1:size(u,1)/3)] + E
    (:,1);
402     u2 = [zeros((N(2)+1)*(N(3)+1),1); u(size(u,1)/3+1:2*size(u
    ,1)/3)] + E(:,2);
403     u3 = [zeros((N(2)+1)*(N(3)+1),1); u(2*size(u,1)/3+1:3*size(
    u,1)/3)]+ E(:,3);
404
405
406     u1 = 1/norm(u1,Inf)*u1;
407     u2 = 1/norm(u2,Inf)*u2;
408     u3 = 1/norm(u3,Inf)*u3;
409
410     [D,E] = Domain(N,Delta);
411     plane = D(:,:,ceil((N(3)+1)/2))';
412     plane = plane(:);
413     uplx = u1(plane);
414     uply = u2(plane);
415
416    % w1 = w(1:size(w,1)/3);
417    % w2 = w(size(w,1)/3+1:2*size(w,1)/3);
418    % w3 = w(2*size(w,1)/3+1:3*size(w,1)/3);
419
420   % mwb.Update(3, 1, 0.4, 'Plot');
421     ix = [];
422     if(N(1)+1 > 200)
423        % iy = [1 (N(2)+2)/2 (N(2)+1) (N(2)+1)*(N(3)+1)-(N(2)+1)
    +1 (N(2)+1)*(N(3)+1)];
424         ih = ((N(2)+1)-1)/2;
425         iv = 1+((N(3)+1)-1)/2*(N(2)+1);
426         iy = iv+ih; %[1 1+ih 1+2*ih iv iv+ih iv+2*ih 2*iv-1 2*
    iv+ih-1 2*iv+2*ih-1];%[iv+ih];%
427         icount = 1;
428         div = floor((N(1)+1)/200);
429         for k = 1:div:(N(1)+1)
430             for j = 1:size(iy,2)
431                 ix(icount) = iy(j)+ (k-1)*(N(2)+1)*(N(3)+1);
432                 icount = icount +1;
433             end
434         end
435         u1p = u1(ix);
436         u2p = u2(ix);
437         u3p = u3(ix);
438        % w1p = w1(ix);
439        % w2p = w2(ix);
```

```
440         % w3p = w3(ix);
441
442         E1p = E(ix,1);
443         E2p = E(ix,2);
444         E3p = E(ix,3);
445         Psize = size(iy,2);
446     else
447         u1p = u1;
448         u2p = u2;
449         u3p = u3;
450
451       %  w1p = w1;
452       %  w2p = w2;
453       %  w3p = w3;
454
455         E1p = E(:,1);
456         E2p = E(:,2);
457         E3p = E(:,3);
458
459         Psize = (N(2)+1)*(N(3)+1);
460     end
461     %mwb.Update(3, 1, 0.7, 'Plot');
462
463     u1p = 1/norm(u1p,Inf)*u1p;
464     %u2p = 1/norm(u2p,Inf)*u2p;
465     %u3p = 1/norm(u3p,Inf)*u3p;
466
467     %umx = u1p(size(u1p,1)/2
468
469
470     scatter3(u1p,u2p,u3p);
471     hold on
472     %scatter3(E1p,E2p,E3p,0.1);
473     hold on
474     %scatter3(w1p,w2p,w3p);
475     %mwb.Update(3, 1, 1, 'Plot');
476     u1s = size(u1p);
477     u2s = size(u2p);
478     u3s = size(u3p);
479     for k = 1:Psize
480         hold on
481         plot3(u1p(k:Psize:k+u1s-2*Psize),u2p(k:Psize:k+u2s-2*
    Psize),u3p(k:Psize:k+u3s-2*Psize),'-');
482     end
483 temp_png = strcat('\Plots\',sprintf('%.6f',n1),'\PNG\Plot',
    sprintf('%.6f',i),'.png');
484 temp_fig = strcat('\Plots\',sprintf('%.6f',n1),'\Fig\Plot',
    sprintf('%.6f',i),'.fig');
```

```
485 view([0 0 90])
486 %legend(['Eigenvalue: ' num2str(Eig(i))]);
487 %saveas(plot_fig,strcat(pwd,temp_png))
488 %savefig(plot_fig,strcat(pwd,temp_fig))
489 %close(plot_fig)
490 end
491 clear u
492
493 %}
494 %mwb.Update(1, 1, 1, 'Total Progress');
495 %   mwb.Close();
496 return;
497
498 function [D,E] = Domain(N,Delta)
499     D = zeros(N(1)+1,N(2)+1,N(3)+1);
500     icount = 1;
501
502     for i = 1:N(1)+1
503        for k = 1:N(3)+1
504           for j = 1:N(2)+1
505              D(i,j,k) = icount;
506              icount = icount + 1;
507           end
508        end
509     end
510     E = zeros((N(1)+1)*(N(2)+1)*(N(3)+1),3);
511     ix = 1;
512     iy = 1;
513     iz = 1;
514     ixt = 0;
515     for i = 1:(N(1)+1)*(N(2)+1)*(N(3)+1)
516         E(i,:) = [Delta(1)*(ix-1),Delta(2)*(iy-1),Delta(3)*(iz
    -1)];
517
518         iy = iy+1;
519
520         if(ix == N(1)+2)
521             ix = 1;
522         end
523         if(iy == N(2)+2)
524             iy = 1;
525             ixt = ixt +1;
526             iz = iz+1;
527         end
528         if(ixt == N(3)+1)
529             ix = ix+1;
530             ixt = 0;
531         end
```

```
        if(iz == N(3)+2)
            iz = 1;
        end

    end
    %[Cubes,CubeNumbers] = CreateCubes(E,N);
    %Plot(E,N,Cubes)
return

function Next = Adjacent(N,D)
    Next = zeros((N(1)+1)*(N(2)+1)*(N(3)+1),27);
    %1 - Itself
    %2 - Forward
    %3 - Backward
    %4 - Forward + Left
    %5 - Forward + Right
    %6 - Left
    %7 - Right
    %8 - Backward + Left
    %9 - Backward + Right
    for i = 1:N(1)+1
       for j = 1:N(2)+1
          for k = 1:N(3)+1
             Next(D(i,j,k),1) = D(i,j,k);
             if(i<N(1)+1)
                Next(D(i,j,k),2) = D(i+1,j,k);
             else
                 Next(D(i,j,k),2) = nan;
             end
             if(i>1)
                Next(D(i,j,k),3) = D(i-1,j,k);
             else
                 Next(D(i,j,k),3) = nan;
             end
             if(i<N(1)+1 && j < N(2)+1)
                Next(D(i,j,k),4) = D(i+1,j+1,k);
             else
                 Next(D(i,j,k),4) = nan;
             end
             if(i<N(1)+1 && j > 1)
                Next(D(i,j,k),5) = D(i+1,j-1,k);
             else
                 Next(D(i,j,k),5) = nan;
             end
             if(j < N(2)+1)
                Next(D(i,j,k),6) = D(i,j+1,k);
             else
                 Next(D(i,j,k),6) = nan;
```

```
580                 end
581                 if(j>1)
582                    Next(D(i,j,k),7) = D(i,j-1,k);
583                 else
584                     Next(D(i,j,k),7) = nan;
585                 end
586                 if(i>1 && j < N(2)+1)
587                    Next(D(i,j,k),8) = D(i-1,j+1,k);
588                 else
589                     Next(D(i,j,k),8) = nan;
590                 end
591                 if(i>1 && j>1)
592                    Next(D(i,j,k),9) = D(i-1,j-1,k);
593                 else
594                     Next(D(i,j,k),9) = nan;
595                 end
596
597                 if(k < N(3)+1)
598                     Next(D(i,j,k),10) = D(i,j,k+1);
599                     if(i<N(1)+1)
600                        Next(D(i,j,k),11) = D(i+1,j,k+1);
601                     else
602                         Next(D(i,j,k),11) = nan;
603                     end
604                     if(i>1)
605                        Next(D(i,j,k),12) = D(i-1,j,k+1);
606                     else
607                         Next(D(i,j,k),12) = nan;
608                     end
609                     if(i<N(1)+1 && j < N(2)+1)
610                        Next(D(i,j,k),13) = D(i+1,j+1,k+1);
611                     else
612                         Next(D(i,j,k),13) = nan;
613                     end
614                     if(i<N(1)+1 && j > 1)
615                        Next(D(i,j,k),14) = D(i+1,j-1,k+1);
616                     else
617                         Next(D(i,j,k),14) = nan;
618                     end
619                     if(j < N(2)+1)
620                        Next(D(i,j,k),15) = D(i,j+1,k+1);
621                     else
622                         Next(D(i,j,k),15) = nan;
623                     end
624                     if(j>1)
625                        Next(D(i,j,k),16) = D(i,j-1,k+1);
626                     else
627                         Next(D(i,j,k),16) = nan;
```

```
628                     end
629                     if(i>1 && j < N(2)+1)
630                        Next(D(i,j,k),17) = D(i-1,j+1,k+1);
631                     else
632                         Next(D(i,j,k),17) = nan;
633                     end
634                     if(i>1 && j>1)
635                        Next(D(i,j,k),18) = D(i-1,j-1,k+1);
636                     else
637                         Next(D(i,j,k),18) = nan;
638                     end
639                 else
640                     Next(D(i,j,k),10) = nan;
641                     Next(D(i,j,k),11) = nan;
642                     Next(D(i,j,k),12) = nan;
643                     Next(D(i,j,k),13) = nan;
644                     Next(D(i,j,k),14) = nan;
645                     Next(D(i,j,k),15) = nan;
646                     Next(D(i,j,k),16) = nan;
647                     Next(D(i,j,k),17) = nan;
648                     Next(D(i,j,k),18) = nan;
649                 end
650
651                 if(k>1)
652                     Next(D(i,j,k),19) = D(i,j,k-1);
653                     if(i<N(1)+1)
654                        Next(D(i,j,k),20) = D(i+1,j,k-1);
655                     else
656                         Next(D(i,j,k),20) = nan;
657                     end
658                     if(i>1)
659                        Next(D(i,j,k),21) = D(i-1,j,k-1);
660                     else
661                         Next(D(i,j,k),21) = nan;
662                     end
663                     if(i<N(1)+1 && j < N(2)+1)
664                        Next(D(i,j,k),22) = D(i+1,j+1,k-1);
665                     else
666                         Next(D(i,j,k),22) = nan;
667                     end
668                     if(i<N(1)+1 && j > 1)
669                        Next(D(i,j,k),23) = D(i+1,j-1,k-1);
670                     else
671                         Next(D(i,j,k),23) = nan;
672                     end
673                     if(j < N(2)+1)
674                        Next(D(i,j,k),24) = D(i,j+1,k-1);
675                     else
```

```
                    Next(D(i,j,k),24) = nan;
                end
                if(j>1)
                   Next(D(i,j,k),25) = D(i,j-1,k-1);
                else
                    Next(D(i,j,k),25) = nan;
                end
                if(i>1 && j < N(2)+1)
                   Next(D(i,j,k),26) = D(i-1,j+1,k-1);
                else
                    Next(D(i,j,k),26) = nan;
                end
                if(i>1 && j>1)
                   Next(D(i,j,k),27) = D(i-1,j-1,k-1);
                else
                    Next(D(i,j,k),27) = nan;
                end
            else
                Next(D(i,j,k),19) = nan;
                Next(D(i,j,k),20) = nan;
                Next(D(i,j,k),21) = nan;
                Next(D(i,j,k),22) = nan;
                Next(D(i,j,k),23) = nan;
                Next(D(i,j,k),24) = nan;
                Next(D(i,j,k),25) = nan;
                Next(D(i,j,k),26) = nan;
                Next(D(i,j,k),27) = nan;
            end
        end
    end
end
return

function B = AdjacentType()%CHECKED
    B = zeros(27,27,16);
    %CHECKED
    B(1,1,:) = [2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
    B(1,2,:) = [2 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
    B(1,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
    B(1,4,:) = [2 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
   Left
    B(1,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
   Right
    B(1,6,:) = [2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
    B(1,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
    B(1,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
   Left
```

```
720     B(1,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
721     %Up%CHECKED
722     B(1,10,:) = [2 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
723     B(1,11,:) = [2 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
724     B(1,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
725     B(1,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
726     B(1,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
727     B(1,15,:) = [2 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
728     B(1,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
729     B(1,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
730     B(1,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
731     %Down%CHECKED
732     B(1,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
733     B(1,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
734     B(1,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
735     B(1,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
736     B(1,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
737     B(1,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
738     B(1,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
739     B(1,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
740     B(1,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
741     %
    ..........................................................................

742     %CHECKED
743     B(2,1,:) = [1 1 2 2 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
744     B(2,2,:) = [2 3 1 4 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
745     B(2,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
746     B(2,4,:) = [2 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
747     B(2,5,:) = [1 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
748     B(2,6,:) = [2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
749     B(2,7,:) = [1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
750     B(2,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
751     B(2,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
752     %Up%CHECKED
```

```
753     B(2,10,:) = [2 6 1 5 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
754     B(2,11,:) = [2 7 1 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
755     B(2,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
756     B(2,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
757     B(2,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
758     B(2,15,:) = [2 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
759     B(2,16,:) = [1 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
760     B(2,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
761     B(2,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
762     %Down%CHECKED
763     B(2,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
764     B(2,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
765     B(2,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
766     B(2,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
767     B(2,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
768     B(2,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
769     B(2,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
770     B(2,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
771     B(2,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
772     %
    ..........................................................................

773     %CHECKED
774     B(3,1,:) = [1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
775     B(3,2,:) = [1 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
776     B(3,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
777     B(3,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
778     B(3,5,:) = [1 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
779     B(3,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
780     B(3,7,:) = [1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
781     B(3,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
782     B(3,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
783     %Up%CHECKED
784     B(3,10,:) = [1 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
785     B(3,11,:) = [1 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
786     B(3,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
```

```
787     B(3,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
788     B(3,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
789     B(3,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
790     B(3,16,:) = [1 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
791     B(3,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
792     B(3,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
793     %Down%CHECKED
794     B(3,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
795     B(3,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
796     B(3,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
797     B(3,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
798     B(3,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
799     B(3,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
800     B(3,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
801     B(3,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
802     B(3,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
803     %
    ..........................................................................

804     %CHECKED
805     B(4,1,:) = [2 2 6 6 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
806     B(4,2,:) = [2 3 6 7 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
807     B(4,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
808     B(4,4,:) = [2 4 6 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
809     B(4,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
810     B(4,6,:) = [2 1 6 5 0 0 0 0 0 0 0 0 0 0 0 0];%Left
811     B(4,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
812     B(4,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
813     B(4,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
814     %Up%CHECKED
815     B(4,10,:) = [2 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
816     B(4,11,:) = [2 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
817     B(4,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
818     B(4,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
```

```
819     B(4,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
820     B(4,15,:) = [2 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
821     B(4,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
822     B(4,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
823     B(4,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
824     %Down%CHECKED
825     B(4,19,:) = [6 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
826     B(4,20,:) = [6 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
827     B(4,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
828     B(4,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
829     B(4,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
830     B(4,24,:) = [6 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
831     B(4,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
832     B(4,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
833     B(4,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
834     %
    ..........................................................................

835     %CHECKED
836     B(5,1,:) = [1 1 2 2 5 5 6 6 0 0 0 0 0 0 0 0]; %Itself
837     B(5,2,:) = [2 3 1 4 5 8 6 7 0 0 0 0 0 0 0 0];%Forward
838     B(5,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
839     B(5,4,:) = [2 4 6 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
840     B(5,5,:) = [1 3 5 7 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
841     B(5,6,:) = [2 1 6 5 0 0 0 0 0 0 0 0 0 0 0 0];%Left
842     B(5,7,:) = [1 2 5 6 0 0 0 0 0 0 0 0 0 0 0 0];%Right
843     B(5,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
844     B(5,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
845     %Up%CHECKED
846     B(5,10,:) = [2 6 1 5 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
847     B(5,11,:) = [2 7 1 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
848     B(5,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
849     B(5,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
850     B(5,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
851     B(5,15,:) = [2 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
```

```
852     B(5,16,:) = [1 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
853     B(5,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
854     B(5,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
855     %Down%CHECKED
856     B(5,19,:) = [5 1 6 2 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
857     B(5,20,:) = [5 4 6 3 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
858     B(5,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
859     B(5,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
860     B(5,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
861     B(5,24,:) = [6 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
862     B(5,25,:) = [5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
863     B(5,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
864     B(5,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
865     %
    ..........................................................................

866     %CHECKED
867     B(6,1,:) = [1 1 5 5 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
868     B(6,2,:) = [1 4 5 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
869     B(6,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
870     B(6,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
871     B(6,5,:) = [1 3 5 7 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
872     B(6,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
873     B(6,7,:) = [1 2 5 6 0 0 0 0 0 0 0 0 0 0 0 0];%Right
874     B(6,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
875     B(6,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
876     %Up%CHECKED
877     B(6,10,:) = [1 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
878     B(6,11,:) = [1 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
879     B(6,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
880     B(6,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
881     B(6,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
882     B(6,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
883     B(6,16,:) = [1 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
884     B(6,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
```

```
885     B(6,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
886     %Down%CHECKED
887     B(6,19,:) = [5 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
888     B(6,20,:) = [5 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
889     B(6,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
890     B(6,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
891     B(6,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
892     B(6,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
893     B(6,25,:) = [5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
894     B(6,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
895     B(6,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
896     %
    ..........................................................................

897     %CHECKED
898     B(7,1,:) = [6 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
899     B(7,2,:) = [6 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
900     B(7,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
901     B(7,4,:) = [6 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
902     B(7,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
903     B(7,6,:) = [6 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
904     B(7,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
905     B(7,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
906     B(7,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
907     %Up%CHECKED
908     B(7,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
909     B(7,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
910     B(7,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
911     B(7,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
912     B(7,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
913     B(7,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
914     B(7,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
915     B(7,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
916     B(7,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
917     %Down%CHECKED
```

```
 B(7,19,:) = [6 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
 B(7,20,:) = [6 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
 B(7,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
 B(7,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Left
 B(7,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Right
 B(7,24,:) = [6 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
 B(7,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
 B(7,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Left
 B(7,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Right
 %
.....................................................................

 %CHECKED
 B(8,1,:) = [5 5 6 6 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
 B(8,2,:) = [6 7 5 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
 B(8,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
 B(8,4,:) = [6 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Left
 B(8,5,:) = [5 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Right
 B(8,6,:) = [6 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
 B(8,7,:) = [5 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
 B(8,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Left
 B(8,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Right
 %Up%CHECKED
 B(8,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
 B(8,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
 B(8,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
 B(8,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Left
 B(8,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Right
 B(8,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
 B(8,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
 B(8,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Left
 B(8,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Right
 %Down%CHECKED
 B(8,19,:) = [5 1 6 2 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
 B(8,20,:) = [5 4 6 3 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
 B(8,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
```

```
952     B(8,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
953     B(8,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
954     B(8,24,:) = [6 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
955     B(8,25,:) = [5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
956     B(8,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
957     B(8,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
958     %
    ..........................................................................

959     %CHECKED
960     B(9,1,:) = [5 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
961     B(9,2,:) = [5 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
962     B(9,3,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
963     B(9,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
964     B(9,5,:) = [5 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
965     B(9,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
966     B(9,7,:) = [5 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
967     B(9,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
968     B(9,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
969     %Up%CHECKED
970     B(9,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
971     B(9,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
972     B(9,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
973     B(9,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
974     B(9,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
975     B(9,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
976     B(9,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
977     B(9,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
978     B(9,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
979     %Down%CHECKED
980     B(9,19,:) = [5 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
981     B(9,20,:) = [5 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
982     B(9,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
983     B(9,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
```

```
    B(9,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Right
    B(9,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
    B(9,25,:) = [5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
    B(9,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Left
    B(9,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Right
    %>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

    %CHECKED
    B(10,1,:) = [2 2 3 3 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
    B(10,2,:) = [2 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
    B(10,3,:) = [3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
    B(10,4,:) = [2 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Left
    B(10,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Right
    B(10,6,:) = [2 1 3 4 0 0 0 0 0 0 0 0 0 0 0 0];%Left
    B(10,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
    B(10,8,:) = [3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Left
    B(10,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Right
    %Up%CHECKED
    B(10,10,:) = [2 6 3 7 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
    B(10,11,:) = [2 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
    B(10,12,:) = [3 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
    B(10,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Left
    B(10,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Right
    B(10,15,:) = [2 5 3 8 0 0 0 0 0 0 0 0 0 0 0 0];%Left
    B(10,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
    B(10,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Left
    B(10,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Right
    %Down%CHECKED
    B(10,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
    B(10,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
    B(10,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
    B(10,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Left
    B(10,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Right
    B(10,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
```

```
1017     B(10,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1018     B(10,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
1019     B(10,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Right
1020     %
     ..................................................................

1021     %CHECKED
1022     B(11,1,:) = [1 1 2 2 3 3 4 4 0 0 0 0 0 0 0 0 0]; %Itself
1023     B(11,2,:) = [2 3 1 4 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1024     B(11,3,:) = [3 2 4 1 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1025     B(11,4,:) = [2 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Left
1026     B(11,5,:) = [1 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Right
1027     B(11,6,:) = [2 1 3 4 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1028     B(11,7,:) = [1 2 4 3 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1029     B(11,8,:) = [3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
1030     B(11,9,:) = [4 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Right
1031     %Up%CHECKED
1032     B(11,10,:) = [2 6 1 5 3 7 4 8 0 0 0 0 0 0 0 0 0];%Itself
1033     B(11,11,:) = [2 7 1 8 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1034     B(11,12,:) = [3 6 4 5 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1035     B(11,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Left
1036     B(11,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Right
1037     B(11,15,:) = [2 5 3 8 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1038     B(11,16,:) = [1 6 4 7 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1039     B(11,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
1040     B(11,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Right
1041     %Down%CHECKED
1042     B(11,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1043     B(11,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1044     B(11,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1045     B(11,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Left
1046     B(11,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Right
1047     B(11,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1048     B(11,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1049     B(11,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
```

```
1050     B(11,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1051     %
    ..........................................................................

1052     %CHECKED
1053     B(12,1,:) = [1 1 4 4 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1054     B(12,2,:) = [1 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1055     B(12,3,:) = [4 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1056     B(12,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1057     B(12,5,:) = [1 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1058     B(12,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1059     B(12,7,:) = [1 2 4 3 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1060     B(12,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1061     B(12,9,:) = [4 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1062     %Up%CHECKED
1063     B(12,10,:) = [1 5 4 8 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1064     B(12,11,:) = [1 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1065     B(12,12,:) = [4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1066     B(12,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1067     B(12,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1068     B(12,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1069     B(12,16,:) = [1 6 4 7 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1070     B(12,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1071     B(12,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1072     %Down%CHECKED
1073     B(12,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1074     B(12,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1075     B(12,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1076     B(12,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1077     B(12,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1078     B(12,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1079     B(12,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1080     B(12,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1081     B(12,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
```

```
1082     %
         ..........................................................................

1083     %CHECKED
1084     B(13,1,:) = [2 2 3 3 6 6 7 7 0 0 0 0 0 0 0 0]; %Itself
1085     B(13,2,:) = [2 3 6 7 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
1086     B(13,3,:) = [3 2 7 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1087     B(13,4,:) = [2 4 6 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Left
1088     B(13,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Right
1089     B(13,6,:) = [2 1 6 5 3 4 7 8 0 0 0 0 0 0 0 0];%Left
1090     B(13,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1091     B(13,8,:) = [3 1 7 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Left
1092     B(13,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Right
1093     %Up%CHECKED
1094     B(13,10,:) = [2 6 3 7 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1095     B(13,11,:) = [2 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1096     B(13,12,:) = [3 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1097     B(13,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Left
1098     B(13,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Right
1099     B(13,15,:) = [2 5 3 8 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1100     B(13,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1101     B(13,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Left
1102     B(13,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Right
1103     %Down%CHECKED
1104     B(13,19,:) = [6 2 7 3 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1105     B(13,20,:) = [6 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1106     B(13,21,:) = [7 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1107     B(13,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Left
1108     B(13,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Right
1109     B(13,24,:) = [6 1 7 4 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1110     B(13,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1111     B(13,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Left
1112     B(13,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Right
1113     %
         ..........................................................................
```

```
1114     %CHECKED
1115     B(14,1,:) = [1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8]; %Itself
1116     B(14,2,:) = [1 4 2 3 5 8 6 7 0 0 0 0 0 0 0 0];%Forward
1117     B(14,3,:) = [4 1 3 2 8 5 7 6 0 0 0 0 0 0 0 0];%Backward
1118     B(14,4,:) = [2 4 6 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1119     B(14,5,:) = [1 3 5 7 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1120     B(14,6,:) = [2 1 6 5 3 4 7 8 0 0 0 0 0 0 0 0];%Left
1121     B(14,7,:) = [1 2 5 6 4 3 8 7 0 0 0 0 0 0 0 0];%Right
1122     B(14,8,:) = [3 1 7 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1123     B(14,9,:) = [4 2 8 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1124     %Up%CHECKED
1125     B(14,10,:) = [1 5 2 6 3 7 4 8 0 0 0 0 0 0 0 0];%Itself
1126     B(14,11,:) = [2 7 1 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1127     B(14,12,:) = [3 6 4 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1128     B(14,13,:) = [2 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1129     B(14,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1130     B(14,15,:) = [2 5 3 8 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1131     B(14,16,:) = [1 6 4 7 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1132     B(14,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1133     B(14,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1134     %Down%CHECKED
1135     B(14,19,:) = [5 1 6 2 7 3 8 4 0 0 0 0 0 0 0 0];%Itself
1136     B(14,20,:) = [5 4 6 3 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1137     B(14,21,:) = [8 1 7 2 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1138     B(14,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1139     B(14,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1140     B(14,24,:) = [6 1 7 4 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1141     B(14,25,:) = [5 2 8 3 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1142     B(14,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1143     B(14,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1144     %
    ..................................................................

1145     B(15,1,:) = [1 1 4 4 5 5 8 8 0 0 0 0 0 0 0 0]; %Itself
1146     B(15,2,:) = [1 4 5 8 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1147     B(15,3,:) = [4 1 8 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
```

```
1148     B(15,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1149     B(15,5,:) = [1 3 5 7 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1150     B(15,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1151     B(15,7,:) = [1 2 5 6 4 3 8 7 0 0 0 0 0 0 0 0];%Right
1152     B(15,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1153     B(15,9,:) = [4 2 8 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1154     %Up
1155     B(15,10,:) = [1 5 4 8 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1156     B(15,11,:) = [1 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1157     B(15,12,:) = [4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1158     B(15,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1159     B(15,14,:) = [1 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1160     B(15,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1161     B(15,16,:) = [1 6 4 7 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1162     B(15,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1163     B(15,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1164     %Down
1165     B(15,19,:) = [5 1 8 4 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1166     B(15,20,:) = [5 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1167     B(15,21,:) = [8 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1168     B(15,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1169     B(15,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1170     B(15,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1171     B(15,25,:) = [5 2 8 3 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1172     B(15,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1173     B(15,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1174     %
    ..........................................................................

1175     B(16,1,:) = [6 6 7 7 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1176     B(16,2,:) = [6 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
1177     B(16,3,:) = [7 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1178     B(16,4,:) = [6 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1179     B(16,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
```

```
1180     B(16,6,:) = [6 5 7 8 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1181     B(16,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1182     B(16,8,:) = [7 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Left
1183     B(16,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Right
1184     %Up
1185     B(16,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1186     B(16,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1187     B(16,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1188     B(16,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Left
1189     B(16,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Right
1190     B(16,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1191     B(16,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1192     B(16,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Left
1193     B(16,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Right
1194     %Down
1195     B(16,19,:) = [6 2 7 3 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1196     B(16,20,:) = [6 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1197     B(16,21,:) = [7 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1198     B(16,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Left
1199     B(16,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Right
1200     B(16,24,:) = [6 1 7 4 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1201     B(16,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1202     B(16,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Left
1203     B(16,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Right
1204     %
         ..........................................................................

1205     B(17,1,:) = [5 5 6 6 7 7 8 8 0 0 0 0 0 0 0 0]; %Itself
1206     B(17,2,:) = [5 8 6 7 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1207     B(17,3,:) = [8 5 7 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1208     B(17,4,:) = [6 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Left
1209     B(17,5,:) = [5 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
         Right
1210     B(17,6,:) = [6 5 7 8 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1211     B(17,7,:) = [5 6 8 7 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1212     B(17,8,:) = [7 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
         Left
```

```
1213     B(17,9,:) = [8 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1214     %Up
1215     B(17,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1216     B(17,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1217     B(17,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1218     B(17,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1219     B(17,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1220     B(17,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1221     B(17,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1222     B(17,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1223     B(17,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1224     %Down
1225     B(17,19,:) = [5 1 6 2 7 3 8 4 0 0 0 0 0 0 0 0];%Itself
1226     B(17,20,:) = [5 4 6 3 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1227     B(17,21,:) = [8 1 7 2 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1228     B(17,22,:) = [6 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1229     B(17,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1230     B(17,24,:) = [6 1 7 4 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1231     B(17,25,:) = [5 2 8 3 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1232     B(17,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1233     B(17,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1234     %
    ..........................................................................

1235     B(18,1,:) = [5 5 8 8 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1236     B(18,2,:) = [5 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1237     B(18,3,:) = [8 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1238     B(18,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1239     B(18,5,:) = [5 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1240     B(18,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1241     B(18,7,:) = [5 6 8 7 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1242     B(18,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1243     B(18,9,:) = [8 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1244     %Up
1245     B(18,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
```

```
    B(18,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
    B(18,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
    B(18,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Left
    B(18,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Right
    B(18,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
    B(18,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
    B(18,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Left
    B(18,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Right
    %Down
    B(18,19,:) = [5 1 8 4 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
    B(18,20,:) = [5 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
    B(18,21,:) = [8 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
    B(18,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Left
    B(18,23,:) = [5 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Right
    B(18,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
    B(18,25,:) = [5 2 8 3 0 0 0 0 0 0 0 0 0 0 0 0];%Right
    B(18,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Left
    B(18,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Right
    %>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

    B(19,1,:) = [3 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
    B(19,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
    B(19,3,:) = [3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
    B(19,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Left
    B(19,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward + Right
    B(19,6,:) = [3 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
    B(19,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
    B(19,8,:) = [3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Left
    B(19,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward + Right
    %Up
    B(19,10,:) = [3 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
    B(19,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
    B(19,12,:) = [3 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
```

```
1279     B(19,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1280     B(19,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1281     B(19,15,:) = [3 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1282     B(19,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1283     B(19,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1284     B(19,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1285     %Down
1286     B(19,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1287     B(19,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1288     B(19,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1289     B(19,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1290     B(19,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1291     B(19,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1292     B(19,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1293     B(19,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1294     B(19,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1295     %
    ..........................................................................


1296
1297     B(20,1,:) = [3 3 4 4 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1298     B(20,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1299     B(20,3,:) = [3 2 4 1 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1300     B(20,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1301     B(20,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1302     B(20,6,:) = [3 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1303     B(20,7,:) = [4 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1304     B(20,8,:) = [3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1305     B(20,9,:) = [4 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1306     %Up
1307     B(20,10,:) = [4 8 3 7 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1308     B(20,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1309     B(20,12,:) = [3 6 4 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1310     B(20,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
```

```
 B(20,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Right
 B(20,15,:) = [3 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
 B(20,16,:) = [4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
 B(20,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Left
 B(20,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Right
 %Down
 B(20,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
 B(20,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
 B(20,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
 B(20,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Left
 B(20,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Right
 B(20,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
 B(20,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
 B(20,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Left
 B(20,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Right
 %
.....................................................................


 B(21,1,:) = [4 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
 B(21,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
 B(21,3,:) = [4 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
 B(21,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Left
 B(21,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Right
 B(21,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
 B(21,7,:) = [4 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
 B(21,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Left
 B(21,9,:) = [4 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
Right
 %Up
 B(21,10,:) = [4 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
 B(21,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
 B(21,12,:) = [4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
 B(21,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Left
 B(21,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
Right
 B(21,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
```

```
1344     B(21,16,:) = [4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1345     B(21,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
1346     B(21,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Right
1347     %Down
1348     B(21,19,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1349     B(21,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1350     B(21,21,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1351     B(21,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Left
1352     B(21,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Right
1353     B(21,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1354     B(21,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1355     B(21,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
1356     B(21,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Right
1357     %
     ..........................................................................


1358
1359     B(22,1,:) = [3 3 7 7 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1360     B(22,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
1361     B(22,3,:) = [3 2 7 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1362     B(22,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Left
1363     B(22,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Right
1364     B(22,6,:) = [7 8 3 4 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1365     B(22,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1366     B(22,8,:) = [3 1 7 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
1367     B(22,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Right
1368     %Up
1369     B(22,10,:) = [3 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1370     B(22,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1371     B(22,12,:) = [3 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1372     B(22,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Left
1373     B(22,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
     Right
1374     B(22,15,:) = [3 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1375     B(22,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1376     B(22,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
     Left
```

```
1377     B(22,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1378     %Down
1379     B(22,19,:) = [7 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1380     B(22,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1381     B(22,21,:) = [7 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1382     B(22,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1383     B(22,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1384     B(22,24,:) = [7 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1385     B(22,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1386     B(22,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1387     B(22,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1388     %
    ..........................................................................


1389
1390     B(23,1,:) = [3 3 4 4 7 7 8 8 0 0 0 0 0 0 0 0]; %Itself
1391     B(23,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1392     B(23,3,:) = [4 1 3 2 8 5 7 6 0 0 0 0 0 0 0 0];%Backward
1393     B(23,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1394     B(23,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1395     B(23,6,:) = [3 4 7 8 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1396     B(23,7,:) = [4 3 8 7 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1397     B(23,8,:) = [3 1 7 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1398     B(23,9,:) = [4 2 8 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1399     %Up
1400     B(23,10,:) = [4 8 3 7 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1401     B(23,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1402     B(23,12,:) = [3 6 4 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1403     B(23,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1404     B(23,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1405     B(23,15,:) = [3 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1406     B(23,16,:) = [4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1407     B(23,17,:) = [3 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1408     B(23,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1409     %Down
```

```
1410     B(23,19,:) = [8 4 7 3 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1411     B(23,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1412     B(23,21,:) = [8 1 7 2 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1413     B(23,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1414     B(23,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1415     B(23,24,:) = [7 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1416     B(23,25,:) = [8 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1417     B(23,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1418     B(23,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1419     %
    ..........................................................................

1420     B(24,1,:) = [4 4 8 8 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1421     B(24,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1422     B(24,3,:) = [4 1 8 5 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1423     B(24,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1424     B(24,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1425     B(24,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1426     B(24,7,:) = [4 3 8 7 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1427     B(24,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1428     B(24,9,:) = [4 2 8 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1429     %Up
1430     B(24,10,:) = [4 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1431     B(24,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1432     B(24,12,:) = [4 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1433     B(24,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1434     B(24,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1435     B(24,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1436     B(24,16,:) = [4 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1437     B(24,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1438     B(24,18,:) = [4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1439     %Down
1440     B(24,19,:) = [8 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1441     B(24,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1442     B(24,21,:) = [8 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
```

```
1443     B(24,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1444     B(24,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1445     B(24,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1446     B(24,25,:) = [8 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1447     B(24,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1448     B(24,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1449     %
    ..........................................................................

1450     B(25,1,:) = [7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1451     B(25,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Forward
1452     B(25,3,:) = [7 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1453     B(25,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1454     B(25,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1455     B(25,6,:) = [7 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1456     B(25,7,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1457     B(25,8,:) = [7 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1458     B(25,9,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1459     %Up
1460     B(25,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1461     B(25,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1462     B(25,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1463     B(25,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1464     B(25,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1465     B(25,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1466     B(25,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1467     B(25,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1468     B(25,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1469     %Down
1470     B(25,19,:) = [7 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1471     B(25,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1472     B(25,21,:) = [7 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1473     B(25,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1474     B(25,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
```

```
1475     B(25,24,:) = [7 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1476     B(25,25,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1477     B(25,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1478     B(25,27,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1479     %
    ..........................................................................

1480     B(26,1,:) = [7 7 8 8 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1481     B(26,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1482     B(26,3,:) = [8 5 7 6 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1483     B(26,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1484     B(26,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1485     B(26,6,:) = [7 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1486     B(26,7,:) = [8 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1487     B(26,8,:) = [7 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1488     B(26,9,:) = [8 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1489     %Up
1490     B(26,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1491     B(26,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1492     B(26,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1493     B(26,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1494     B(26,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1495     B(26,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1496     B(26,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1497     B(26,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1498     B(26,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1499     %Down
1500     B(26,19,:) = [7 3 8 4 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1501     B(26,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1502     B(26,21,:) = [8 1 7 2 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1503     B(26,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1504     B(26,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1505     B(26,24,:) = [7 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1506     B(26,25,:) = [8 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1507     B(26,26,:) = [7 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
```

```
1508     B(26,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1509     %
    ..........................................................................

1510     B(27,1,:) = [8 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0]; %Itself
1511     B(27,2,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1512     B(27,3,:) = [8 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1513     B(27,4,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1514     B(27,5,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1515     B(27,6,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1516     B(27,7,:) = [8 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1517     B(27,8,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1518     B(27,9,:) = [8 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1519     %Up
1520     B(27,10,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1521     B(27,11,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1522     B(27,12,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1523     B(27,13,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1524     B(27,14,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1525     B(27,15,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1526     B(27,16,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1527     B(27,17,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1528     B(27,18,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1529     %Down
1530     B(27,19,:) = [8 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Itself
1531     B(27,20,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward
1532     B(27,21,:) = [8 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward
1533     B(27,22,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Left
1534     B(27,23,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Forward +
    Right
1535     B(27,24,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Left
1536     B(27,25,:) = [8 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Right
1537     B(27,26,:) = [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Left
1538     B(27,27,:) = [8 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0];%Backward +
    Right
1539 return
1540
```

```
function [K11,K12,K13,K22,K23,K33,M] = SmallMatrix(Delta)
%{

syms x
syms y
syms z
mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(10) '%']);
Q = zeros(64,1)*x;
icount = 1;
for i = 0:3
   for j = 0:3
      for k = 0:3
          Q(icount,1) = x^i*y^j*z^k;
          icount = icount + 1;
      end
   end
end
mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(20) '%']);
K11 = zeros(size(Q,1))*x*y*z;
K12 = zeros(size(Q,1))*x*y*z;
K13 = zeros(size(Q,1))*x*y*z;
K22 = zeros(size(Q,1))*x*y*z;
K23 = zeros(size(Q,1))*x*y*z;
K33 = zeros(size(Q,1))*x*y*z;
M   = zeros(size(Q,1))*x*y*z;
mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(25) '%']);
for i = 1:size(Q,1)
   for j = 1:size(Q,1)
      K11(j,i) = diff(Q(j),x)*diff(Q(i),x);
      K12(j,i) = diff(Q(j),y)*diff(Q(i),x);
      K13(j,i) = diff(Q(j),z)*diff(Q(i),x);
      K22(j,i) = diff(Q(j),y)*diff(Q(i),y);
      K23(j,i) = diff(Q(j),z)*diff(Q(i),y);
      K33(j,i) = diff(Q(j),z)*diff(Q(i),z);
      M(j,i)   = Q(j)*Q(i);
   end
end
mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(30) '%']);
K11 = int(int(int(K11,x,[0,1]),y,[0,1]),z,[0,1]);
K12 = int(int(int(K12,x,[0,1]),y,[0,1]),z,[0,1]);
K13 = int(int(int(K13,x,[0,1]),y,[0,1]),z,[0,1]);
K22 = int(int(int(K22,x,[0,1]),y,[0,1]),z,[0,1]);
K23 = int(int(int(K23,x,[0,1]),y,[0,1]),z,[0,1]);
K33 = int(int(int(K33,x,[0,1]),y,[0,1]),z,[0,1]);
M   = int(int(int(M,x,[0,1]),y,[0,1]),z,[0,1]);
mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(35) '%']);
T = MATRIX_T(Q);
Tinv = inv(T);
```

```
mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(40) '%']);
K11 = (Tinv)'*K11*Tinv;
K12 = (Tinv)'*K12*Tinv;
K13 = (Tinv)'*K13*Tinv;
K22 = (Tinv)'*K22*Tinv;
K23 = (Tinv)'*K23*Tinv;
K33 = (Tinv)'*K33*Tinv;
M   = (Tinv)'*M*Tinv;
mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(45) '%']);

save('matrices.mat','K11','K12','K13','K22','K23','K33','M');
%}
L = load('matrices.mat');
K11 = L.K11;
K12 = L.K12;
K13 = L.K13;
K22 = L.K22;
K23 = L.K23;
K33 = L.K33;
M = L.M;


K11 = double(K11*Delta(2)*Delta(3)/Delta(1));
K12 = double(K12*Delta(3));
K13 = double(K13*Delta(2));
K22 = double(K22*Delta(1)*Delta(3)/Delta(2));
K23 = double(K23*Delta(1));
K33 = double(K33*Delta(1)*Delta(2)/Delta(3));
M   = double(M*Delta(1)*Delta(2)*Delta(3));
%mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(50) '%']);
return

function T = MATRIX_T(Q)
%{
syms x;
syms y;
syms z;

n = size(Q,1);
T = zeros(n);
for j = 1:n
   T(j,1) = subs(Q(j),[x,y,z],[0,1,0]);
   T(j,2) = subs(Q(j),[x,y,z],[0,0,0]);
   T(j,3) = subs(Q(j),[x,y,z],[1,0,0]);
   T(j,4) = subs(Q(j),[x,y,z],[1,1,0]);
   T(j,5) = subs(Q(j),[x,y,z],[0,1,1]);
   T(j,6) = subs(Q(j),[x,y,z],[0,0,1]);
   T(j,7) = subs(Q(j),[x,y,z],[1,0,1]);
```

```
1637    T(j,8) = subs(Q(j),[x,y,z],[1,1,1]);
1638
1639    T(j,9) = subs(diff(Q(j),x),[x,y,z],[0,1,0]);
1640    T(j,10) = subs(diff(Q(j),x),[x,y,z],[0,0,0]);
1641    T(j,11) = subs(diff(Q(j),x),[x,y,z],[1,0,0]);
1642    T(j,12) = subs(diff(Q(j),x),[x,y,z],[1,1,0]);
1643    T(j,13) = subs(diff(Q(j),x),[x,y,z],[0,1,1]);
1644    T(j,14) = subs(diff(Q(j),x),[x,y,z],[0,0,1]);
1645    T(j,15) = subs(diff(Q(j),x),[x,y,z],[1,0,1]);
1646    T(j,16) = subs(diff(Q(j),x),[x,y,z],[1,1,1]);
1647
1648    T(j,17) = subs(diff(Q(j),y),[x,y,z],[0,1,0]);
1649    T(j,18) = subs(diff(Q(j),y),[x,y,z],[0,0,0]);
1650    T(j,19) = subs(diff(Q(j),y),[x,y,z],[1,0,0]);
1651    T(j,20) = subs(diff(Q(j),y),[x,y,z],[1,1,0]);
1652    T(j,21) = subs(diff(Q(j),y),[x,y,z],[0,1,1]);
1653    T(j,22) = subs(diff(Q(j),y),[x,y,z],[0,0,1]);
1654    T(j,23) = subs(diff(Q(j),y),[x,y,z],[1,0,1]);
1655    T(j,24) = subs(diff(Q(j),y),[x,y,z],[1,1,1]);
1656
1657    T(j,25) = subs(diff(Q(j),z),[x,y,z],[0,1,0]);
1658    T(j,26) = subs(diff(Q(j),z),[x,y,z],[0,0,0]);
1659    T(j,27) = subs(diff(Q(j),z),[x,y,z],[1,0,0]);
1660    T(j,28) = subs(diff(Q(j),z),[x,y,z],[1,1,0]);
1661    T(j,29) = subs(diff(Q(j),z),[x,y,z],[0,1,1]);
1662    T(j,30) = subs(diff(Q(j),z),[x,y,z],[0,0,1]);
1663    T(j,31) = subs(diff(Q(j),z),[x,y,z],[1,0,1]);
1664    T(j,32) = subs(diff(Q(j),z),[x,y,z],[1,1,1]);
1665
1666    T(j,33) = subs(diff(diff(Q(j),x),y),[x,y,z],[0,1,0]);
1667    T(j,34) = subs(diff(diff(Q(j),x),y),[x,y,z],[0,0,0]);
1668    T(j,35) = subs(diff(diff(Q(j),x),y),[x,y,z],[1,0,0]);
1669    T(j,36) = subs(diff(diff(Q(j),x),y),[x,y,z],[1,1,0]);
1670    T(j,37) = subs(diff(diff(Q(j),x),y),[x,y,z],[0,1,1]);
1671    T(j,38) = subs(diff(diff(Q(j),x),y),[x,y,z],[0,0,1]);
1672    T(j,39) = subs(diff(diff(Q(j),x),y),[x,y,z],[1,0,1]);
1673    T(j,40) = subs(diff(diff(Q(j),x),y),[x,y,z],[1,1,1]);
1674
1675    T(j,41) = subs(diff(diff(Q(j),x),z),[x,y,z],[0,1,0]);
1676    T(j,42) = subs(diff(diff(Q(j),x),z),[x,y,z],[0,0,0]);
1677    T(j,43) = subs(diff(diff(Q(j),x),z),[x,y,z],[1,0,0]);
1678    T(j,44) = subs(diff(diff(Q(j),x),z),[x,y,z],[1,1,0]);
1679    T(j,45) = subs(diff(diff(Q(j),x),z),[x,y,z],[0,1,1]);
1680    T(j,46) = subs(diff(diff(Q(j),x),z),[x,y,z],[0,0,1]);
1681    T(j,47) = subs(diff(diff(Q(j),x),z),[x,y,z],[1,0,1]);
1682    T(j,48) = subs(diff(diff(Q(j),x),z),[x,y,z],[1,1,1]);
1683
1684    T(j,49) = subs(diff(diff(Q(j),y),z),[x,y,z],[0,1,0]);
```

```
    T(j,50) = subs(diff(diff(Q(j),y),z),[x,y,z],[0,0,0]);
    T(j,51) = subs(diff(diff(Q(j),y),z),[x,y,z],[1,0,0]);
    T(j,52) = subs(diff(diff(Q(j),y),z),[x,y,z],[1,1,0]);
    T(j,53) = subs(diff(diff(Q(j),y),z),[x,y,z],[0,1,1]);
    T(j,54) = subs(diff(diff(Q(j),y),z),[x,y,z],[0,0,1]);
    T(j,55) = subs(diff(diff(Q(j),y),z),[x,y,z],[1,0,1]);
    T(j,56) = subs(diff(diff(Q(j),y),z),[x,y,z],[1,1,1]);

    T(j,57) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[0,1,0]);
    T(j,58) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[0,0,0]);
    T(j,59) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[1,0,0]);
    T(j,60) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[1,1,0]);
    T(j,61) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[0,1,1]);
    T(j,62) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[0,0,1]);
    T(j,63) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[1,0,1]);
    T(j,64) = subs(diff(diff(diff(Q(j),x),z),y),[x,y,z],[1,1,1]);
end
%}
T = [1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
     0 0 0 0 0;
 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1
    1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
     0 0 0;
 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2
    2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
     0 0 0;
 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3
    3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
     0 0 0;
 1 0 0 1 1 0 0 1 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
     0 0 0;
 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 0 0 1 1 0 0
    1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0
     0 0 0;
 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 2 0 0
    2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 0 0 0 0 0
     0 0 0;
```

```
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 3 0 0
  3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 0 0 0 0 0 0
   0 0 0;
1 0 0 1 1 0 0 1 0 0 0 0 0 0 0 0 2 0 0 2 2 0 0 2 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 2 1 0 0 1 1 0 0
  1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 2 2 0 0 2 0 0 0 0 0
   0 0 0;
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 2 0 0 0 0 2 0 0
  2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 0 0 4 0 0 0 0 0
   0 0 0;
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 2 0 0 0 0 3 0 0
  3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 0 0 6 0 0 0 0 0
   0 0 0;
1 0 0 1 1 0 0 1 0 0 0 0 0 0 0 0 3 0 0 3 3 0 0 3 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 3 1 0 0 1 1 0 0
  1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 3 3 0 0 3 0 0 0 0 0
   0 0 0;
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 3 0 0 0 0 2 0 0
  2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 0 0 6 0 0 0 0 0
   0 0 0;
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 3 0 0 0 0 3 0 0
  3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9 0 0 9 0 0 0 0 0
   0 0 0;
0 0 1 1 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1
  1 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
  2 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3
  3 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 1 0 0 0 1 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 1 0 0 0 0 0 0 0
  0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0
  1 0 0 0 0 1 1 1 1 1 0 0 1 1 0 0 1 0 0 1 1 0 0 1 1 1 1 1 1 1
   1 1 1;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0
  2 0 0 0 0 1 1 1 1 0 0 0 0 2 0 0 2 0 0 0 0 0 0 2 2 0 0 0 0 2
   2 2 2;
```

```
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0
  3 0 0 0 0 1 1 1 1 0 0 0 0 3 0 0 3 0 0 0 0 0 0 3 3 0 0 0 0 3
    3 3 3;
0 0 0 1 0 0 0 1 1 0 0 1 1 0 0 1 0 0 0 2 0 0 0 2 0 0 0 0 0 0 0
  0 2 0 0 2 2 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 2 0 0 0 1 0 0 0
  1 0 0 0 0 2 0 0 2 1 0 0 1 1 0 0 1 0 0 0 2 0 0 0 2 2 0 0 2 2
    0 0 2;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
  2 0 0 0 0 2 0 0 2 0 0 0 0 2 0 0 2 0 0 0 0 0 0 0 4 0 0 0 0 4
    0 0 4;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
  3 0 0 0 0 2 0 0 2 0 0 0 0 3 0 0 3 0 0 0 0 0 0 0 6 0 0 0 0 6
    0 0 6;
0 0 0 1 0 0 0 1 1 0 0 1 1 0 0 1 0 0 0 3 0 0 0 3 0 0 0 0 0 0 0
  0 3 0 0 3 3 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 3 0 0 0 1 0 0 0
  1 0 0 0 0 3 0 0 3 1 0 0 1 1 0 0 1 0 0 0 3 0 0 0 3 3 0 0 3 3
    0 0 3;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0
  2 0 0 0 0 3 0 0 3 0 0 0 0 2 0 0 2 0 0 0 0 0 0 0 6 0 0 0 0 6
    0 0 6;
0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0
  3 0 0 0 0 3 0 0 3 0 0 0 0 3 0 0 3 0 0 0 0 0 0 0 9 0 0 0 0 9
    0 0 9;
0 0 1 1 0 0 1 1 0 0 2 2 0 0 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 0 0 2 2 0 0 0 0 0 0 0 0 0 1 1 0 0 1
  1 0 0 0 0 0 0 0 0 0 0 2 2 0 0 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 0 0 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
  2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 4 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 0 0 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3
  3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 1 0 0 0 1 0 0 0 2 0 0 0 2 0 0 1 1 0 0 1 1 0 0 0 0 0 0 0
  0 0 0 2 2 0 0 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0
  1 0 0 0 0 0 0 2 2 0 0 0 2 0 0 0 2 0 0 1 1 0 0 1 1 0 0 2 2 0
    0 2 2;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0
  2 0 0 0 0 0 0 2 2 0 0 0 0 0 0 0 4 0 0 0 0 0 0 2 2 0 0 0 0 0
    0 4 4;
```

```
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0
  3 0 0 0 0 0 0 2 2 0 0 0 0 0 0 0 6 0 0 0 0 0 0 3 3 0 0 0 0 0
   0 6 6;
0 0 0 1 0 0 0 1 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 0 0 0 0
  0 0 0 0 4 0 0 0 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 2 0 0 0 1 0 0 0
  1 0 0 0 0 0 0 0 4 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 2 0 0 0 4 0
   0 0 4;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
  2 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 4 0 0 0 0 0
   0 0 8;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
  3 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 6 0 0 0 0 0
   0 0 12;
0 0 0 1 0 0 0 1 0 0 0 2 0 0 0 2 0 0 0 3 0 0 0 3 0 0 0 0 0 0 0
  0 0 0 0 6 0 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 3 0 0 0 1 0 0 0
  1 0 0 0 0 0 0 0 6 0 0 0 2 0 0 0 2 0 0 0 3 0 0 0 3 0 0 0 6 0
   0 0 6;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0
  2 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 6 0 0 0 0 0
   0 0 12;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0
  3 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 9 0 0 0 0 0
   0 0 18;
0 0 1 1 0 0 1 1 0 0 3 3 0 0 3 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 0 0 3 3 0 0 0 0 0 0 0 0 0 1 1 0 0 1
  1 0 0 0 0 0 0 0 0 0 0 3 3 0 0 3 3 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 0 0 3 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
  2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 6 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 1 1 0 0 0 0 0 0 3 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3
  3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 9 9 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 1 0 0 0 1 0 0 0 3 0 0 0 3 0 0 1 1 0 0 1 1 0 0 0 0 0 0 0
  0 0 0 3 3 0 0 3 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0
  1 0 0 0 0 0 0 3 3 0 0 0 3 0 0 0 3 0 0 1 1 0 0 1 1 0 0 3 3 0
   0 3 3;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0
  2 0 0 0 0 0 0 3 3 0 0 0 0 0 0 0 6 0 0 0 0 0 0 2 2 0 0 0 0 0
   0 6 6;
```

```
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0
   3 0 0 0 0 0 0 3 3 0 0 0 0 0 0 0 9 0 0 0 0 0 0 3 3 0 0 0 0 0
    0 9 9;
0 0 0 1 0 0 0 1 0 0 0 3 0 0 0 3 0 0 0 2 0 0 0 2 0 0 0 0 0 0 0
   0 0 0 0 6 0 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 2 0 0 0 1 0 0 0
   1 0 0 0 0 0 0 0 6 0 0 0 3 0 0 0 3 0 0 0 2 0 0 0 2 0 0 0 6 0
    0 0 6;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
   2 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 4 0 0 0 0 0
    0 0 12;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
   3 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 6 0 0 0 0 0
    0 0 18;
0 0 0 1 0 0 0 1 0 0 0 3 0 0 0 3 0 0 0 3 0 0 0 3 0 0 0 0 0 0 0
   0 0 0 0 9 0 0 0 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 3 0 0 0 1 0 0 0
   1 0 0 0 0 0 0 0 9 0 0 0 3 0 0 0 3 0 0 0 3 0 0 0 3 0 0 0 9 0
    0 0 9;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0
   2 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 6 0 0 0 0 0
    0 0 18;
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0
   3 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 9 0 0 0 0 0
    0 0 27];
T = T';
return;

function [B11,B12,B13,B22,B23,B33,BM] = AddMatrix(K11,K12,K13,
   K22,K23,K33,M)
B = AdjacentType();
B11 = zeros(216,216);
B12 = zeros(216,216);
B13 = zeros(216,216);
B22 = zeros(216,216);
B23 = zeros(216,216);
B33 = zeros(216,216);
BM = zeros(216,216);
for g = 1:8
    for f = 1:8
        for i = 1:27
           for j = 1:27
              for k = 1:2:15
                  if B(i,j,k) ~= 0
                    B11(i+(g-1)*27,j+(f-1)*27) = B11(i+(g-1)
   *27,j+(f-1)*27) + K11(B(i,j,k)+(g-1)*8,B(i,j,k+1)+(f-1)*8);
```

```
                        B12(i+(g-1)*27,j+(f-1)*27) = B12(i+(g-1)
    *27,j+(f-1)*27) + K12(B(i,j,k)+(g-1)*8,B(i,j,k+1)+(f-1)*8);
                        B13(i+(g-1)*27,j+(f-1)*27) = B13(i+(g-1)
    *27,j+(f-1)*27) + K13(B(i,j,k)+(g-1)*8,B(i,j,k+1)+(f-1)*8);
                        B22(i+(g-1)*27,j+(f-1)*27) = B22(i+(g-1)
    *27,j+(f-1)*27) + K22(B(i,j,k)+(g-1)*8,B(i,j,k+1)+(f-1)*8);
                        B23(i+(g-1)*27,j+(f-1)*27) = B23(i+(g-1)
    *27,j+(f-1)*27) + K23(B(i,j,k)+(g-1)*8,B(i,j,k+1)+(f-1)*8);
                        B33(i+(g-1)*27,j+(f-1)*27) = B33(i+(g-1)
    *27,j+(f-1)*27) + K33(B(i,j,k)+(g-1)*8,B(i,j,k+1)+(f-1)*8);
                        BM(i+(g-1)*27,j+(f-1)*27) = BM(i+(g-1)*27,j
    +(f-1)*27) + M(B(i,j,k)+(g-1)*8,B(i,j,k+1)+(f-1)*8);
                    else
                        break
                    end
                end
            end
        end
    end
end
return;

function [K11,K12,K13,K22,K23,K33,M,D,E] = Matrices(Delta,N,
    method)
%mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(0) '%']);
[K11q,K12q,K13q,K22q,K23q,K33q,Mq] = SmallMatrix(Delta);
[B11,B12,B13,B22,B23,B33,BM] = AddMatrix(K11q,K12q,K13q,K22q,
    K23q,K33q,Mq);
%{
K11 = spalloc((N(1)+1)*(N(2)+1)*(N(3)+1),(N(1)+1)*(N(2)+1)*(N
    (3)+1),(N(1)+1)*(N(2)+1)*(N(3)+1)*27);
K12 = spalloc((N(1)+1)*(N(2)+1)*(N(3)+1),(N(1)+1)*(N(2)+1)*(N
    (3)+1),(N(1)+1)*(N(2)+1)*(N(3)+1)*27);
K13 = spalloc((N(1)+1)*(N(2)+1)*(N(3)+1),(N(1)+1)*(N(2)+1)*(N
    (3)+1),(N(1)+1)*(N(2)+1)*(N(3)+1)*27);
K22 = spalloc((N(1)+1)*(N(2)+1)*(N(3)+1),(N(1)+1)*(N(2)+1)*(N
    (3)+1),(N(1)+1)*(N(2)+1)*(N(3)+1)*27);
K23 = spalloc((N(1)+1)*(N(2)+1)*(N(3)+1),(N(1)+1)*(N(2)+1)*(N
    (3)+1),(N(1)+1)*(N(2)+1)*(N(3)+1)*27);
K33 = spalloc((N(1)+1)*(N(2)+1)*(N(3)+1),(N(1)+1)*(N(2)+1)*(N
    (3)+1),(N(1)+1)*(N(2)+1)*(N(3)+1)*27);
M = spalloc((N(1)+1)*(N(2)+1)*(N(3)+1),(N(1)+1)*(N(2)+1)*(N(3)
    +1),(N(1)+1)*(N(2)+1)*(N(3)+1)*27);
%}
[D,E] = Domain(N,Delta);
A = Adjacent(N,D);
T = Type(N,A);
%
```

```
1819
1820 %mwb.Update(2, 1, 0, ['Matrix Creation ' num2str(55) '%']);
1821 %{
1822 for i = 1:(N(1)+1)*(N(2)+1)*(N(3)+1)
1823     mwb.Update(2, 1, i/((N(1)+1)*(N(2)+1)*(N(3)+1)+1), ['Matrix
     Creation ' num2str(i/((N(1)+1)*(N(2)+1)*(N(3)+1)+1)*100) '
    %']);
1824     for j = 1:27
1825        k = 1;
1826        while (B(T(i),j,k) ~= 0 && ~isnan(A(i,j)))
1827             K11(i,A(i,j)) = K11(i,A(i,j)) + K11q(B(T(i),j,k),B(
    T(i),j,k+1));
1828             K12(i,A(i,j)) = K12(i,A(i,j)) + K12q(B(T(i),j,k),B(
    T(i),j,k+1));
1829             K13(i,A(i,j)) = K13(i,A(i,j)) + K13q(B(T(i),j,k),B(
    T(i),j,k+1));
1830             K22(i,A(i,j)) = K22(i,A(i,j)) + K22q(B(T(i),j,k),B(
    T(i),j,k+1));
1831             K23(i,A(i,j)) = K23(i,A(i,j)) + K23q(B(T(i),j,k),B(
    T(i),j,k+1));
1832             K33(i,A(i,j)) = K33(i,A(i,j)) + K33q(B(T(i),j,k),B(
    T(i),j,k+1));
1833
1834             M(i,A(i,j)) = M(i,A(i,j)) + Mq(B(T(i),j,k),B(T(i),j
    ,k+1));
1835             k = k + 2;
1836             if(k >= 16)
1837                break;
1838             end
1839        end
1840     end
1841 end
1842 %}
1843 n = 0;
1844 for i = 1:(N(1)+1)*(N(2)+1)*(N(3)+1)
1845     for j = 1:27
1846       if ~isnan(A(i,j))
1847          n = n +1;
1848       end
1849     end
1850 end
1851
1852 %{
1853
1854 %}
1855 %{
1856
1857 NAN_A = ~isnan(A);
```

```
A2 = repmat(A(:,1),1,size(A,2));
A3 = repmat([1:27]',1,size(A,1))';
iy = A(NAN_A);
ix = A2(NAN_A);
iz = A3(NAN_A);
[ix iy iz];

for i = 1:size(iy,1)
    mwb.Update(2, 1, i/(size(iy,1)), ['Matrix Creation '
   num2str(i/size(iy,1)*100) '%']);
    k = 1;
    while(k < 16 && B(T(ix(i)),iz(i),k) ~= 0)
        K11s(i) = K11s(i) + K11q(B(T(ix(i)),iz(i),k),B(T(ix(i))
   ,iz(i),k+1));
        K12s(i) = K12s(i) + K12q(B(T(ix(i)),iz(i),k),B(T(ix(i))
   ,iz(i),k+1));
        K13s(i) = K13s(i) + K13q(B(T(ix(i)),iz(i),k),B(T(ix(i))
   ,iz(i),k+1));
        K22s(i) = K22s(i) + K22q(B(T(ix(i)),iz(i),k),B(T(ix(i))
   ,iz(i),k+1));
        K23s(i) = K23s(i) + K23q(B(T(ix(i)),iz(i),k),B(T(ix(i))
   ,iz(i),k+1));
        K33s(i) = K33s(i) + K33q(B(T(ix(i)),iz(i),k),B(T(ix(i))
   ,iz(i),k+1));
        Ms(i) = Ms(i) + Mq(B(T(ix(i)),iz(i),k),B(T(ix(i)),iz(i)
   ,k+1));
        k = k + 2;
    end
end
%}
%%{

if (method == 2)
   % mwb.Update(2, 1, 0.1, ['Matrix Creation ' num2str(55)
   '%']);
    InvA = A';
    NAN_A = ~isnan(InvA);
    A2 = repmat([1:27]',1,size(InvA,2))';
    A3 = repmat(1:size(A,1),size(A,2),1)';
    InvA3 = A3';
    InvA2 = A2';
    iy1 = InvA(NAN_A);
    ix1 = InvA3(NAN_A);
    iz1 = InvA2(NAN_A);
    Typex1 = T(ix1);

    iy = [];
    ix = [];
```

```
1897      iz = [];
1898      Typex = [];
1899
1900
1901      for i = 1:8
1902         for j = 1:8
1903             iy = [iy; iy1+(j-1)*size(A,1)];
1904             iz = [iz; iz1+(j-1)*27];
1905             ix = [ix; ix1+(i-1)*size(A,1)];
1906             Typex = [Typex; Typex1+(i-1)*27];
1907         end
1908      end
1909
1910
1911
1912      %BAdd = B(Typex,Typey,:);
1913      %mwb.Update(2, 1, 0.2, ['Matrix Creation ' num2str(60)
          '%']);
1914      K11s = B11(sub2ind(size(B11),Typex,iz));
1915      %mwb.Update(2, 1, 0.3, ['Matrix Creation ' num2str(65)
          '%']);
1916      K12s = B12(sub2ind(size(B12),Typex,iz));
1917      %mwb.Update(2, 1, 0.4, ['Matrix Creation ' num2str(70)
          '%']);
1918      K13s = B13(sub2ind(size(B13),Typex,iz));
1919      %mwb.Update(2, 1, 0.5, ['Matrix Creation ' num2str(75)
          '%']);
1920      K22s = B22(sub2ind(size(B22),Typex,iz));
1921      %mwb.Update(2, 1, 0.6, ['Matrix Creation ' num2str(80)
          '%']);
1922      K23s = B23(sub2ind(size(B23),Typex,iz));
1923      %mwb.Update(2, 1, 0.7, ['Matrix Creation ' num2str(85)
          '%']);
1924      K33s = B33(sub2ind(size(B33),Typex,iz));
1925      %mwb.Update(2, 1, 0.8, ['Matrix Creation ' num2str(90)
          '%']);
1926      Ms = BM(sub2ind(size(BM),Typex,iz));
1927      %mwb.Update(2, 1, 0.9, ['Matrix Creation ' num2str(95)
          '%']);
1928  elseif (method == 1)
1929      B = AdjacentType();
1930      K11s = zeros(n,1);
1931      K12s = zeros(n,1);
1932      K13s = zeros(n,1);
1933      K22s = zeros(n,1);
1934      K23s = zeros(n,1);
1935      K33s = zeros(n,1);
1936      Ms = zeros(n,1);
```

```
1937     ix = zeros(n,1);
1938     iy = zeros(n,1);
1939     ii = 1;
1940     for i = 1:(N(1)+1)*(N(2)+1)*(N(3)+1)
1941         %mwb.Update(2, 1, i/((N(1)+1)*(N(2)+1)*(N(3)+1)+1), ['
    Matrix Creation ' num2str(i/((N(1)+1)*(N(2)+1)*(N(3)+1)+1)
    *100) '%']);
1942         for j = 1:27
1943           if ~isnan(A(i,j))
1944               ix(ii) = A(i,1);
1945               iy(ii) = A(i,j);
1946               k = 1;
1947               while (B(T(i),j,k) ~= 0 && ~isnan(A(i,j)))
1948
1949                   K11s(ii) = K11s(ii) + K11q(B(T(i),j,k),B(T(i),j
    ,k+1));
1950                   K12s(ii) = K12s(ii) + K12q(B(T(i),j,k),B(T(i),j
    ,k+1));
1951                   K13s(ii) = K13s(ii) + K13q(B(T(i),j,k),B(T(i),j
    ,k+1));
1952                   K22s(ii) = K22s(ii) + K22q(B(T(i),j,k),B(T(i),j
    ,k+1));
1953                   K23s(ii) = K23s(ii) + K23q(B(T(i),j,k),B(T(i),j
    ,k+1));
1954                   K33s(ii) = K33s(ii) + K33q(B(T(i),j,k),B(T(i),j
    ,k+1));
1955                   Ms(ii) = Ms(ii) + Mq(B(T(i),j,k),B(T(i),j,k+1))
    ;
1956                   k = k + 2;
1957                   if(k >= 16)
1958                      break;
1959                   end
1960               end
1961               Tempi(ii) = T(i);
1962                   Tempj(ii) = j;
1963               ii = ii +1;
1964           end
1965         end
1966     end
1967 end
1968
1969 %}
1970 K11 = sparse(ix,iy,K11s,8*(N(1)+1)*(N(2)+1)*(N(3)+1),8*(N(1)+1)
    *(N(2)+1)*(N(3)+1));
1971 K12 = sparse(ix,iy,K12s,8*(N(1)+1)*(N(2)+1)*(N(3)+1),8*(N(1)+1)
    *(N(2)+1)*(N(3)+1));
1972 K13 = sparse(ix,iy,K13s,8*(N(1)+1)*(N(2)+1)*(N(3)+1),8*(N(1)+1)
    *(N(2)+1)*(N(3)+1));
```

```
1973 K22 = sparse(ix,iy,K22s,8*(N(1)+1)*(N(2)+1)*(N(3)+1),8*(N(1)+1)
     *(N(2)+1)*(N(3)+1));
1974 K23 = sparse(ix,iy,K23s,8*(N(1)+1)*(N(2)+1)*(N(3)+1),8*(N(1)+1)
     *(N(2)+1)*(N(3)+1));
1975 K33 = sparse(ix,iy,K33s,8*(N(1)+1)*(N(2)+1)*(N(3)+1),8*(N(1)+1)
     *(N(2)+1)*(N(3)+1));
1976 M = sparse(ix,iy,Ms,8*(N(1)+1)*(N(2)+1)*(N(3)+1),8*(N(1)+1)*(N
     (2)+1)*(N(3)+1));
1977 %{
1978 B(T(1:(N(1)+1)*(N(2)+1)*(N(3)+1)),1:27,2:2:16)
1979 K11q(B(T(1:(N(1)+1)*(N(2)+1)*(N(3)+1)),1:27,1:2:15),B(T(1:(N(1)
     +1)*(N(2)+1)*(N(3)+1)),1:27,2:2:16))
1980
1981 sum(K11q(B(T(1:(N(1)+1)*(N(2)+1)*(N(3)+1)),1:27,1:2:15)>0,B(T
     (1:(N(1)+1)*(N(2)+1)*(N(3)+1)),1:27,2:2:16))>0)
1982 K11(1:(N(1)+1)*(N(2)+1)*(N(3)+1),1:(N(1)+1)*(N(2)+1)*(N(3)+1))
     = sum(B(T(1:(N(1)+1)*(N(2)+1)*(N(3)+1)),1:27,1:2:15))
1983 K11(1,:)
1984 size(K11)
1985 K11(1:(N(1)+1)*(N(2)+1)*(N(3)+1),A(~isnan(A(1:(N(1)+1)*(N(2)+1)
     *(N(3)+1),1:27)))) =  sum(K11q(B(T(1:(N(1)+1)*(N(2)+1)*(N
     (3)+1)),1:27,1:2:15)>0,B(T(1:(N(1)+1)*(N(2)+1)*(N(3)+1))
     ,1:27,2:2:1))>0);
1986 %}
1987
1988 %mwb.Update(2, 1, 1, ['Matrix Creation ' num2str(100) '%']);
1989 return;
1990
1991 function T = Type(N,A)
1992 T = zeros((N(1)+1)*(N(2)+1)*(N(3)+1),1);
1993 TEST = [1    10   nan    11   nan     2   nan   nan   nan     4
        13   nan    14   nan     5   nan   nan   nan   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
1994         2    11   nan    12    10     3     1   nan   nan     5
        14   nan    15    13     6     4   nan   nan   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
1995         3    12   nan   nan    11   nan     2   nan   nan     6
        15   nan   nan    14   nan     5   nan   nan   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
1996         4    13   nan    14   nan     5   nan   nan   nan     7
        16   nan    17   nan     8   nan   nan   nan     1
    10   nan    11   nan     2   nan   nan   nan;
1997         5    14   nan    15    13     6     4   nan   nan     8
        17   nan    18    16     9     7   nan   nan     2
    11   nan    12    10     3     1   nan   nan;
1998         6    15   nan   nan    14   nan     5   nan   nan     9
        18   nan   nan    17   nan     8   nan   nan     3
    12   nan   nan    11   nan     2   nan   nan;
```

```
1999        7    16   nan    17   nan     8   nan   nan   nan   nan
      nan   nan   nan   nan   nan   nan   nan   nan     4
    13   nan    14   nan     5   nan   nan   nan;
2000        8    17   nan    18    16     9     7   nan   nan   nan
      nan   nan   nan   nan   nan   nan   nan   nan     5
    14   nan    15    13     6     4   nan   nan;
2001        9    18   nan   nan    17   nan     8   nan   nan   nan
      nan   nan   nan   nan   nan   nan   nan   nan     6
    15   nan   nan    14   nan     5   nan   nan;
2002       10    19     1    20   nan    11   nan     2   nan
    13    22     4    23   nan    14   nan     5   nan   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
2003       11    20     2    21    19    12    10     3     1
    14    23     5    24    22    15    13     6     4   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
2004       12    21     3   nan    20   nan    11   nan     2
    15    24     6   nan    23   nan    14   nan     5   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
2005       13    22     4    23   nan    14   nan     5   nan
    16    25     7    26   nan    17   nan     8   nan    10
     19     1    20   nan    11   nan     2   nan;
2006       14    23     5    24    22    15    13     6     4
    17    26     8    27    25    18    16     9     7    11
     20     2    21    19    12    10     3     1;
2007       15    24     6   nan    23   nan    14   nan     5
    18    27     9   nan    26   nan    17   nan     8    12
     21     3   nan    20   nan    11   nan     2;
2008       16    25     7    26   nan    17   nan     8   nan
    nan   nan   nan   nan   nan   nan   nan   nan   nan    13
      22     4    23   nan    14   nan     5   nan;
2009       17    26     8    27    25    18    16     9     7
    nan   nan   nan   nan   nan   nan   nan   nan   nan    14
      23     5    24    22    15    13     6     4;
2010       18    27     9   nan    26   nan    17   nan     8
    nan   nan   nan   nan   nan   nan   nan   nan   nan    15
      24     6   nan    23   nan    14   nan     5;
2011       19   nan    10   nan   nan    20   nan    11   nan
    22   nan    13   nan   nan    23   nan    14   nan   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
2012       20   nan    11   nan   nan    21    19    12    10
    23   nan    14   nan   nan    24    22    15    13   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
2013       21   nan    12   nan   nan   nan    20   nan    11
    24   nan    15   nan   nan   nan    23   nan    14   nan
    nan   nan   nan   nan   nan   nan   nan   nan;
2014       22   nan    13   nan   nan    23   nan    14   nan
    25   nan    16   nan   nan    26   nan    17   nan    19
    nan    10   nan   nan    20   nan    11   nan;
```

```
        23   nan    14   nan   nan    24    22    15    13
    26   nan    17   nan   nan    27    25    18    16    20
    nan    11   nan   nan    21    19    12    10;
        24   nan    15   nan   nan   nan    23   nan    14
    27   nan    18   nan   nan   nan    26   nan    17    21
    nan    12   nan   nan   nan    20   nan    11;
        25   nan    16   nan   nan    26   nan    17   nan
    nan   nan   nan   nan   nan   nan   nan   nan   nan    22
     nan    13   nan   nan    23   nan    14   nan;
        26   nan    17   nan   nan    27    25    18    16
    nan   nan   nan   nan   nan   nan   nan   nan   nan    23
     nan    14   nan   nan    24    22    15    13;
        27   nan    18   nan   nan   nan    26   nan    17
    nan   nan   nan   nan   nan   nan   nan   nan   nan    24
     nan    15   nan   nan   nan    23   nan    14];
for i = 1:(N(1)+1)*(N(2)+1)*(N(3)+1)
   for j = 1:27
      bflag = true;
      for k = 1:27
         if(isnan(A(i,k))~= isnan(TEST(j,k)))
            bflag = false;
         end
      end
      if(bflag == true)
         T(i) = j;
         break;
      end
   end
end
return
```