post_processing_code.m

```m
%% Post-processing code

% This code takes computed nodal displacements as input from pre-processing
% code and then calculates disp field, strain field and stress field.

%% Displacement field of the plate

u_field_plate=sym('A%d%d', [11 nel_x*nel_y]);

% There are 06 types of elements in our square plate which is SS on all
% sides. Disp field of all six types of elements is calclulated one by one
% and then a matrix containing disp field of whole plate is constructed.

% 1) "corner elements" of the plate i.e. 04 corners

for ii=1:4
    u_elem=zeros(68,1);
    if ii==1         % lower left corner
        u_elem_1=zeros(17,1);
        u_elem_2=y_edge(u(1:6));
        aa=6*(nel_x-1)+6+1;
        u_elem_3=u(aa:(aa+16));
        u_elem_4=x_edge(u(aa-6:aa-1));
        u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];

    elseif ii==2      % lower right corner
        aa=6*(nel_x-2)+1;
        u_elem_1=y_edge(u(aa:aa+5));
        u_elem_2=zeros(17,1);
        aa=6*(nel_x-1)+6+17*(nel_x-1)+1;
        u_elem_3=x_edge(u(aa:aa+5));
        u_elem_4=u(aa-17:aa-1);
        u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];

    elseif ii==3       % upper left corner
        aa=6*(nel_x-1)+(nel_y-2)*(6+17*(nel_x-1)+6)+1;
        u_elem_1=x_edge(u(aa:aa+5));
        u_elem_2=u(aa+6:aa+22);
        aa=6*(nel_x-1)+(nel_y-1)*(6+17*(nel_x-1)+6)+1;
        u_elem_3=y_edge(u(aa:aa+5));
        u_elem_4=zeros(17,1);
        u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];

    elseif ii==4        % upper right corner
        aa=6*(nel_x-1)+(nel_y-2)*(6+17*(nel_x-1)+6)+6+17*(nel_x-2)+1;
        u_elem_1=u(aa:aa+16);
        u_elem_2=x_edge(u(aa+17:aa+22));
        u_elem_3=zeros(17,1);
        u_elem_4=y_edge(u(end-5:end));
        u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];
    end
    u_field_elem=N*u_elem;
    aa=1;
        for jj=1:11
            if ii==2
                aa=nel_x;
            elseif ii==3
                aa=nel_x+(nel_y-2)*(nel_x)+1;
            elseif ii==4
                aa=nel_x*nel_y;
            end
            u_field_plate(jj,aa)=u_field_elem(jj);
        end
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end

% 2) Elements on the "lower" edge of the plate except corners

aa=1; bb=6*(nel_x-1)+6+17+1; cc=2;
for ii=1:nel_x-2
    u_elem_1=y_edge(u(aa:aa+5));
    u_elem_2=y_edge(u(aa+6:aa+11));
    u_elem_3=u(bb:bb+16);
    u_elem_4=u(bb-17:bb-1);
    u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];
    u_field_elem=N*u_elem;
    aa=aa+6; bb=bb+17;

    for jj=1:11
        u_field_plate(jj,cc)=u_field_elem(jj);
    end
    cc=cc+1;
end

% 3) Elements on the "left" edge of the plate except corners

aa=6*(nel_x-1)+1; bb=6*(nel_x-1)+6+17*(nel_x-1)+6+6+1; cc=nel_x+1;
for ii=1:nel_y-2
    u_elem_1=x_edge(u(aa:aa+5));
    u_elem_2=u(aa+6:aa+22);
    u_elem_3=u(bb:bb+16);
    u_elem_4=x_edge(u(aa-6:aa-1));
    u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];
    u_field_elem=N*u_elem;
    aa=aa+6+17*(nel_x-1)+6; bb=bb+17*(nel_x-1)+6+6;

    for jj=1:11
        u_field_plate(jj,cc)=u_field_elem(jj);
    end
    cc=cc+nel_x;
end

% 4) Elements on the "right" edge of the plate except corners

aa=6*(nel_x-1)+6+17*(nel_x-1)-16; cc=2*nel_x;
for ii=1:nel_y-2
    bb=aa+17+6+6+17*(nel_x-1);
    u_elem_1=u(aa:aa+16);
    u_elem_2=x_edge(u(aa+17:aa+22));
    u_elem_3=x_edge(u(bb:bb+5));
    u_elem_4=u(bb-17:bb-1);
    u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];
    u_field_elem=N*u_elem;
    aa=aa+17+6+6+17*(nel_x-1)-17;

    for jj=1:11
        u_field_plate(jj,cc)=u_field_elem(jj);
    end
    cc=cc+nel_x;
end

% 5) Elements on the "top" edge of the plate except corners

aa=6*(nel_x-1)+(nel_y-2)*(6+17*(nel_x-1)+6)+6+1;
bb=6*(nel_x-1)+(nel_y-1)*(6+17*(nel_x-1)+6)+6+1;
cc=nel_x*(nel_y-1)+2;
for ii=1:nel_x-2
    u_elem_1=u(aa:aa+16);
    u_elem_2=u(aa+17:aa+33);
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    u_elem_3=y_edge(u(bb:bb+5));
    u_elem_4=y_edge(u(bb-6:bb-1));
    u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];
    u_field_elem=N*u_elem;
    aa=aa+17; bb=bb+6;

    for jj=1:11
        u_field_plate(jj,cc)=u_field_elem(jj);
    end
    cc=cc+1;
end

% 6) Elements which are in-between the edges and have 17-DOF at each
%    node of the element

aa=6*(nel_x-1)+6+1;  bb=6*(nel_x-1)+6+17*(nel_x-1)+6+6+17+1;
cc=nel_x+2;
for ii=1:nel_y-2
    for jj=1:nel_x-2
        u_elem_1=u(aa:aa+16);
        u_elem_2=u(aa+17:aa+33);
        u_elem_3=u(bb:bb+16);
        u_elem_4=u(bb-17:bb-1);
        u_elem=[u_elem_1; u_elem_2; u_elem_3; u_elem_4];
        u_field_elem=N*u_elem;
        aa=aa+17; bb=bb+17;

        for kk=1:11
            u_field_plate(kk,cc)=u_field_elem(kk);
        end
        cc=cc+1;
    end
    aa=aa+17+6+6; bb=bb+6+6+17;
    cc=cc+2;
end

%%  Strain field of the face-sheets

% There are 03 types of strains in the face-sheets which are
% E_xx, E_yy and E_xy. Therefore, for our case there'll be a
% total of 06 strains in the face-sheets (03 in each).

U=u_field_plate;
zeta_t=z-(c+(ft/2));
zeta_b=z+(c+(fb/2));

% Top face-sheet
strain_field_plate_top=sym('A%d%d', [3 nel_x*nel_y]);
for ii=1:nel_x*nel_y
    strain_field_plate_top(1,ii)=diff(U(1,ii),x) - zeta_t*(diff(U(3,ii),x,2));
    strain_field_plate_top(2,ii)=diff(U(2,ii),y) - zeta_t*(diff(U(3,ii),y,2));
    strain_field_plate_top(3,ii)=diff(U(1,ii),y) + diff(U(2,ii),x)...
                                 - 2*zeta_t*(diff(diff(U(3,ii),y),x));
end

% Bottom face-sheet
strain_field_plate_bottom=sym('A%d%d', [3 nel_x*nel_y]);
for ii=1:nel_x*nel_y
    strain_field_plate_bottom(1,ii)=diff(U(4,ii),x) - zeta_t*(diff(U(6,ii),x,2));
    strain_field_plate_bottom(2,ii)=diff(U(5,ii),y) - zeta_t*(diff(U(6,ii),y,2));
    strain_field_plate_bottom(3,ii)=diff(U(4,ii),y) + diff(U(5,ii),x)...
                                    - 2*zeta_t*(diff(diff(U(6,ii),y),x));
end

%%  Strain field of the core
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```
194
195 % There are 06 strains in the core whcih are E_xx, E_yy, E_zz, E_xy, E_yz
196 % and E_xz.
197
198 strain_field_plate_core=sym('A%d%d', [6 nel_x*nel_y]);
199 for ii=1:nel_x*nel_y
200     strain_field_plate_core(1,ii)=diff(U(7,ii),x) + z*(diff(U(10,ii),x)) - ...
201             (z^3/(4*c^3))*(2*diff(U(4,ii),x)-2*diff(U(1,ii),x)+4*c*diff(U(10,ii),x)-
    fb*diff(U(6,ii),x,2)-ft*diff(U(3,ii),x,2))-...
202             (z^2/(4*c^2))*(-2*diff(U(4,ii),x)+4*diff(U(7,ii),x)-2*
    (diff(U(1,ii),x))+fb*diff(U(6,ii),x,2)-ft*diff(U(3,ii),x,2));
203
204     strain_field_plate_core(2,ii)=diff(U(8,ii),y) - z*(diff(U(11,ii),y)) - ...
205             (z^3/(4*c^3))*(2*diff(U(5,ii),y)-2*diff(U(2,ii),y)-4*c*diff(U(11,ii),y)-
    fb*diff(U(6,ii),y,2)-ft*diff(U(3,ii),y,2))-...
206             (z^2/(4*c^2))*(-2*diff(U(5,ii),y)+4*diff(U(8,ii),y)-2*
    (diff(U(2,ii),y))+fb*diff(U(6,ii),y,2)-ft*diff(U(3,ii),y,2));
207
208     strain_field_plate_core(3,ii)=-(z/(c^2))*(2*U(9,ii)-U(6,ii)-U(3,ii))-(1/(2*c)*(U(6,ii)-
    U(3,ii)));
209
210     strain_field_plate_core(4,ii)=-U(11,ii)+diff(U(9,ii),y)-(z^2/(2*c^2))*(2*diff(U(9,ii),y)-
    diff(U(6,ii),y)-diff(U(3,ii),y))-...
211             (z/(2*c))*(diff(U(6,ii),y)-diff(U(3,ii),y))-(3*z^2/(4*c^3))*
    (2*U(5,ii)-2*U(2,ii)-4*c*U(11,ii)-fb*diff(U(6,ii),y)-ft*diff(U(3,ii),y))-...
212             (z/(2*c^2))*(-2*U(5,ii)+4*U(8,11)-2*U(2,ii)+fb*diff(U(6,ii),y)-
    ft*diff(U(3,ii),y));
213
214     strain_field_plate_core(5,ii)=U(10,ii)+diff(U(9,ii),x)-(z^2/(2*c^2))*(2*diff(U(9,ii),x))-
    diff(U(6,ii),x)-diff(U(3,ii),x)-...
215             (z/(2*c))*(diff(U(6,ii),x)-diff(U(3,ii),x))-(3*z^2/(4*c^3))*
    (2*U(4,ii)-2*U(1,ii)+4*c*U(10,ii)-fb*diff(U(6,ii),x)-ft*diff(U(3,ii),x))-...
216             (z/(2*c^2))*(-2*U(4,ii)+4*U(7,ii)-2*U(1,ii)+fb*diff(U(6,ii),x)-
    ft*diff(U(3,ii),x));
217
218     strain_field_plate_core(6,ii)=diff(U(7,ii),y)+z*diff(U(10,ii),y)+diff(U(8,ii),x)-
    z*diff(U(11,ii),x)-...
219             (z^3/(4*c^3))*(2*diff(U(4,ii),y)-2*diff(U(1,ii),y)+4*c*diff(U(10,ii),y)-
    fb*diff(diff(U(6,ii),y),x)-ft*diff(diff(U(3,ii),y),x))-...
220             (z^3/(4*c^3))*(2*diff(U(5,ii),x)-2*diff(U(2,ii),x)-4*c*diff(U(11,ii),x)-
    fb*diff(diff(U(6,ii),y),x)-ft*diff(diff(U(3,ii),y),x))-...
221             (z^2/(4*c^2))*
    (-2*diff(U(4,ii),y)+4*diff(U(7,ii),y)-2*diff(U(1,ii),y)+fb*diff(diff(U(6,ii),y),x)-
    ft*diff(diff(U(3,ii),y),x))-...
222             (z^2/(4*c^2))*
    (-2*diff(U(5,ii),x)+4*diff(U(8,ii),x)-2*diff(U(2,ii),x)+fb*diff(diff(U(6,ii),y),x)-
    ft*diff(diff(U(3,ii),y),x));
223 end
224
225 %% Stress field
226
227 % There are 03 types of stresses in the face-sheets which are
228 %sig_xx, sig_yy and sig_xy. Therefore, for our case there'll be a
229 % total of 06 stresses in the face-sheets (03 in each).
230 % Whereas, in core there are all 06 stresses present which are
231 % sig_xx, sig_yy, sig_zz, sig_xz, sig_yz and sig_xy.
232
233 % Top face-sheet
234 stress_field_plate_top=C_t*strain_field_plate_top;
235
236 % Bottom face-sheet
237 stress_field_plate_bottom=C_b*strain_field_plate_bottom;
238
239 % Core
240 stress_field_plate_core=C_c*strain_field_plate_core;
```

241
242
243