ME 4210 Composites HW9 - Robert Ressler

clc

clear all

format shortg

% 2.

E = [163e9 11.31e9 11.31e9];

nu = [3.13 0 0];

G = [5.5e9 0 0];

t = 1e-3;

% a) [ +- 30 / -+ 45 ]s

stack = [ 30 -30 -45 45 45 -45 -30 30 ];

fprintf('\nStack:')

disp(stack);

[A,B,D] = laminaStiffness\_ressler(E,nu,G,stack,t);

disp([A B; B D]);

% b)

stack = [ 0 90 0 90 ];

fprintf('\nStack:')

disp(stack);

[A,B,D] = laminaStiffness\_ressler(E,nu,G,stack,t);

disp([A B; B D]);

% c)

stack = [ 30 0 60 -30 -60];

fprintf('\nStack:')

disp(stack);

[A,B,D] = laminaStiffness\_ressler(E,nu,G,stack,t);

disp([A B; B D]);

% d)

stack = [ 0 90 0 90 90 0 90 0 ];

fprintf('\nStack:')

disp(stack);

[A,B,D] = laminaStiffness\_ressler(E,nu,G,stack,t);

disp([A B; B D]);

Stack: 30 -30 -45 45 45 -45 -30 30

Bending-Twisting coupling present.

2.1239e+09 1.4115e+09 0 2.3283e-10 1.1642e-10 0

1.4115e+09 1.1765e+09 0 1.1642e-10 -5.8208e-11 0

0 0 5.7117e+08 0 0 0

2.3283e-10 1.1642e-10 0 13523 7227 1148.3

1.1642e-10 -5.8208e-11 0 7227 4681 365.68

0 0 0 1148.3 365.68 2745

Stack: 0 90 0 90

Stretching-Bending coupling present.

1.0887e+09 4.4219e+08 0 -4.7369e+05 0 0

4.4219e+08 1.0887e+09 0 0 4.7369e+05 0

0 0 2.2e+07 0 0 0

-4.7369e+05 0 0 1451.6 589.59 0

0 4.7369e+05 0 589.59 1451.6 0

0 0 0 0 0 29.333

Stack: 30 0 60 -30 -60

Stretching-Bending coupling present.

Stretching-Twisting coupling present.

Shear-Twisting coupling present.

Bending-Twisting coupling present.

1.3717e+09 7.7866e+08 0 -6.486e+05 56482 -5.454e+05

7.7866e+08 8.9805e+08 0 56482 5.3564e+05 -4.8018e+05

-1.4901e-08 0 2.5343e+08 -5.454e+05 -4.8018e+05 56482

-6.486e+05 56482 -5.454e+05 2682.9 1678.7 125.71

56482 5.3564e+05 -4.8018e+05 1678.7 1932.9 -330.83

-5.454e+05 -4.8018e+05 56482 125.71 -330.83 584.46

Stack: 0 90 0 90 90 0 90 0

2.1773e+09 8.8438e+08 0 0 0 0

8.8438e+08 2.1773e+09 0 0 -7.276e-11 0

0 0 4.4e+07 0 0 -3.638e-12

0 0 0 15402 4716.7 0

0 -7.276e-11 0 4716.7 7822.9 0

0 0 -3.638e-12 0 0 234.67

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function [ A,B,D ] = laminaStiffness\_ressler( E,v,G, stack, thickness )

%laminaStiffness\_ressler takes engineering constants, E, nu, G, a stack

%sequence and a lamina thinkness and returns the stiffness submatrices A, B

%and D.

% Preallocation

A = zeros(3);

B = zeros(3);

D = zeros(3);

eta = zeros(length(stack),4);

z\_k = 0;

v(2) = v(1)/E(1) \* E(2);

% Loop

for k = 1:length(stack);

% Depth of the current ply

z\_k = thickness \* (k-length(stack)/2);

z\_k1 = z\_k - thickness;

% Angle of current ply

s = sind(stack(k));

c = cosd(stack(k));

% Transformation matrix to reference coords

T = [c^2 s^2 2\*c\*s; ...

s^2 c^2 -2\*c\*s; ...

-c\*s c\*s c^2-s^2];

T\_E = [c^2 s^2 c\*s; ...

s^2 c^2 -c\*s; ...

-2\*c\*s 2\*c\*s c^2-s^2];

% Q\_bar matrix

Q = [ E(1)/(1-v(1)\*v(2)) v(1)\*E(2)/(1-v(1)\*v(2)) 0; ...

v(1)\*E(2)/(1-v(1)\*v(2)) E(2)/(1-v(1)\*v(2)) 0; ...

0 0 G(1)];

Qbar = inv(T) \* Q \* T\_E;

% A matrix

A = A + Qbar \* (z\_k - z\_k1);

% B matrix

B = B + (1/2 \* Qbar \* (z\_k^2 - z\_k1^2));

% D matrix

D = D + (1/3 \* Qbar \* (z\_k^3 - z\_k1^3));

end

% Coupling

if abs(A(1,3)) > 1e-6 || abs(A(2,3)) > 1e-6

fprintf('Stretching-Shear coupling present.\n');

end

if abs(B(1,1)) > 1e-6 || abs(B(1,2)) > 1e-6 || abs(B(2,2)) > 1e-6

fprintf('Stretching-Bending coupling present.\n');

end

if abs(B(1,3)) > 1e-6 || abs(B(2,3)) > 1e-6

fprintf('Stretching-Twisting coupling present.\n');

end

if abs(B(3,3)) > 1e-6

fprintf('Shear-Twisting coupling present.\n');

end

if abs(D(1,3)) > 1e-6 || abs(D(2,3)) > 1e-6

fprintf('Bending-Twisting coupling present.\n');

end

end

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