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(1)

UofT Student No :- ~~10~~08,24,75,31

$t = 0.125$ mm

1^{st} Ply $\rightarrow$ $(08-50) * 1.8 \Rightarrow -75.6°$

2^{nd} Ply $\rightarrow$ $(24-50) \times 1.8 \Rightarrow -46.8°$

3^{rd} Ply $\rightarrow$ $(75-50) \times 1.8 \Rightarrow 45°$

4^{th} Ply $\rightarrow$ $(31-50) \times 1.8 \Rightarrow -34.2°$

$[-75.6°/-46.8°/45°/-34.2°]$

$E_1 \Rightarrow 131$ GPa, $E_2 = 9.8$ GPa, $G_{12} = 5.8$ GPa, $\nu_{12} = 0.22$

$$[Q] \Rightarrow \begin{bmatrix} Q_{11} & Q_{12} & 0 \\ Q_{12} & Q_{22} & 0 \\ 0 & 0 & Q_{66} \end{bmatrix}$$

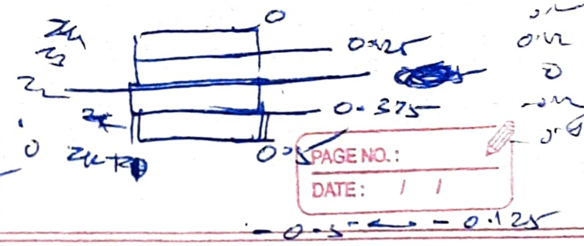
$$\Rightarrow Q_{11} \Rightarrow \frac{E_1}{1-\nu_{12}\nu_{21}} \qquad Q_{66} \Rightarrow G_{12}$$

$$Q_{22} = \frac{E_2}{1-\nu_{12}\nu_{21}}$$

$$Q_{12} \Rightarrow \frac{\nu_{12} E_2}{1-\nu_{12}\nu_{21}}$$

[This is Converted to Code in Matlab & Solved. Code Attached at ~~as a text file~~ last]

$Z_k = (3-k) \times 0.125$



Transformation Matrix:-

$$[T] \Rightarrow \begin{bmatrix} \cos^2\theta & \sin^2\theta & 2\cos\theta\sin\theta \\ \sin^2\theta & \cos^2\theta & -2\cos\theta\sin\theta \\ -\cos\theta\sin\theta & \cos\theta\sin\theta & \cos^2\theta-\sin^2\theta \end{bmatrix}$$

$\bar{Q} \Rightarrow [T]^{-1}\,[Q]\,[T^T]^{-1}$ } → To be done for all Lamina.

↓

Done using Code.

Once I have $\bar{Q}_{ij}$,

$$A_{ij} \Rightarrow \sum_{k=1}^{N} \left((\bar{Q}_{ij})_k\right)(Z_k - Z_{k-1}) \Rightarrow t\left(\Sigma(\bar{Q}_{ij})_k\right)$$

$$B_{ij} \Rightarrow \frac{1}{2} \times \sum_{k=1}^{N} \left((\bar{Q}_{ij})_k\right)(Z_k^2 - Z_{k-1}^2) \Rightarrow \frac{t}{2}\left(\Sigma(\bar{Q}_{ij})(Z_k + Z_{k-1})\right)$$

$$D_{ij} \Rightarrow \frac{1}{3} \sum_{k=1}^{N} \left((\bar{Q}_{ij})_k\right)(Z_k^3 - Z_{k-1}^3) \Rightarrow \frac{t}{3}\left(\Sigma(\bar{Q}_{ij})(Z_k^2 + Z_{k-1}^2 + Z_k Z_{k-1})\right)$$

$Z_k \Rightarrow (3-k) \times 0.125$ → Z_k on top

$Z_{k-1} = Z_k - 0.125$ → Z_{k-1} on Bottom.

symmetric

Sol :-

$$\begin{bmatrix} 19.9905 & 12.0785 & & & & \\ 12.0785 & 28.6721 & -5.8650 & & & \\ -4.8512 & -5.8650 & 13.8966 & 0.7364 & & \\ -2.7625 & -0.8450 & 0.7364 & 1.2402 & 0.6050 & \\ -0.8450 & 4.4525 & -1.3579 & -0.6050 & 2.1007 & -0.6213 \\ 0.7364 & -1.3579 & -0.8450 & -0.5522 & -0.6213 & 0.7186 \end{bmatrix}$$

```
t = 0.125;
theta = [-75.6 -46.8 45 -34.2]; % In Degrees
theta = theta.*(pi/180); % Conversion to Radians - I my system Default is
radians

E1 = 131;
E2 = 9.8;
G12 = 5.8;
nu_12 = 0.22;

S = [1/E1 -nu_12/E1 0; -nu_12/E1 1/E2 0; 0 0 1/G12];

Q_local = S^-1;

T = @(x) [(cos(x))^2 (sin(x))^2 2*cos(x)*sin(x); (sin(x))^2 (cos(x))^2 -
2*cos(x)*sin(x); -cos(x)*sin(x) cos(x)*sin(x) (cos(x))^2 - (sin(x))^2];

%Q_global = (inv(T))*(Q_local)*(inv(transpose(T)));

A = zeros(3);
B = zeros(3);
D = zeros(3);

for k = 1:4
   z_k = (3-k)*0.125;
   z_k1 = z_k - 0.125;
   Q_global = ((inv(T(theta(k))))*(Q_local)*(inv(transpose(T(theta(k))))));
   A = A + 0.125*Q_global;
   B = B + (0.125*(z_k + z_k1))*Q_global;
   D = D + (0.125*(z_k^2 + z_k1^2 + z_k*z_k1))*Q_global;
end

sol = [A B;B D]
```