2014년도 2학기 항공기 구조역학 중간고사 답안

1. $\sigma_1 = 150MPa \quad \sigma_2 = 250MPa \quad \sigma_3 = -120MPa$
   $\tau_{12} = 70MPa \quad \tau_{13} = -50MPa \quad \tau_{23} = 130MPa$

$$\begin{bmatrix} 150 & 70 & -50 \\ 70 & 250 & 130 \\ -50 & 130 & -120 \end{bmatrix} \begin{Bmatrix} n_1 \\ n_2 \\ n_3 \end{Bmatrix} = \{0\}$$

$$\rightarrow \ [A]\{\vec{n}\} = \{0\}$$

(1) Eigenvalues of matrix [A] → Ans.) -175.8834, 146.8548, 309. 0286

(2) Determine normalized eigenvectors.

→ {0.21, -0.3168, 0.9249}, {-0.9213, 0.2526, 0.2957}, {-0.3273, -0.9142, -0.2389}

2. The cantilevered beam

(1) <O. D. E.> Hu''''(x)=p_o

<B. C.> u(0)=0, u'(0)=0, u''(L)=0, -Hu'''=P-ku(L)

(2) The displacement field, $u(x) = \frac{1}{24H} p_0 x^4 + ax^3 + bx^2$

$$u'(x) = \frac{1}{6H} p_0 x^3 + 3ax^2 + 2bx \qquad u''(x) = \frac{1}{2H} p_0 x^2 + 6ax + 2 \qquad u'''(x) = \frac{p_0}{H} x + 6a$$

Using the beam boundary condition,

$$u''(L) = \frac{1}{2H} p_0 L^2 + 6aL + 2b = 0 \qquad \rightarrow \qquad b = -(\frac{1}{4H} p_0 L^2 + 3aL)$$

$$u'''(L) = \frac{p_0}{H} L + 6a$$

Rewrite the spring boundary condition and determine the constants, a and b.

$$-H(\frac{p_0}{H}L+6a)=P-kL^2(\frac{1}{24H}p_0L^2+aL+b)$$

$$-H(\frac{p_0}{H}L+6a)=P-kL^2(\frac{1}{24H}p_0L^2+aL-(\frac{1}{4H}p_0L^2+3aL))$$

$$-p_0L-P+\frac{1}{24H}p_0kL^4-\frac{p_0k}{4H}L^4=-(3kL^3+kL^3-6H)a$$

$$a=-\frac{p_0L+P+\frac{5p_0k}{24H}L^4}{2kL^3+6H}$$

$$b=-(\frac{1}{4H}p_0L^2+3aL)=-\frac{1}{4H}p_0L^2+3L(\frac{p_0L+P+\frac{5p_0k}{24H}L^4}{2kL^3+6H})$$

3. The thin-walled, rectangular beam section

(1) The centroidal bending stiffnesses of the section

$$b=\beta h$$

$$b_0=\frac{h\beta(1+\beta)}{2(3+\beta)} \qquad H_{22}=Eh^3t\frac{(1+\beta)}{2} \qquad H_{33}=E\beta^2h^3t\frac{(15+12\beta+\beta^2)}{6(\beta+3)} \qquad H_{23}=0$$

(2) The shear flow distribution

$$f_1=-\frac{3(5h^2\beta(\beta+1)+2h\beta(1+\beta)S_1-2(3+\beta)S_1{}^2)V_2}{2\beta^2h^3(15+12\beta+\beta^2)} \qquad f_2=-\frac{3V_2(h-2S_2)(\beta+5)}{2\beta h^2(15+12\beta+\beta^2)}$$

$$f_3=\frac{3(h^2\beta(5+\beta)+2h\beta(5+\beta)S_3-2(3+\beta)S_3{}^2)V_2}{2\beta^2h^3(15+12\beta+\beta^2)} \qquad f_4=\frac{15(1+\beta)(h-2S_4)V_2}{2\beta h^2(15+12\beta+\beta^2)}$$