1. (2 pts each)

(1) rocker
(2) midrail
(3) Shock tower
(4) Front roof header
(5) Roof rail
(6) Hinge pillar
(7) B pillar
(8) shear
(9) peel
(10) square

2. (4 pts each)

(1) Stiffness: Characterized by small and elastic deformation, (applied load)/(unit of deformation)

(2) Strength: Characterized by the onset of a small permanent deformation, Lowest load at which a permanent deformation first appears

(3) Energy Absorption: Characterized by very large permanent deformations where the amount of energy absorbed by the structure

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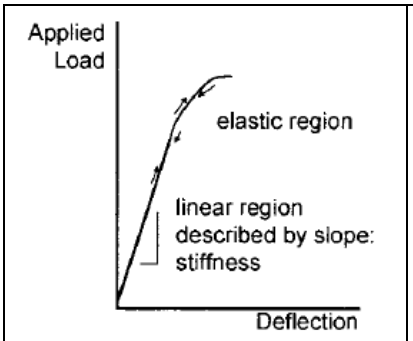
<td> 
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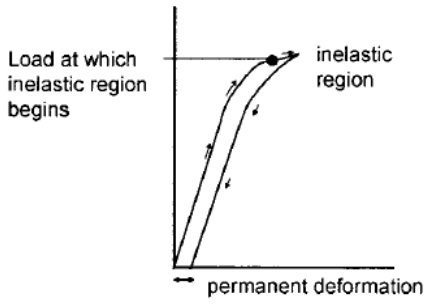
<td> 
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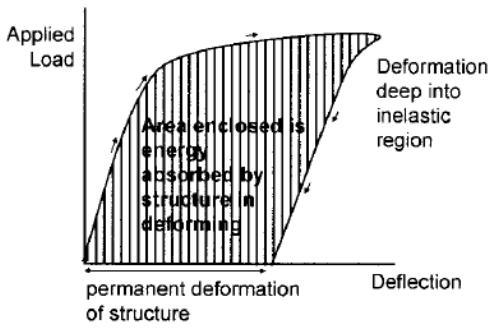
<td> 
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<tr>
<td>Stiffness</td>
<td>Strength</td>
<td>Energy Absorption</td>
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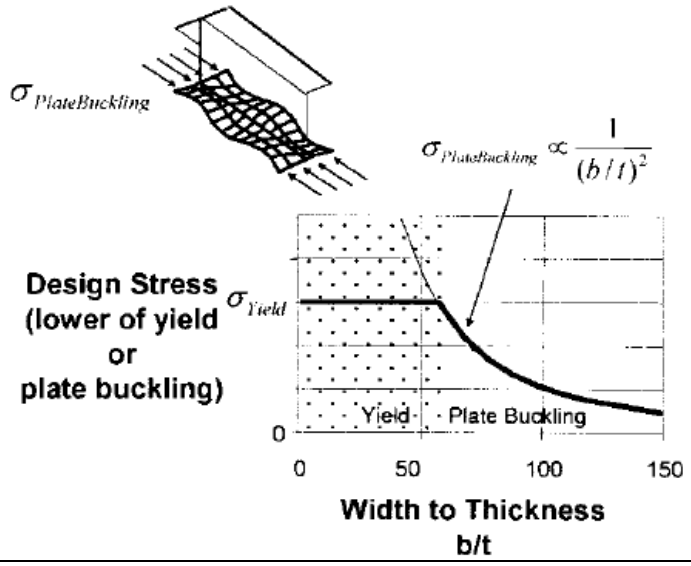
</table>

3. (4 pts each)

(1) $\sigma_{CR} = \dfrac{E\pi^2}{12\left(1-\mu^2\right)\left(b/t\right)^2} k = \dfrac{748355}{\left(b/t\right)^2}$

(2) $\sigma_{design} = \begin{cases} \sigma_{yield} = 207\ N/mm \\ \sigma_{buckle} = \dfrac{748355}{\left(b/t\right)^2}\ N/mm \end{cases}$

$\sigma_{yield} = \sigma_{buckle} \rightarrow \left(b/t\right) \approx 60$



4.

(1) Xd(2F), Xs1(2F), Xa(4/5F), Xs3(8/5F), Xb(8/5F), 각 1점

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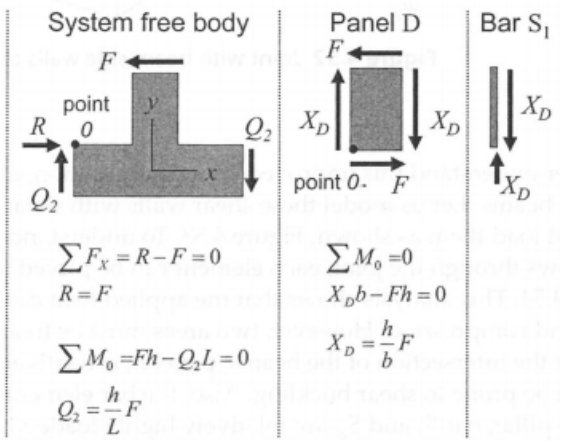
<td> 
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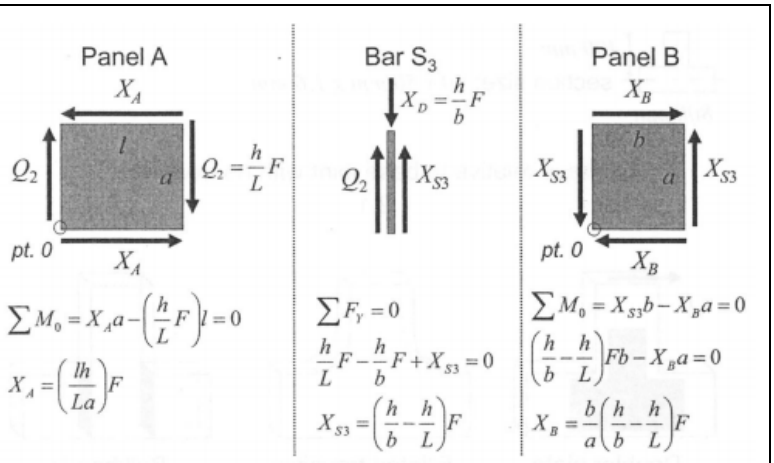
<td> 
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<td>R=F, Q2=0.4F</td>
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(2) (10점)

$$\sigma_{cr} = k\frac{E\pi^2}{12(1-\nu^2)(b/t)^2} = 935443.3(t/b)^2$$

$$\text{panel } A: \sigma_{cr,A} = 935443.3(0.89/100)^2 = 74.1MPa \rightarrow P_{cr,A} = \sigma_{cr,A}(bt) = 6595N$$

$$\text{panel } B: \sigma_{cr,B} = 935443.3(0.89/100)^2 = 74.1MPa \rightarrow P_{cr,B} = \sigma_{cr,B}(bt) = 6595N$$

$$\text{panel } C: \sigma_{cr,C} = 935443.3(0.89/100)^2 = 74.1MPa \rightarrow P_{cr,C} = \sigma_{cr,C}(bt) = 6595N$$

$$\text{panel } D: \sigma_{cr,D} = 935443.3(1/100)^2 = 93.5MPa \rightarrow P_{cr,D} = \sigma_{cr,D}(bt) = 9350N$$

(3) 동일 하중 F에 대해 판넬 D에 걸리는 하중은 2F, B에 걸리는 하중은 1.6F로 1.25배이다. 그러나 허용하중의 경우 D 판넬의 9350N이 B 판넬의 6595N의 1.42배이므로 최종적으로 B 판넬이 가장 취약하다. (5점)

(4)

$$\frac{1}{2}F\delta = \sum_{\text{all surfaces}} \frac{1}{2}q_i^2\left[\frac{\text{panel area}}{(Gt)}\right]_i \text{ (5 pts)} \quad q_i = (\text{edge force}/\text{edge length}), \quad G = \frac{E}{2(1+\nu)} = 79.6GPa$$

$$\delta = \frac{1}{F}\left[(\frac{Q_2}{a})^2\frac{al}{Gt_A} + (\frac{X_B}{a})^2\frac{al}{Gt_B} + (\frac{Q_2}{a})^2\frac{a(L-l-b)}{Gt_C} + (\frac{F}{b})^2\frac{bh}{Gt_D}\right]$$

$$= \frac{1}{GF}\left[(\frac{hF}{aL})^2\frac{al}{t_A} + (\frac{b}{a^2}(\frac{h}{b}-\frac{h}{L})F)^2\frac{al}{t_B} + (\frac{hF}{aL})^2\frac{a(L-l-b)}{t_C} + (\frac{F}{b})^2\frac{bh}{t_D}\right]$$

$$= \frac{F}{G}\left[\frac{h^2}{aL^2}\frac{l}{t_A} + \frac{b^2}{a^3}(\frac{h}{b}-\frac{h}{L})^2\frac{l}{t_B} + (\frac{h^2}{aL^2})\frac{(L-l-b)}{t_C} + \frac{1}{b}\frac{h}{t_D}\right] \text{ (5 pts)}$$

5.

(1) (5 pts)

$$F_w = \frac{Fw}{2h} = \frac{(8000N)(1500mm)}{2(1300mm)} = 4615.4N$$

$$F_h = \frac{F}{2} = 4000N$$

$$F_L = \frac{FL}{2h} = \frac{(8000N)(3000mm)}{2(1300mm)} = 9230.8N$$

(2) (10 pts)

$$e = \int \frac{\tau\gamma}{2} dV = \int \frac{\tau^2}{2G} dV = \frac{(q/t)^2}{2G}(abt) = q^2 \frac{ab}{2(Gt)} \quad (5 \text{ pts})$$

$$\frac{1}{2}T\theta = \sum_{\text{all surfaces}} \frac{1}{2} q^2 \left[\frac{ab}{(Gt)}\right]_i \xrightarrow{q=\frac{F}{2h}=\frac{T/w}{2h}=\frac{T}{2wh}} \frac{1}{2}T\theta = \sum_{\text{all surfaces}} \frac{1}{2}\left(\frac{T}{2wh}\right)^2 \left[\frac{ab}{(Gt)}\right]_i$$

$$\theta = T\left(\frac{1}{2wh}\right)^2 \sum_{\text{all surfaces}} \left[\frac{ab}{(Gt)}\right]_i \rightarrow K = \frac{T}{\theta} = (2wh)^2 \frac{1}{\sum_{\text{all surfaces}} \left[\frac{ab}{(Gt)}\right]_i}$$

(3) (5 pts)

Front & Rear: $\frac{ab}{Gt} = \frac{(1300mm)(1500mm)}{80000N/mm^2} = 24.375$

Top & Bottom: $\frac{ab}{Gt} = \frac{(1500mm)(3000mm)}{80000N/mm^2} = 56.25$

Right & Left: $\frac{ab}{Gt} = \frac{(1300mm)(3000mm)}{80000N/mm^2} = 48.75$

$$K = \frac{T}{\theta} = (2wh)^2 \frac{1}{\sum_{\text{all surfaces}} \left[\frac{ab}{(Gt)}\right]_i} = 4(1500mm)^2(1300mm)^2 \frac{1}{2(24.375+56.25+48.75)}$$

$$= 5.88E10[Nmm/rad] = 1.03E6[Nm/°]$$

(4) (10 pts)

Front & Rear: $\frac{ab}{Gt} = \frac{(1300mm)(1500mm)}{80000N/mm^2} = 24.375$

Top: $\frac{ab}{Gt} = \frac{(1500mm)(3000mm)}{0.22(80000N/mm^2)} = 255.7$

Bottom: $\frac{ab}{Gt} = \frac{(1500mm)(3000mm)}{80000N/mm^2} = 56.25$

Right & Left: $\frac{ab}{Gt} = \frac{(1300mm)(3000mm)}{80000N/mm^2} = 48.75$

$$K = \frac{T}{\theta} = (2wh)^2 \frac{1}{\sum_{\text{all surfaces}} \left[\frac{ab}{(Gt)}\right]_i} = 4(1500mm)^2(1300mm)^2 \frac{1}{2(24.375+48.75)+255.7+56.25}$$

$$= 3.32E10[Nmm/rad] = 5.79E5[Nm/°] \ (44\% \downarrow)$$