

1. Fill in the blanks. (1 pts each)

Body Configuration

(1) Central closed tunnel (2) (3)

(4) front strut tower (5) upper rail (6) rear strut tower (7) roof header (8) shelf panel

1 2 3 4 5 cross members

side frame assembly

roof side rail

A pillar inner & outer

upper rail (9) (6) (10) inner & outer

outer wheel house (11)

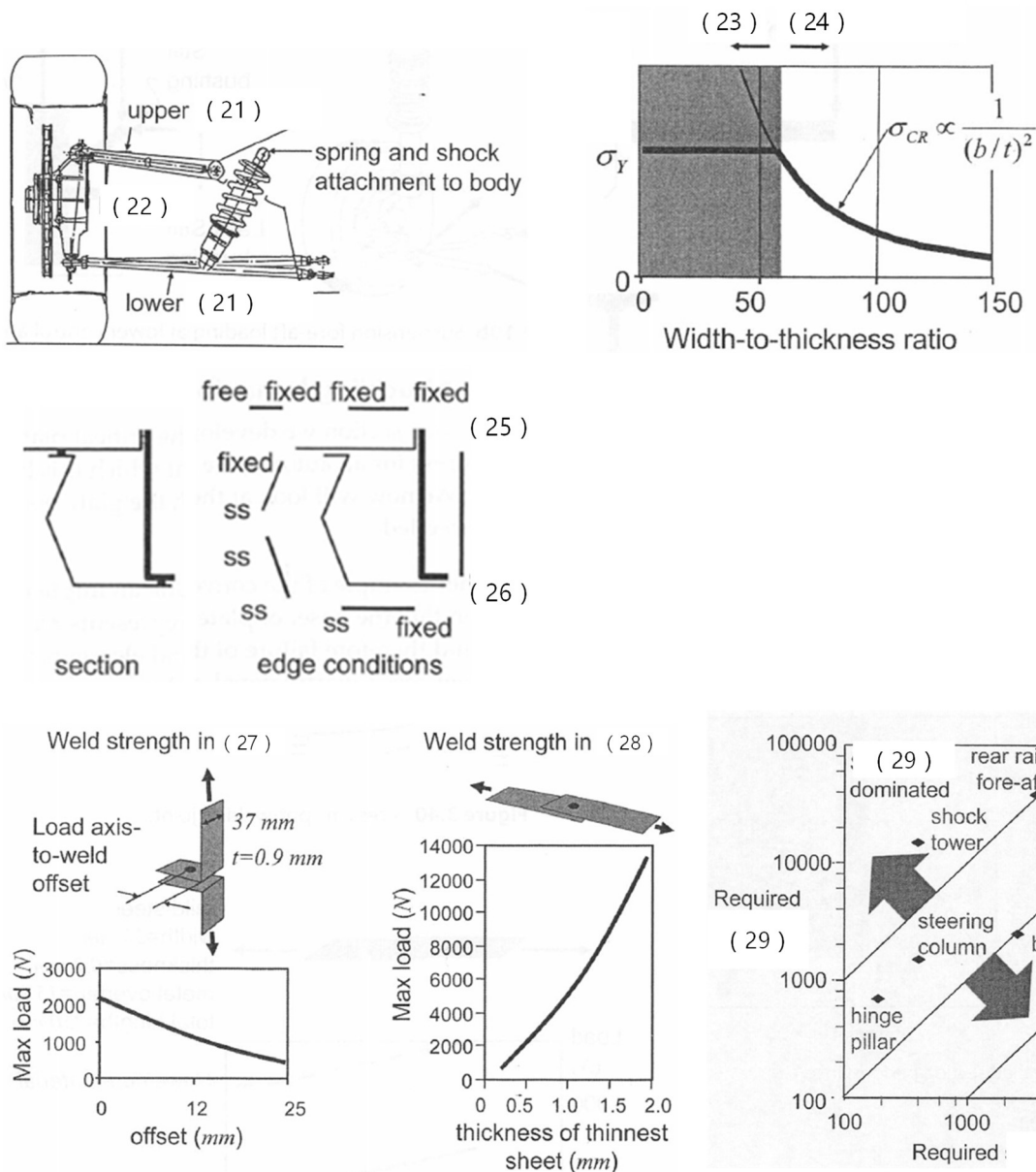
Body in white less closures

(12) rear close out panel (13) rear roof header (14) (15) (16)

Restraints at Suspension Attachments

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Bending Stiffness Nominal Value Stiffness = (17)	Bending Strength Nominal Value (18) no permanent deformation	Torsion Stiffness Nominal Value Stiffness = (19)	Torsion Strength Nominal Value (20) no permanent deformation
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2. Describe the followings. (5 pts each)

- (1) all modes to calculate the steady-state maximum front tire patch loads
- (2) three categories of structural requirements by drawing a typical load-deflection curve
- (3) lightweight index of the automotive body structure
- (4) effect of spot-weld on longitudinal stiffness
- (5) effective width of the plate
- (6) joint efficiency

3. Describe the procedure to calculate the body torsional stiffness analytically. (10 pts)

4. The desired maximum deflection for the convertible is 1 mm elastic under a load of 6670 N, or the stiffness requirement is: $K \geq (6670 \text{ N}) / (1 \text{ mm}) = 6670 \text{ N/mm}$. Also the rocker fails at a minimum load of 6670 N in yield or buckling. Determine a and t to minimize rocker mass. (15 pts)

2550 mm

6670 N total load at center of span

a
1.5 a
t

$$I = \frac{(1.5a)^2 t (3a + 1.5a)}{6} = \frac{27}{16} a^3 t$$

$$\delta = \frac{FL^3}{48EI}$$

$$\sigma = \frac{My}{I} \rightarrow \sigma_{design} = \begin{cases} \sigma_{yield} = 207 \text{ N/mm} \\ \sigma_{buckle} = \frac{748355}{(a/t)^2} \text{ N/mm} \end{cases}$$

5. A Z section beam is part of a bumper reaction structure. ($E = 207 \text{ N/mm}^2$, $\nu = 0.3$, $\sigma_y = 207 \text{ N/mm}^2$) (15 pts)

(1) Calculate the ultimate compressive load for this section.

(2) Consider again the Z section under compressive loading, but now with buckling inhibiting techniques. Calculate the ultimate load and compare with the result of (1).

500mm (a)

flange
20mm
web
80mm
t=1mm
Physical Section

$$\sigma_{cr} = k \frac{E\pi^2}{12(1-\nu^2)} \frac{1}{(b/t)^2}, w = \frac{1}{2} \left(1 + \frac{\sigma_{cr}}{\sigma_s} \right) b$$

Case	Boundary Condition	Loading	k
(a)	ss ss ss	Compression	4.0
(b)	ss fixed ss	Compression	6.97
(c)	ss ss free	Compression	0.425
(d)	ss fixed free	Compression	1.277
(e)	ss fixed ss	Compression	5.42
(f)	ss ss ss	Shear	5.34
(g)	ss fixed ss	Shear	8.98
(h)	ss ss ss	Bending	23.9
(i)	fix fixed fix	Bending	41.8