

Optimum Design Of Automotive Bumper

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1. Introduction



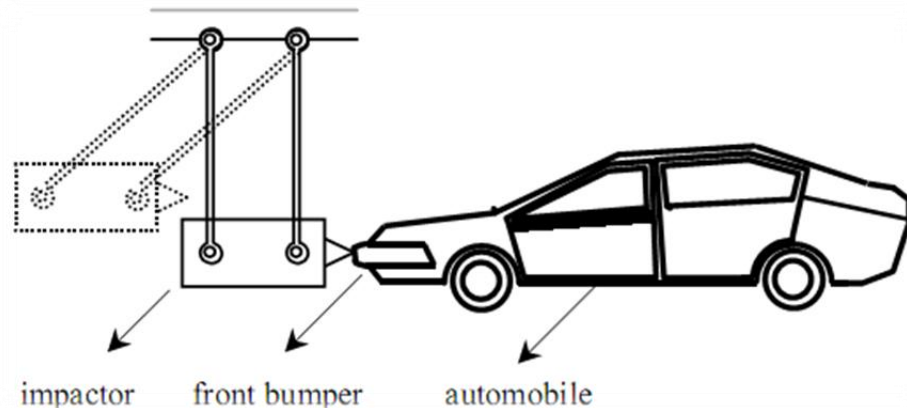
Automotive bumper

- ❖ 충돌시 차량의 기계적인 손상을 방지하고 승객을 보호하는 역할
- ❖ 일반적으로 셀 구조인 범퍼빔과 발포체 구조의 충격 흡수제로 구성되어 있음

2. Problem Statement

- ✓ 차량용 전방범퍼의 셀 구조물인 범퍼 빔의 거동해석
- ✓ 3차원 셀 구조물을 1차원 빔으로 모델링
- ✓ 셀 구조물을 직선부 빔으로 모델링
- ✓ 에너지 보존법칙과 운동량 보존법칙을 빔이론과 결부시켜서 발생된 응력과 변형률을 계산

Schematic diagram
of the impact test



3. Data and Information collection

Material properties of Al6082T6

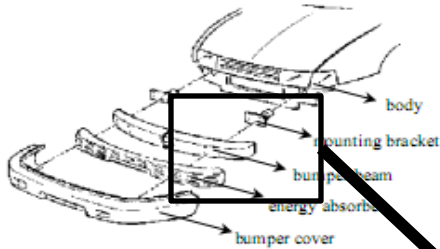
- Young's modulus(Mpa) : 70000
- Yielding stress(tens or comp.,Mpa) : 240
- Yielding stress(shear,Mpa) : 138
- Density(kg/m^3) : 2773
- Length(m) : 1.036
- Height(m) : 0.104

Mass of the car : 1820(kg)

Velocity of the car : 2.235 (m/s)

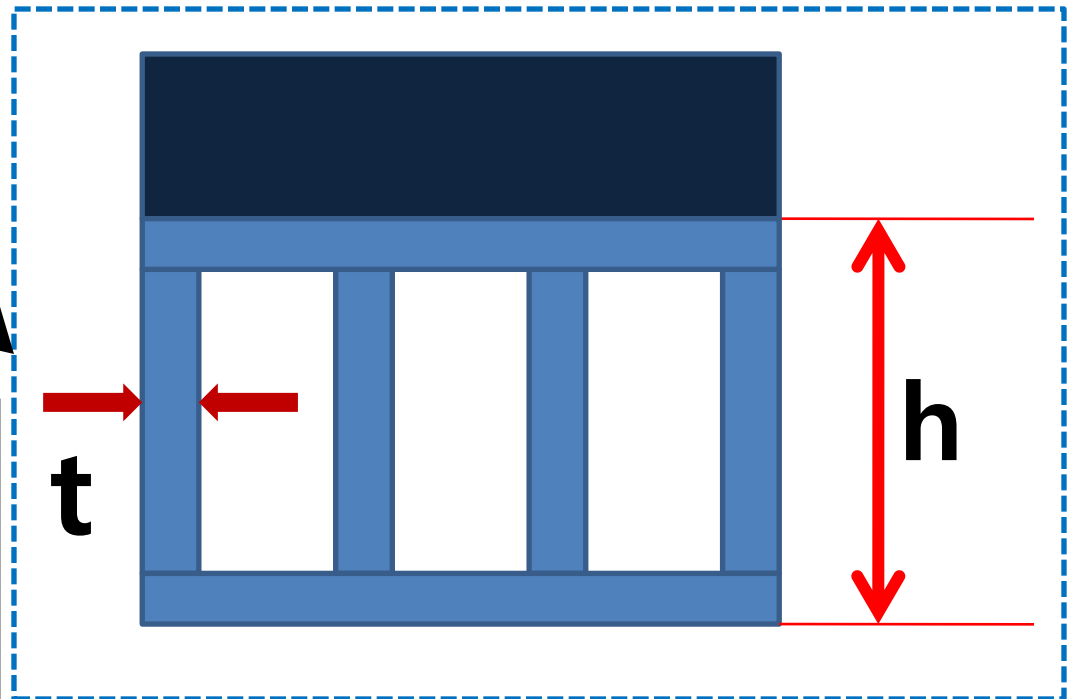


4. Design variables



(a) Components of a front bumper

Schematic of the bumper



t : thickness of the cell

h : width of the cell

5. Cost function

Minimize total mass of the bumper

$$f = 2\rho Lt(b + h)$$

6. Constraints

Maximum
normal
stress

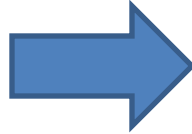
$$\sigma_{\max} \leq \sigma_Y$$

Maximum
shear stress

$$\tau_{\max} \leq \tau_Y$$

Maximum
deformation

$$\delta_{\max} \leq \delta_{allow}$$



$$g1 = \frac{h}{2} \sqrt{\frac{3mv_0^2 E}{LI}} - \sigma_Y \leq 0$$

$$g2 = \frac{h(2b+h)}{2} \sqrt{\frac{3mv_0^2}{L^3 I}} - \tau_Y \leq 0$$

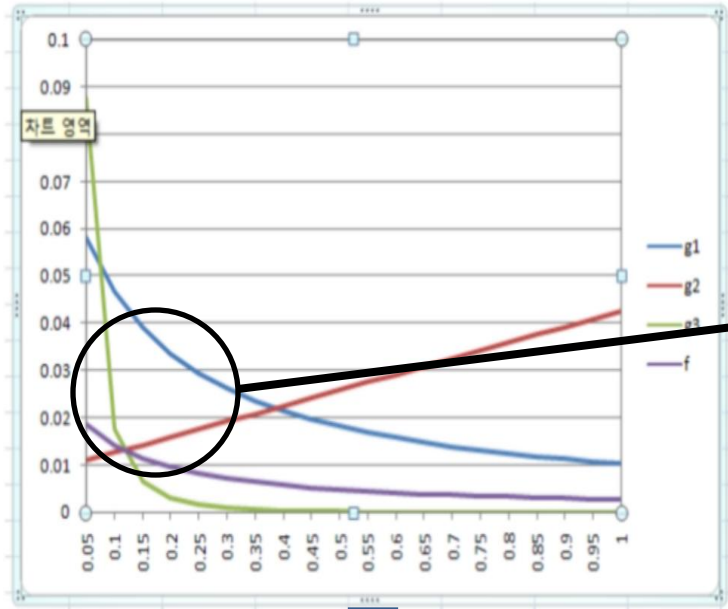
$$g3 = \sqrt{\frac{mv_0^2 L^3}{48EI}} - \delta_{allow} \leq 0$$

$$g4 = -h \leq 0$$

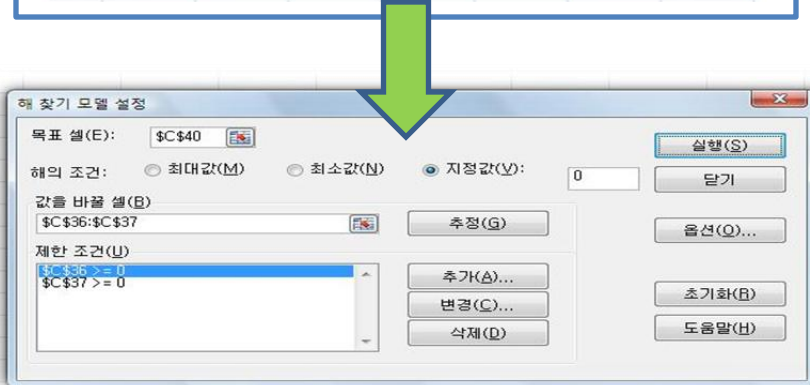
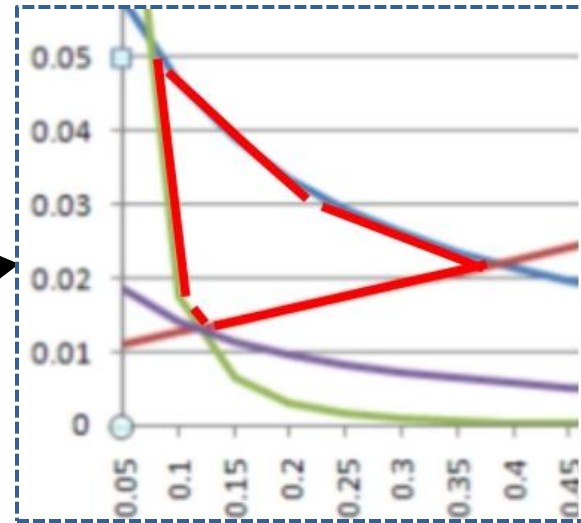
$$g5 = -t \leq 0$$

7. Solution

Graph using excel



Feasible region



Finding root

	초기값	해찾기	
t	0.02	0.01317	mm
h	0.2	0.11971	mm
g2(normal	-1.53E+02	1.73E-03	
g3	-57.25428684	0.00186	
sum	163.4292714	0.00254	
min. f		16.33954	kg

8. Future work

- 충격 흡수 구조물도 고려한 최적설계
- 알루미늄 셀 단면형태 변경에 따른 영향을 고려
- 구체적인 목적함수 설정(유지비, 원자재비, etc.)

Reference

1. **Mechanics of materials, P. Beer, Mc-Graw Hill, 2006.07.26**
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3. **손상성,수리성향상을 위한 범퍼 체결특성 규명에 관한 연구(Astudy on improving a repairability and damageability by verify ing a bumper mounting characteristics), 김지원, 한양대학교산업대학원, 2000.6**