

태풍에 의한 Sign Board 의 최적설계

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목 차

머 리 문

Assumption

Data

Variable

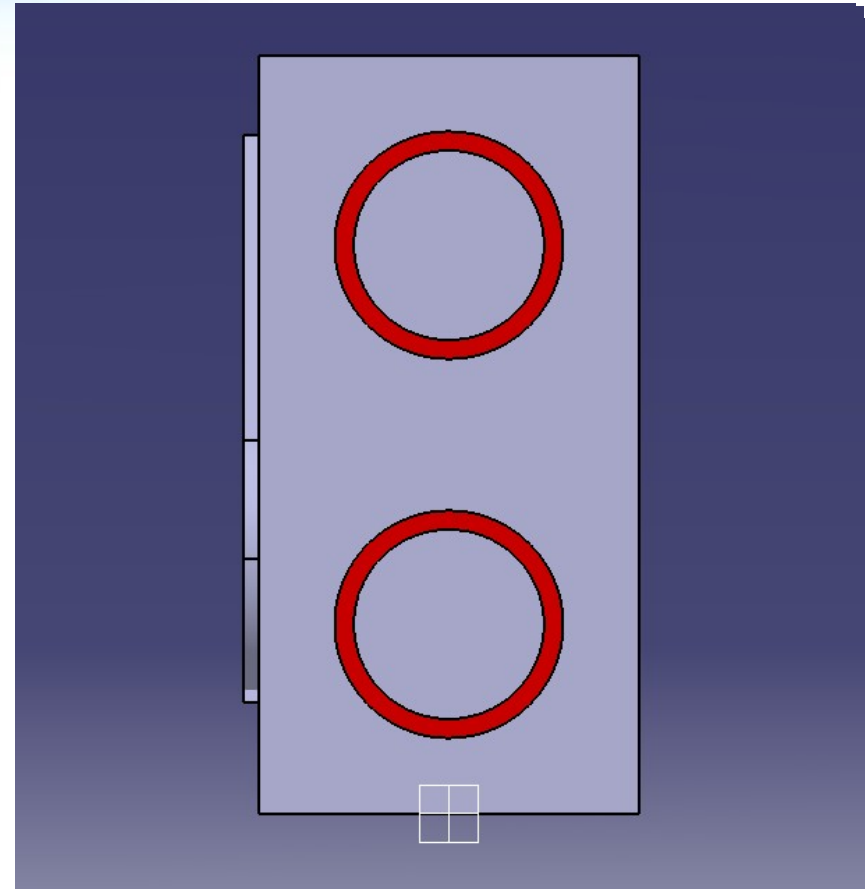
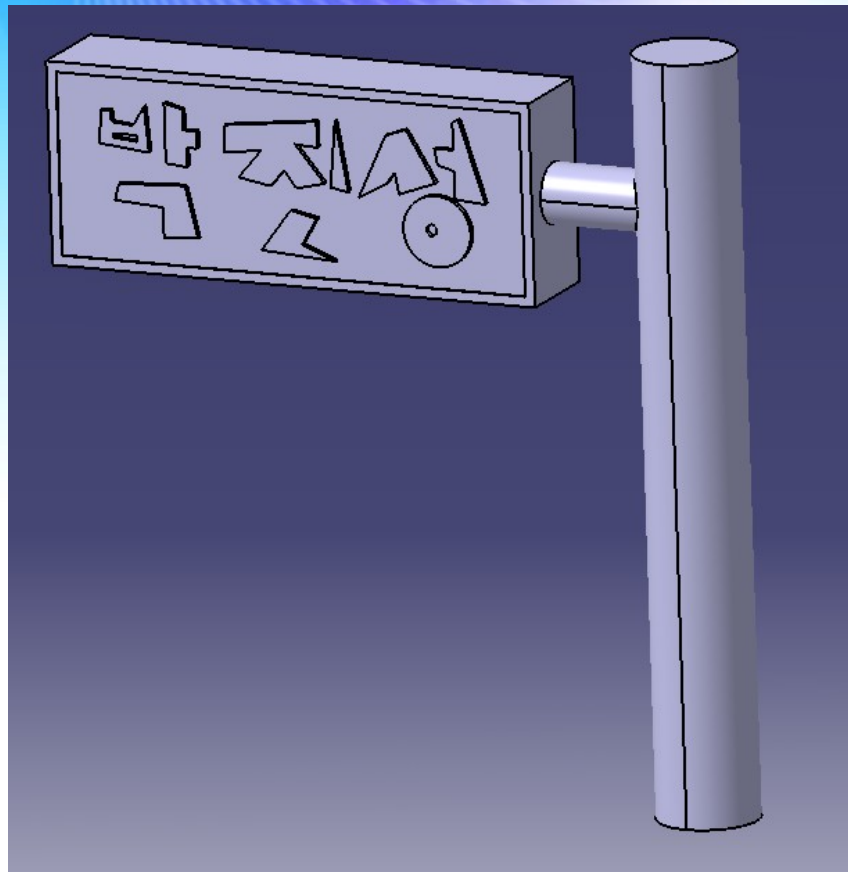
Constraint

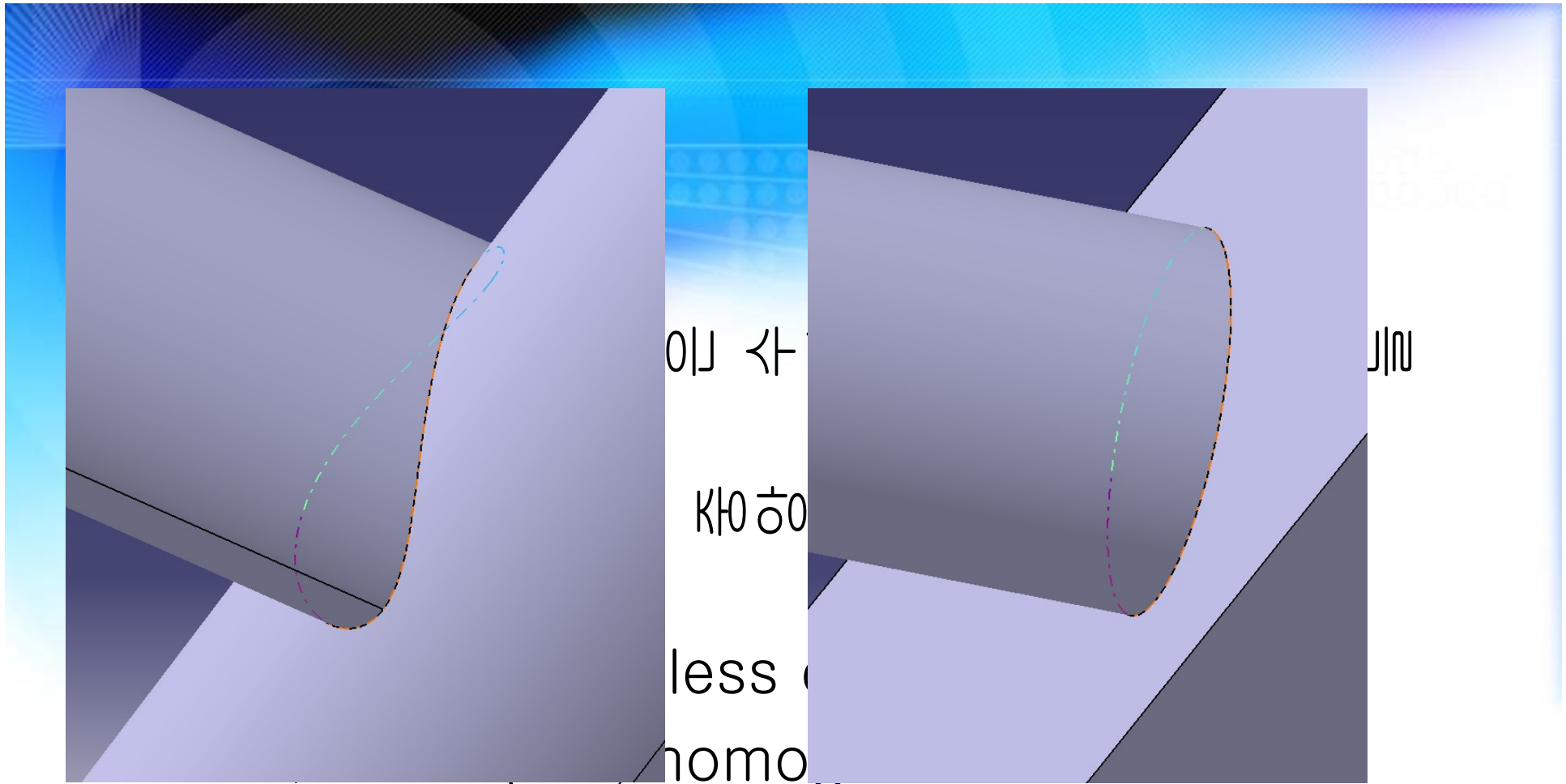
Excel & Matlab Solver

Graphical Solution

부 록

문제 설명





- Bar 이 는 때 가 이 기 이 고 기
- Sign Board 이 Bar 가 이 기 이 기 세 에 마 지

Data

- Sign board ᄒ ᄆᄃ : 1 ton
- Bar ᄒ ᄃᄃᄃ : 1m
- Sign board ᄒ ᄃᄃᄃ : $W=5\text{m}$, $h=2\text{m}$, $t=1\text{m}$
- ᄃᄃᄃ ᄒ ᄃᄃᄃ ᄃᄃᄃ : 80m/s
- Safety Factor : 2.5

Variable

- 1번, 3번 Bar 의 외경 r_o , Bar 의 두께 t
- 2번 Bar 의 변의길이 b , Bar 의 두께 t

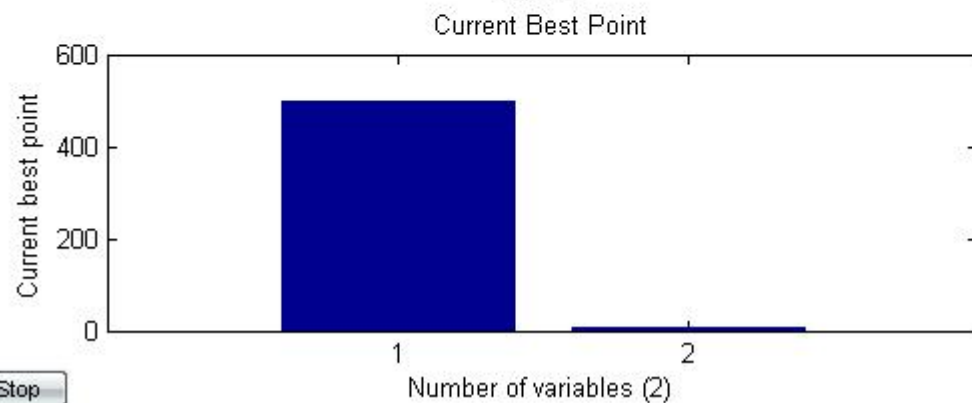
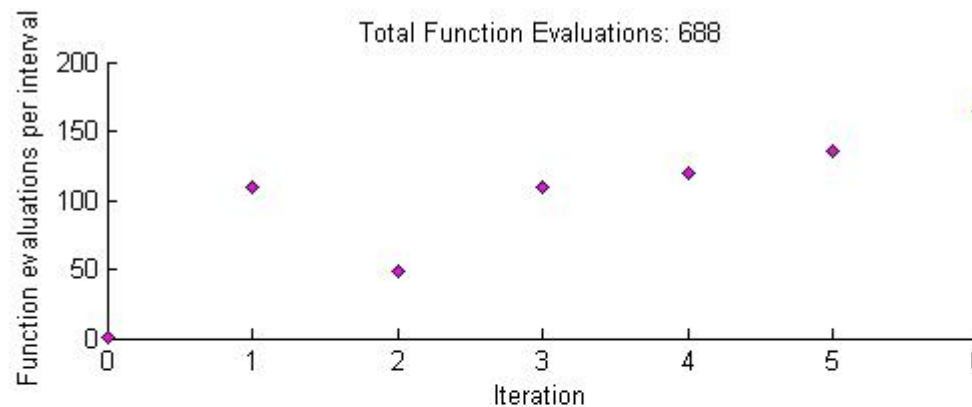
Constraint

- Bar ຫຼັກ ຫຼັກ ຫຼັກ ຫຼັກ ຫຼັກ : $\sigma_{all} \leq 215 \text{ Mpa}$
 $\tau_{all} \leq 107.5 \text{ Mpa}$
- Bar ຫຼັກ ຫຼັກ ຫຼັກ ຫຼັກ ຫຼັກ : $\theta_T \leq 0.01 \text{ rad}$
- Bar ຫຼັກ ຫຼັກ ຫຼັກ ຫຼັກ ຫຼັກ : $\phi_i \leq 0.1 \text{ rad}$
- Bar ຫຼັກ ຫຼັກ ຫຼັກ Deflection: $\delta \leq 1 \text{ mm}$
- $R < 500 \text{ mm}$
- $R > t$

Bar 1개 일 경우

- $$\left\{ \begin{array}{l} g_1 = \frac{M \times R}{I} - 86 \leq 0 \\ g_2 = \frac{T \times R}{J} - 43 \leq 0 \\ g_3 = \frac{T \times L}{G \times J} - 0.01 \leq 0 \\ g_4 = \frac{ML + 0.5R_a L^2}{EI} - 0.01 \leq 0 \\ g_5 = \frac{0.5ML^2 + (1/6)R_a L^3}{EI} - 1 \leq 0 \\ g_6 = 10 \times t - R \leq 0 \end{array} \right.$$

Excel & Matlab



Stop

Optimization Tool

File Help

Problem Setup and Results

Solver: **ga - Genetic Algorithm**

Problem

Fitness function: **@fun_p**

Number of variables: **2**

Constraints:

Linear inequalities: A: b:

Linear equalities: Aeq: beq:

Bounds: Lower: **0** Upper: **500**

Nonlinear constraint function: **@const_p**

Run solver and view results

☐ Use random states from previous run

Start **Pause** **Stop**

Current iteration: **5** **Clear Results**

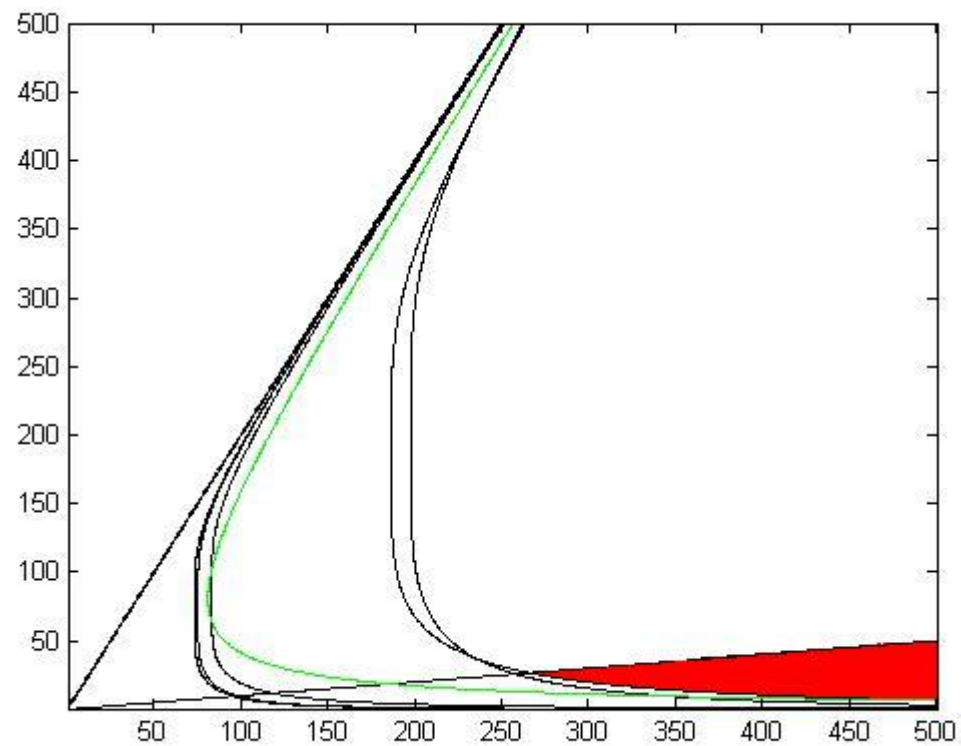
scaled.

Results may be inaccurate. RCOND = 9.570436e-028. Optimization terminated. Objective function value: 20603.285905036177 Optimization terminated: average change in the fitness value less than options.TolFun and constraint violation is less than options.TolCon.

Final point:

1	2
500	6.602

Graphical Solution 1



$f=20603.28 \text{ mm}^2$

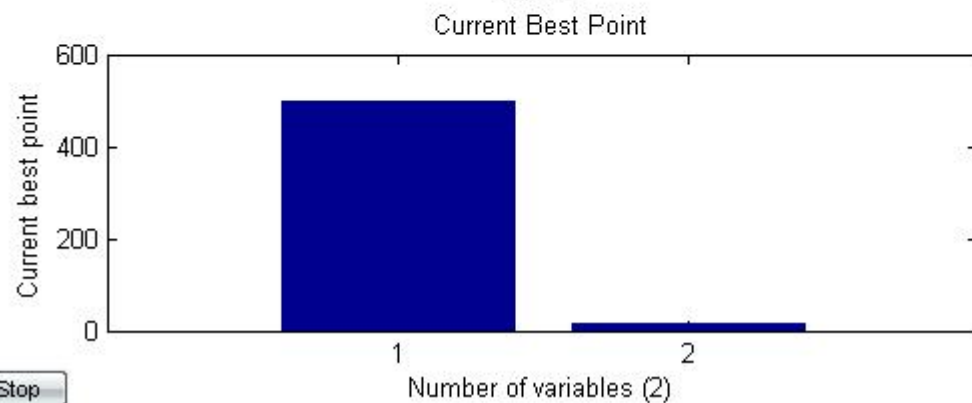
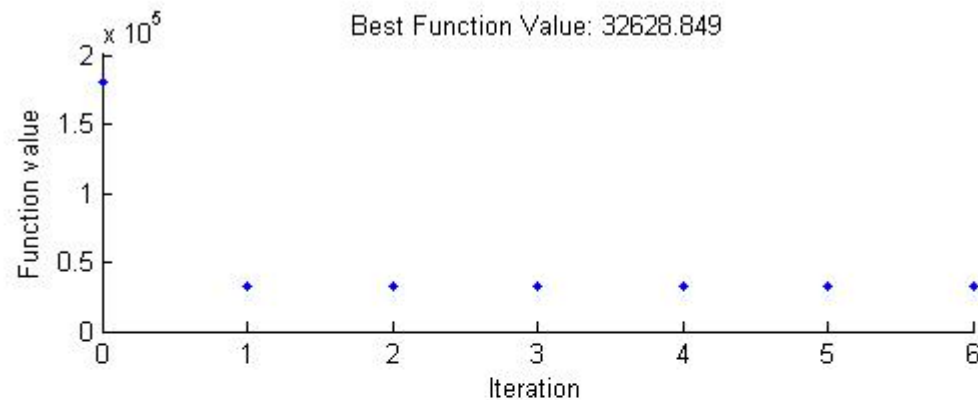
$r=500\text{mm}$

$t=6.6\text{mm}$

Bar가 사각형 일 경우

$$\bullet \left\{ \begin{array}{l}
 g1 = \sqrt{\left(\frac{M_x \left(\frac{b}{2}\right)}{I}\right)^2 + \left(\frac{M_y \left(\frac{b}{2}\right)}{I}\right)^2} - 86 \leq 0 \\
 g2 = \frac{T}{2tb^2} - 43 \leq 0 \\
 g3 = \frac{TL}{0.1406Gb^4} - 0.01 \leq 0 \\
 g4 = \sqrt{\left(\frac{M_x L + 0.5Ra_x L^2}{EI}\right)^2 + \left(\frac{M_y L + 0.5RA_y L^2}{EI}\right)^2} - 0.1 \leq 0 \\
 g5 = \sqrt{\left(\frac{0.5M_x L^2 + \left(\frac{1}{6}\right)RA_x L^3}{EI}\right)^2 + \left(\frac{0.5M_y L^2 + \left(\frac{1}{6}\right)RA_y L^3}{EI}\right)^2} - 1 \leq 0 \\
 g6 = 5t - b \leq 0
 \end{array} \right.$$

Excel & Matlab



Stop

Optimization Tool

File Help

Problem Setup and Results

Solver: **patternsearch - Pattern Search**

Problem

Objective function: **@fun_p2**

Start point: **[450 300]**

Constraints:

Linear inequalities: A: b:

Linear equalities: Aeq: beq:

Bounds: Lower: Upper:

Nonlinear constraint function: **@const_p2**

Run solver and view results

☐ Use random states from previous run

Start **Pause** **Stop**

Current iteration: **6** **Clear Results**

Optimization running.

Optimization terminated.

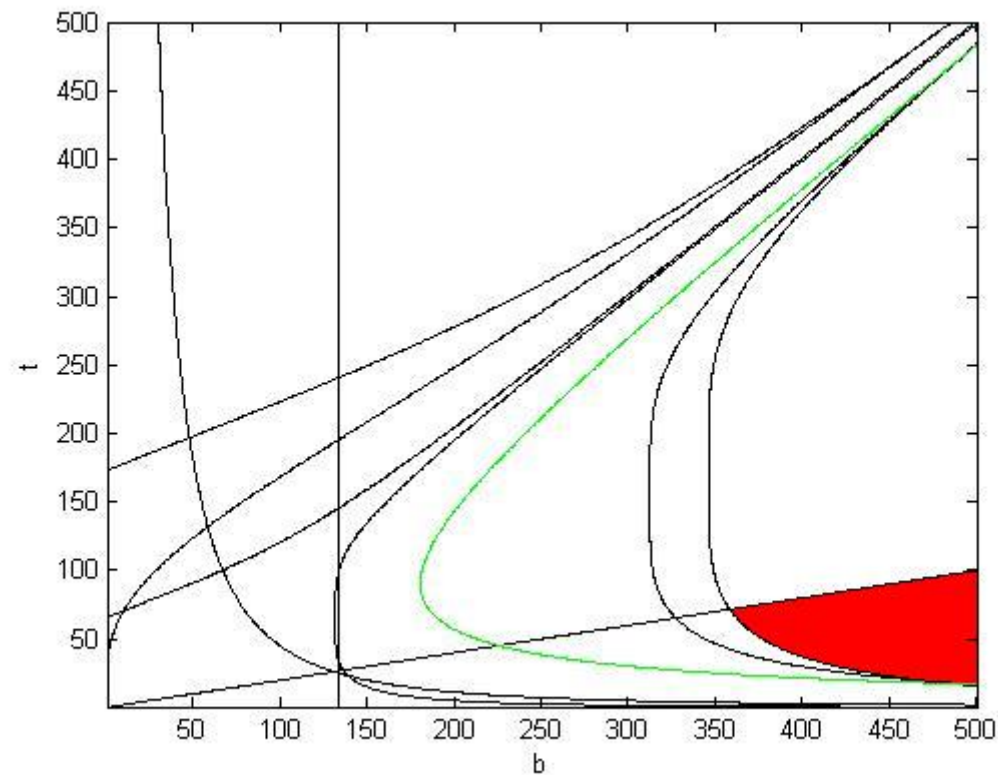
Objective function value: 32628.84901575008

Optimization terminated: Change in X less than options.TolX and constraints violation is less than options.TolCon.

Final point:

1	2
500	16.885

Graphical Solution 2

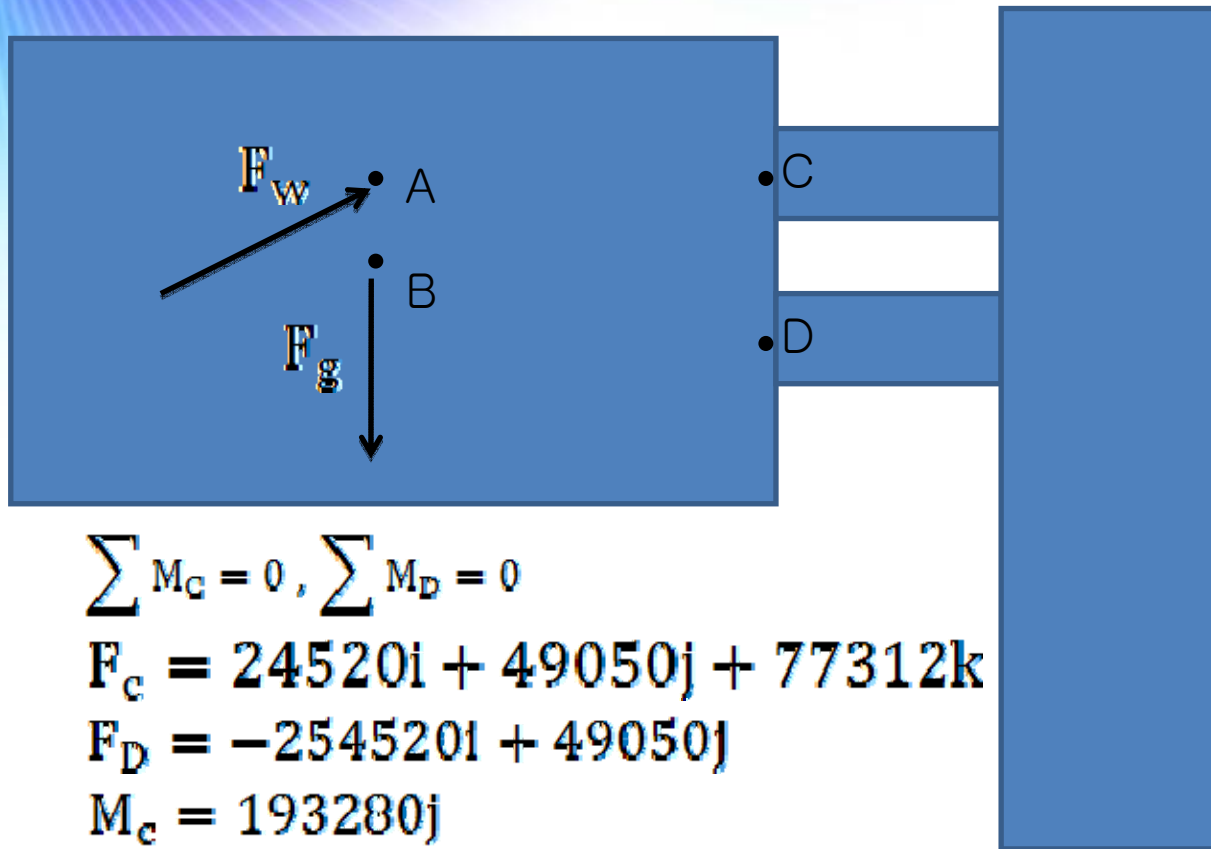


$$f = 32628 \text{ mm}^2$$

$$b = 500 \text{ mm}$$

$$t = 16.9 \text{ mm}$$

Bar 2개 일 경우



$$\sum M_C = 0, \sum M_D = 0$$

$$F_C = 24520i + 49050j + 77312k$$

$$F_D = -254520i + 49050j$$

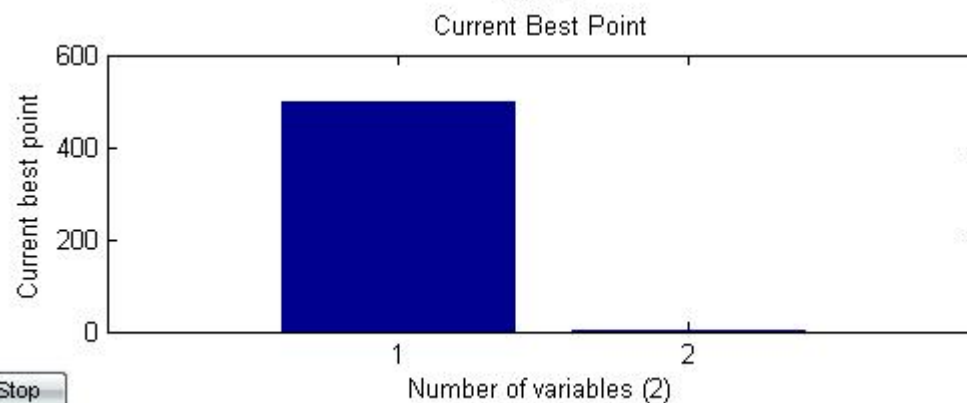
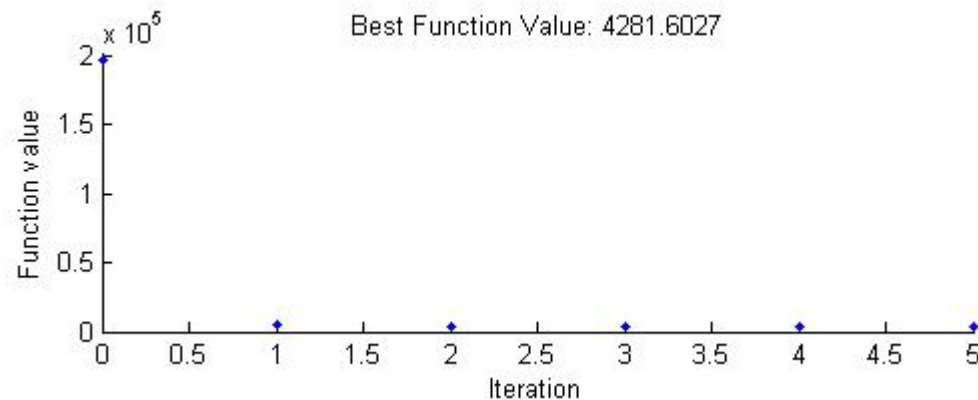
$$M_C = 193280j$$

$$M_D = 193280j$$

Bar 2개 일 경우

- $$\left\{ \begin{array}{l} g_1 = \frac{M \times R}{I} - 86 \leq 0 \\ g_2 = \frac{F_x}{A} - 86 \leq 0 \\ g_4 = \frac{\sqrt{(M_y L)^2 + (0.5 F_z L)^2}}{EI} - 0.1 \leq 0 \\ g_5 = \frac{\sqrt{(0.5 M_y L^2)^2 + \left(\frac{F_z L^3}{3}\right)^2}}{EI} - 1 \leq 0 \\ g_6 = 3t - b \leq 0 \end{array} \right.$$

Excel & Matlab



Stop

Optimization Tool

File Help

Problem Setup and Results

Solver: **patternsearch - Pattern Search**

Problem

Objective function: **@fun_p3**

Start point: **[250 250]**

Constraints:

Linear inequalities: A: b:

Linear equalities: Aeq: beq:

Bounds: Lower: Upper:

Nonlinear constraint function: **@const_p3**

Run solver and view results

☐ Use random states from previous run

Start **Pause** **Stop**

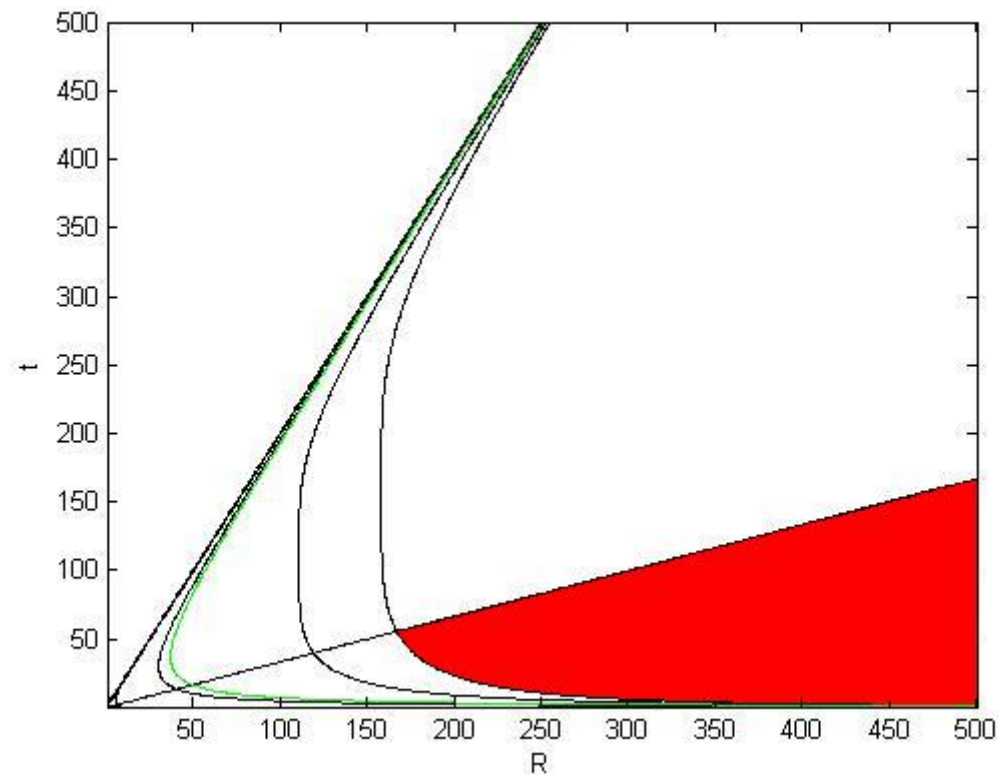
Current iteration: **5** **Clear Results**

Warning: Divide by zero. Warning: Divide by zero. Optimization terminated.
Objective function value: 4281.602739915565
Optimization terminated: Change in X less than options.TolX
and constraints violation is less than options.TolCon.

Final point:

1	2
500	1.365

Graphical Solution 3



$$f=4281.59 \text{ mm}^2$$

$$r=500 \text{ mm}$$

$$t=1.36 \text{ mm}$$

결과값 비교

1. Bar하 처짐을 비교

$$r_0 = 500 \text{ mm}, t = 6.6 \text{ mm} \quad A = 20603 \text{ mm}^2$$

2. Bar하 처짐을 비교

$$b = 500 \text{ mm}, t = 16.9 \text{ mm} \quad A = 32628 \text{ mm}^2$$

3. Bar하 처짐을 비교

$$r_0 = 500 \text{ mm}, t = 1.36 \text{ mm}$$

$$A = 4281 \times 2 = 8562 \text{ mm}^2$$

고찰

- $\bar{r}$ 와 $\bar{r}$ 가 2개 $\bar{r}$ 가 있는 경우.
- $\bar{r}$ 와 $\bar{r}$ 가 있는 $\bar{r}$ 와 $\bar{r}$ 가 있는 경우.
→ Constraint 없음
- $\bar{r}$ 와 $\bar{r}$ 가 있는 $\bar{r}$ 와 $\bar{r}$ 가 있는 경우.
→ Constraint 없음



THANK YOU

한 학기 수고 많으셨습니다 ^^