태풍에 의한 Sign Board 의 최적설계

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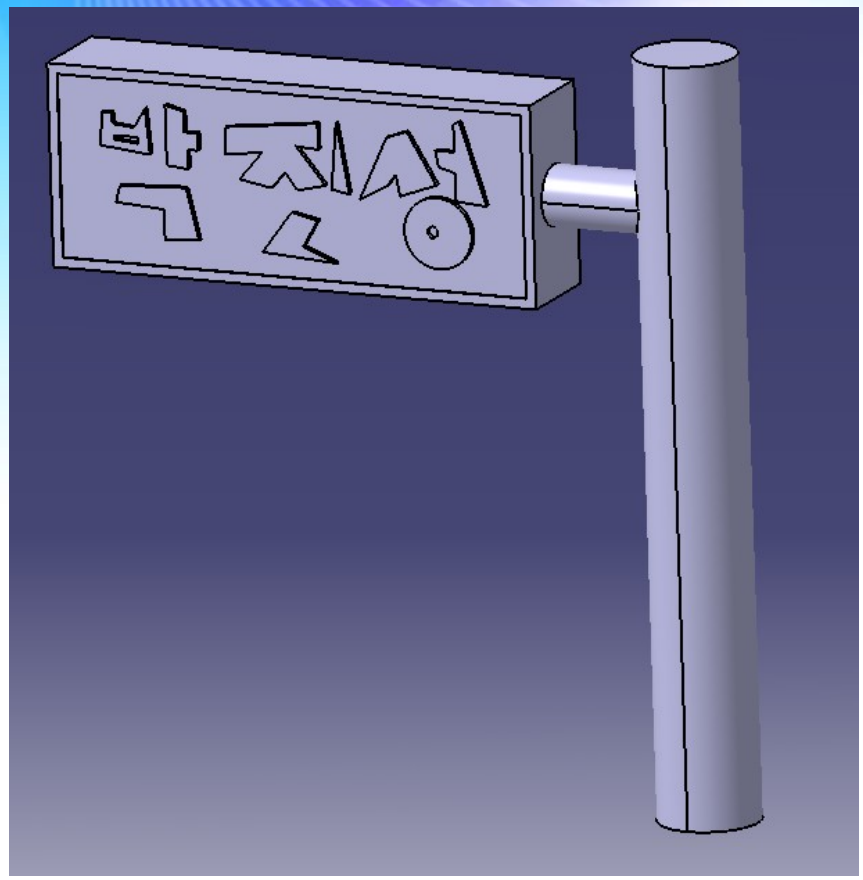
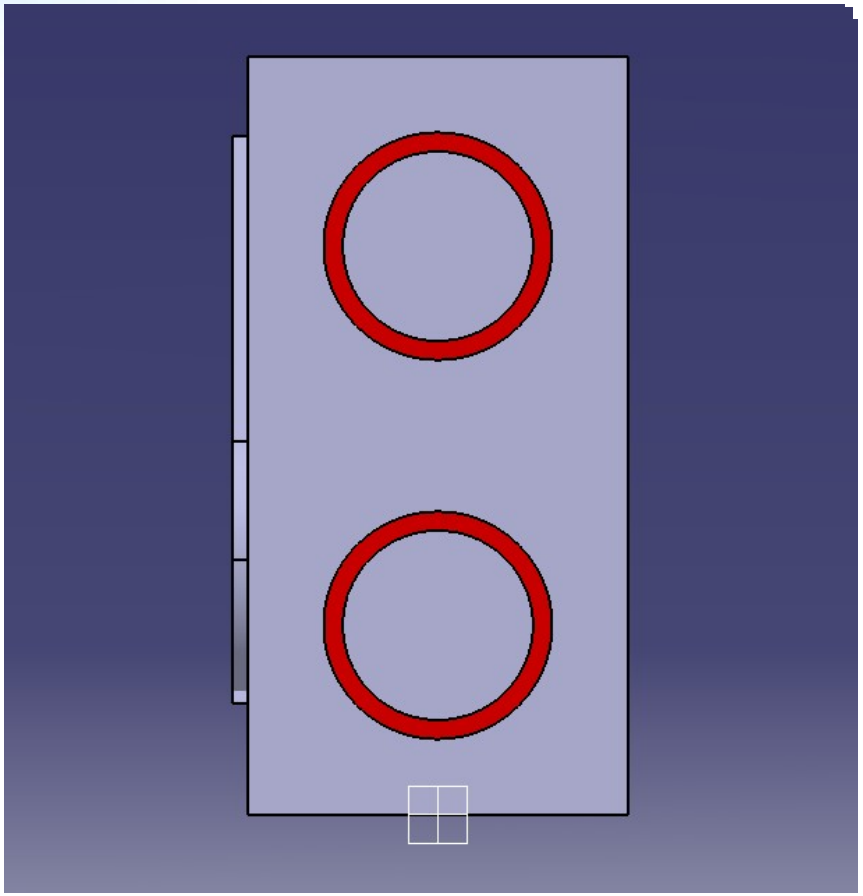
문제 설명





- Bar 허 ㄴ배 ᄎ이 ᄀ 편
- Sign Board 허 Bar ᄎ이 ᄒ 표 에 마 ᄌ

Data

- Sign board 의 무게 : 1 ton
- Bar 의 길이 : 1m
- Sign board 의 길이 : W=5m, h=2m, t=1m
- 바람의 최대 속도 : 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

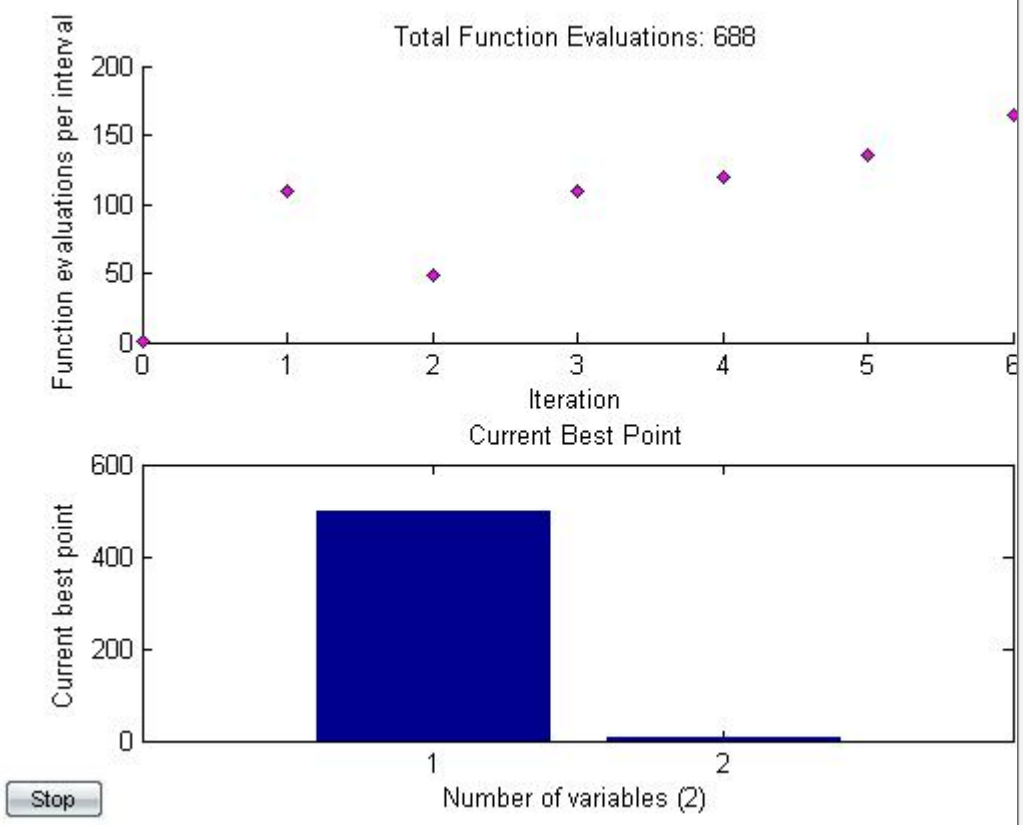
Constraint

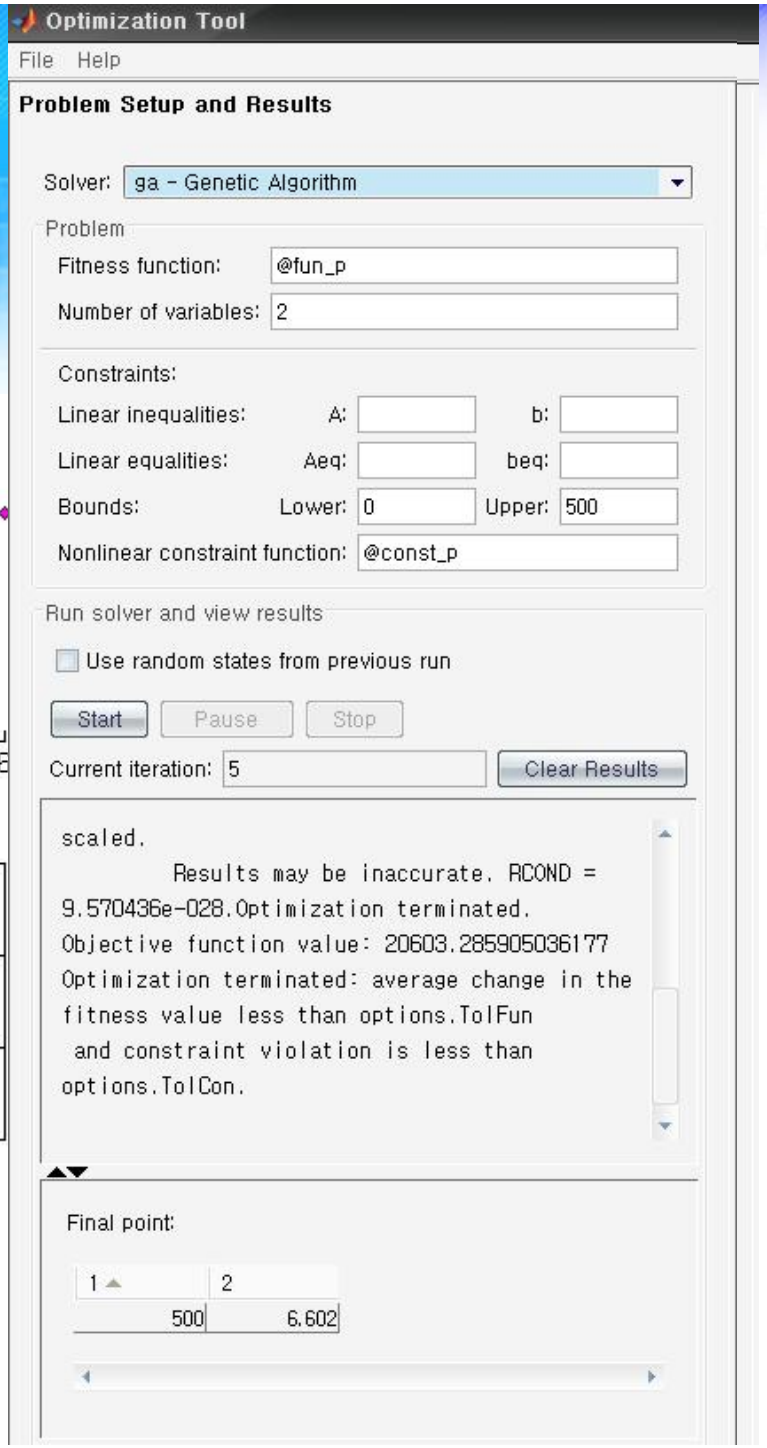
- 굽힘응력 허용값 : σ_{all} 이 215 Mpa
  τ_{all} 이 107.5 Mpa
- Bar 중앙의 회전각 : θ_T 이 0.01 rad
- Bar 중앙의 굽힘각 : Φ_i 이 0.1 rad
- Bar중앙의 Deflection: ω 이 1 mm
- R < 500 mm
- R > t

Bar 1개 일 경우

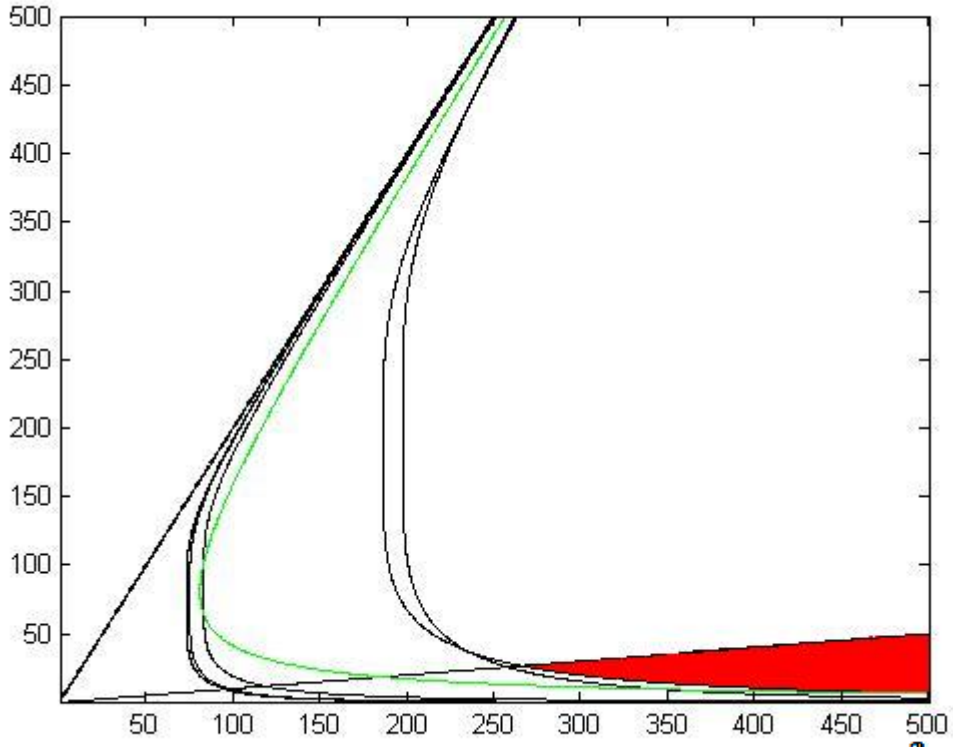
- $$\begin{cases} g_1 = \dfrac{M \times R}{I} - 86 \leq 0 \\ g_2 = \dfrac{T \times R}{J} - 43 \leq 0 \\ g_3 = \dfrac{T \times L}{G \times J} - 0.01 \leq 0 \\ g_4 = \dfrac{ML + 0.5R_aL^2}{EI} - 0.01 \leq 0 \\ g_5 = \dfrac{0.5ML^2 + (1/6)R_aL^3}{EI} - 1 \leq 0 \\ g6 = 10 \times t - R \leq 0 \end{cases}$$

Excel & Matlab





Graphical Solution 1



f=20603.28 mm^2

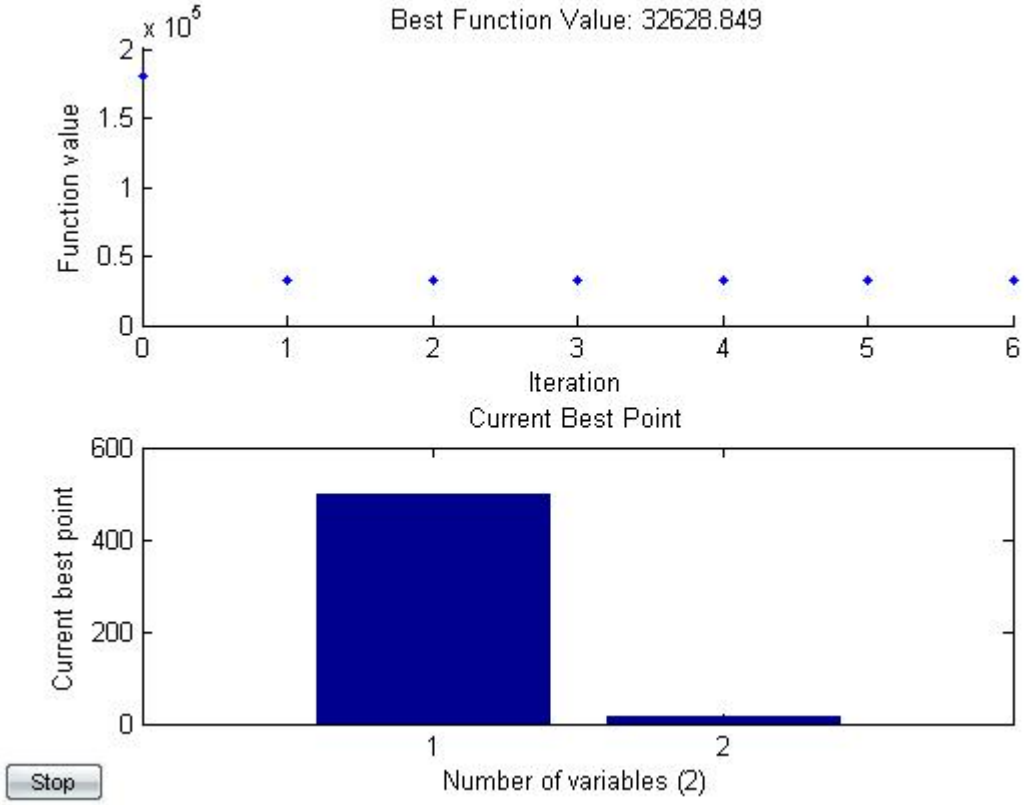
r=500mm

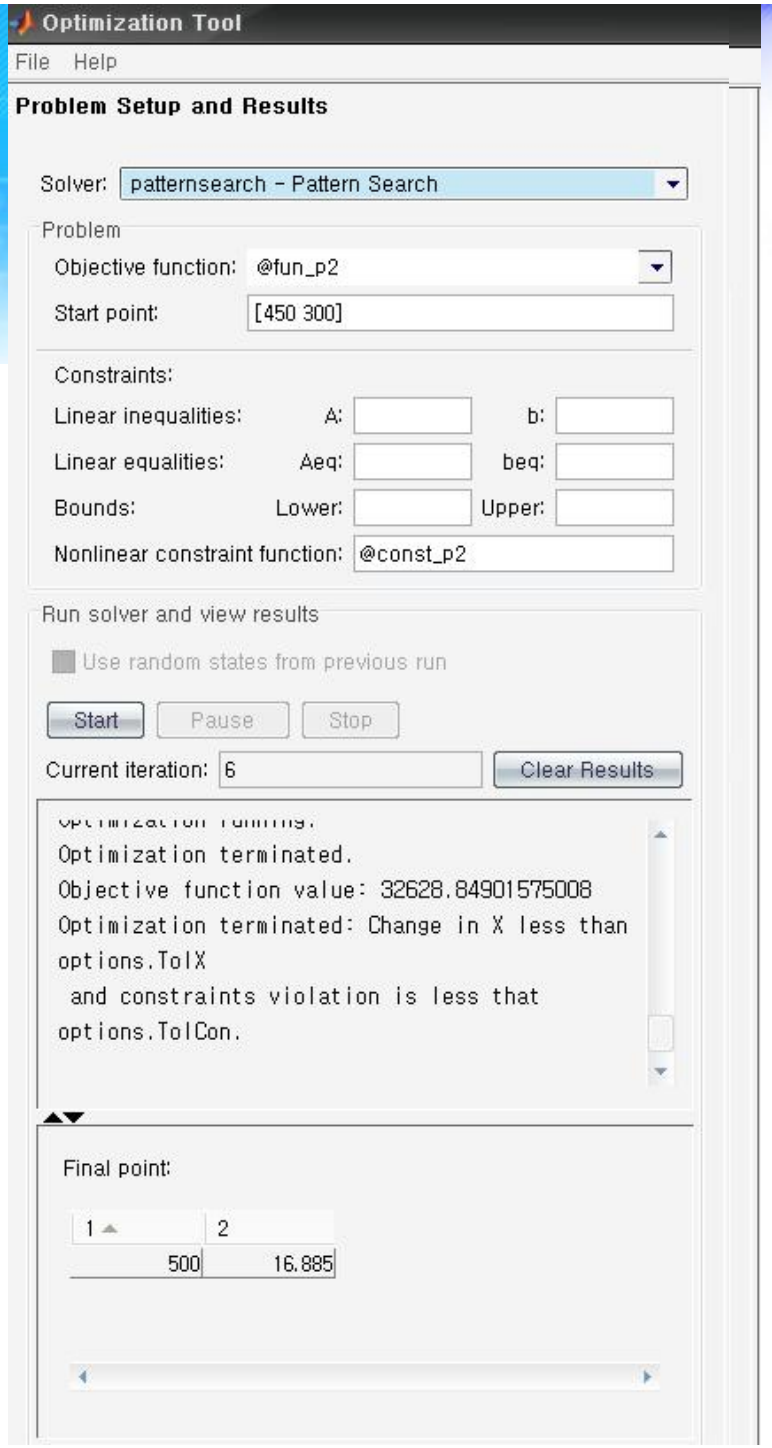
t=6.6mm

Bar가 사각형 일 경우

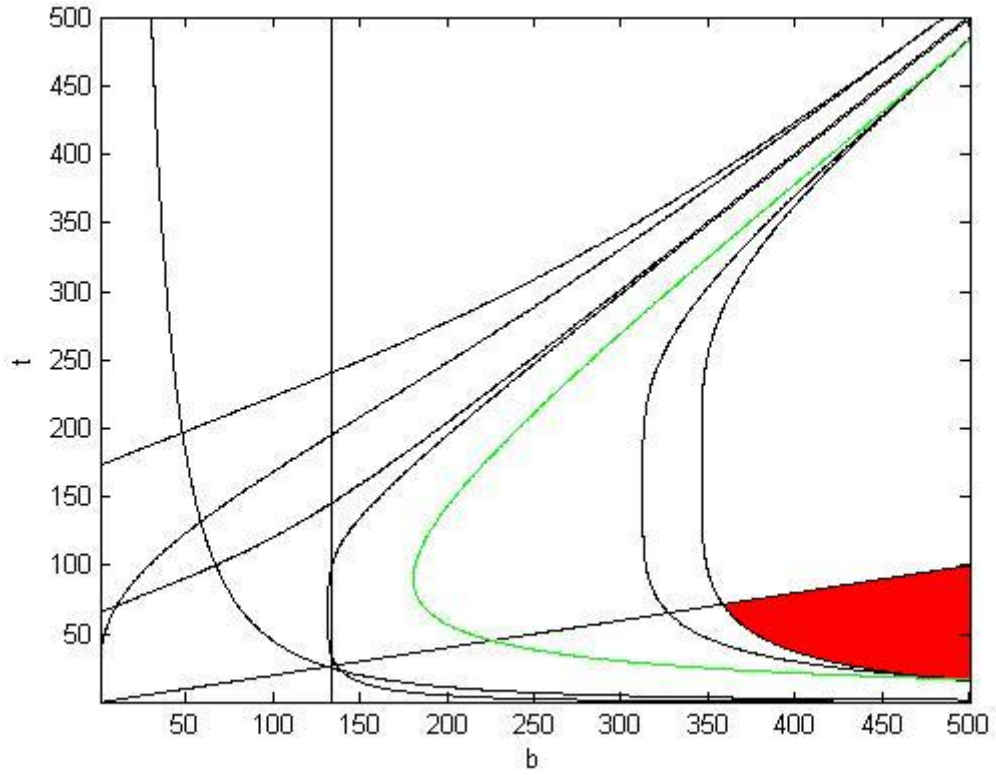
- $$\begin{cases} g1 = \sqrt{\left(\frac{M_x\left(\frac{b}{2}\right)}{I}\right)^2 + \left(\frac{M_y\left(\frac{b}{2}\right)}{I}\right)^2} - 86 \leq 0 \\ g2 = \frac{T}{2tb^2} - 43 \leq 0 \\ g3 = \frac{TL}{0.1406Gb^4} - 0.01 \leq 0 \\ g4 = \sqrt{\left(\frac{M_xL + 0.5Ra_xL^2}{EI}\right)^2 + \left(\frac{M_yL + 0.5RA_yL^2}{EI}\right)^2} - 0.1 \leq 0 \\ g5 = \sqrt{\left(\frac{0.5M_xL^2 + \left(\frac{1}{6}\right)RA_xL^3}{EI}\right)^2 + \left(\frac{0.5M_yL^2 + \left(\frac{1}{6}\right)RA_yL^3}{EI}\right)^2} - 1 \leq 0 \\ g6 = 5t - b \leq 0 \end{cases}$$

Excel & Matlab





Graphical Solution 2

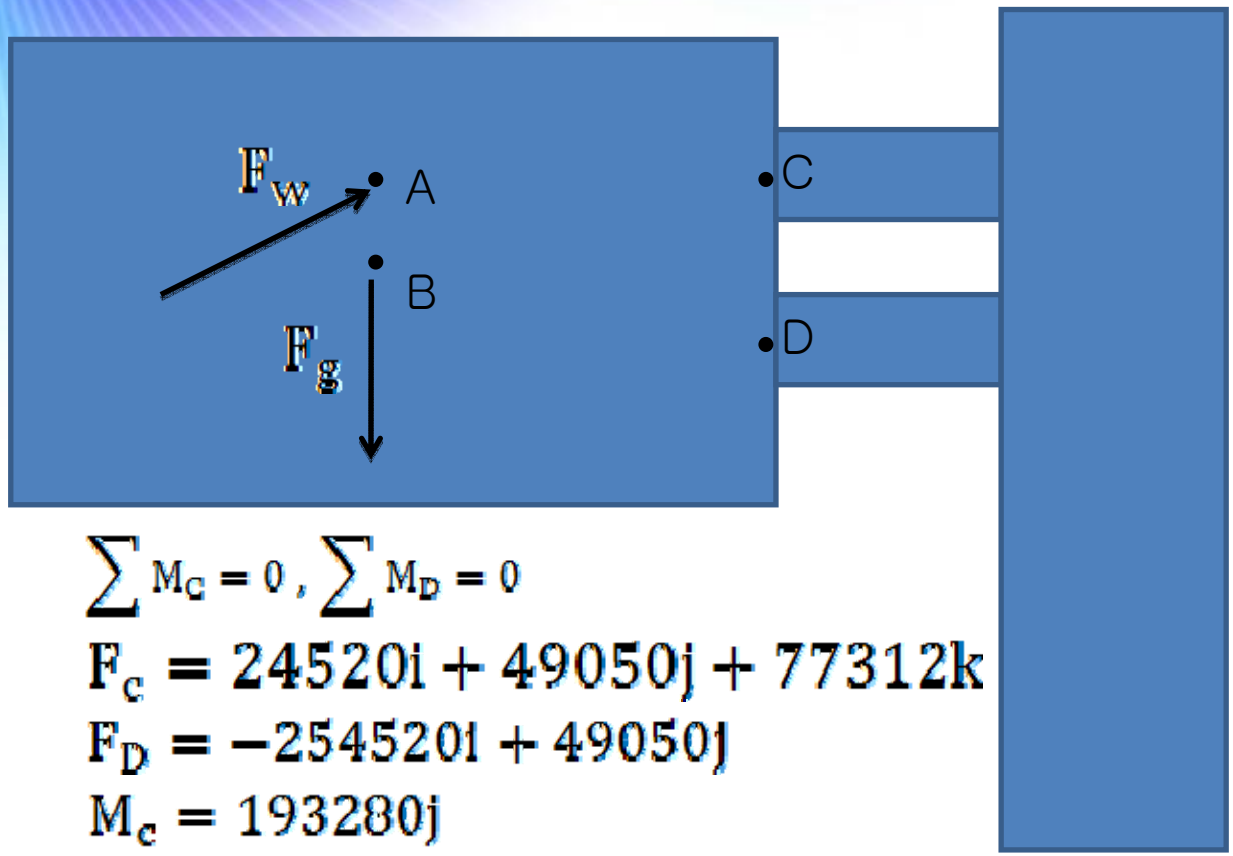


f=32628 mm^2

b=500mm

t=16.9mm

Bar 2개 일 경우



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

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

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

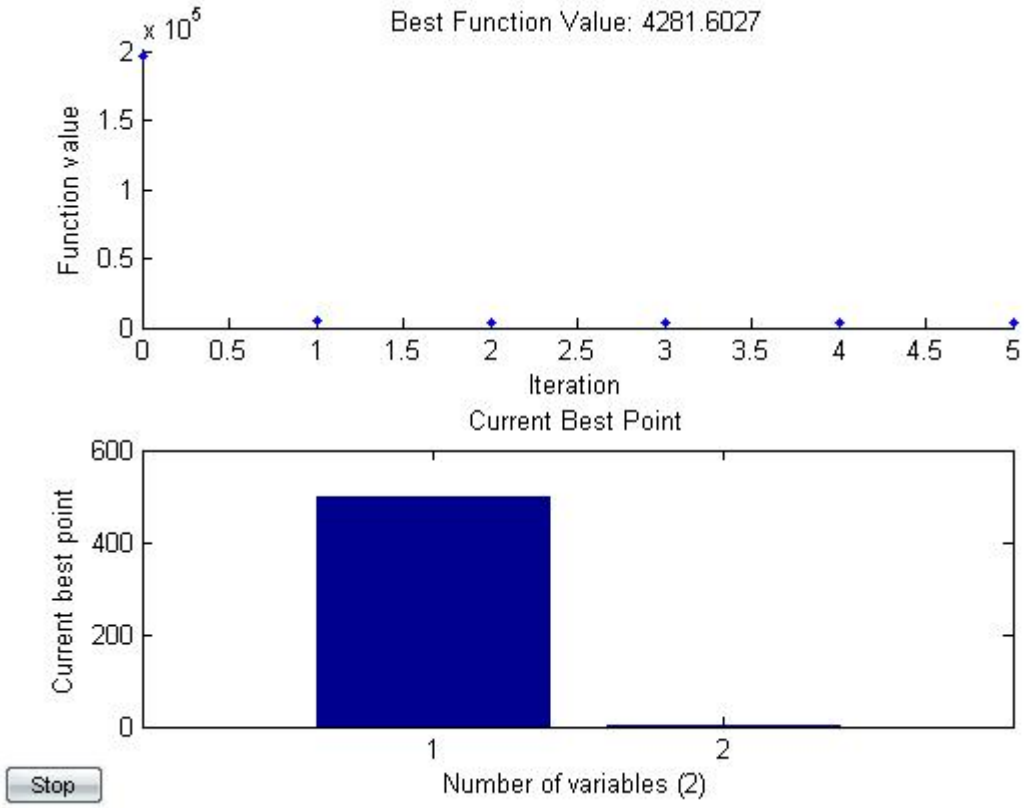
$$M_c = 193280j$$

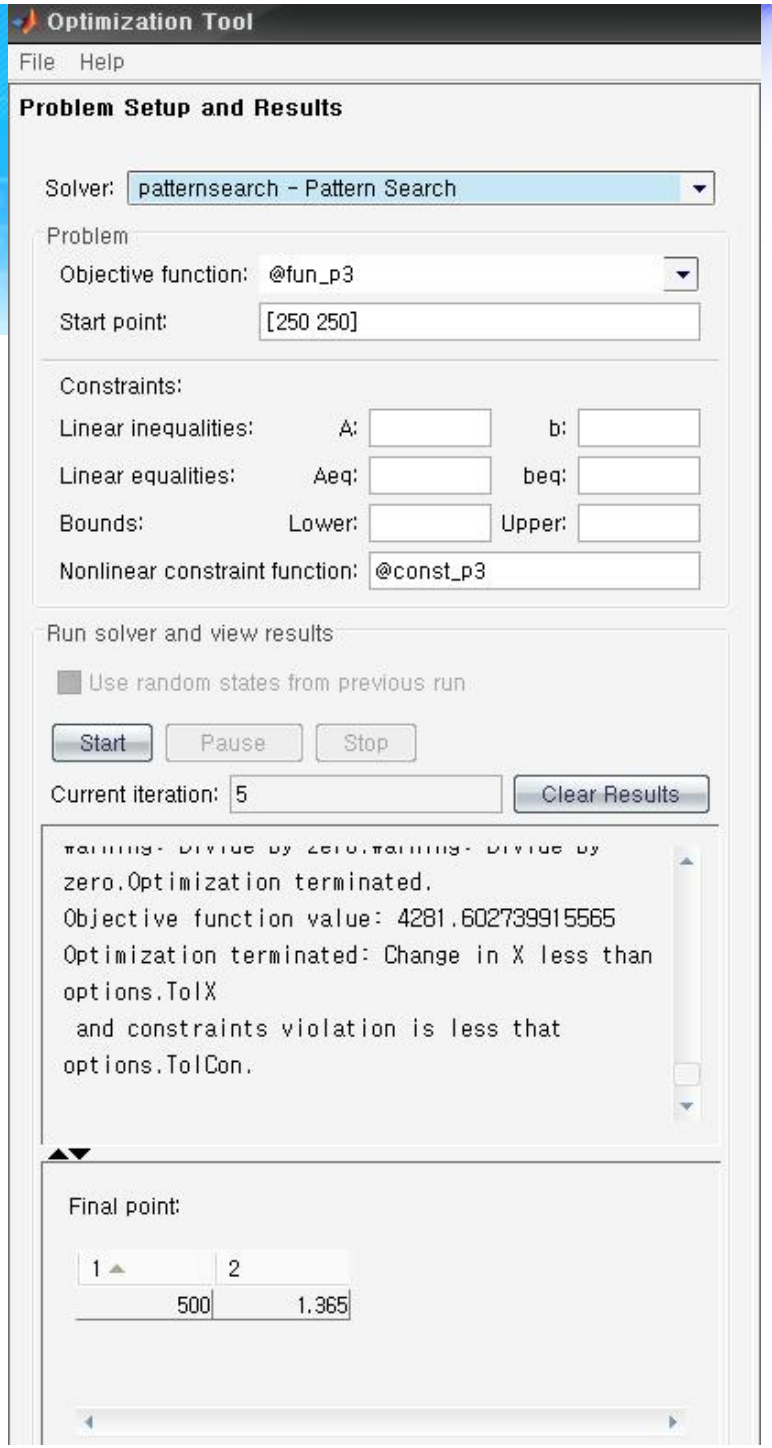
$$M_D = 193280j$$

Bar 2개 일 경우

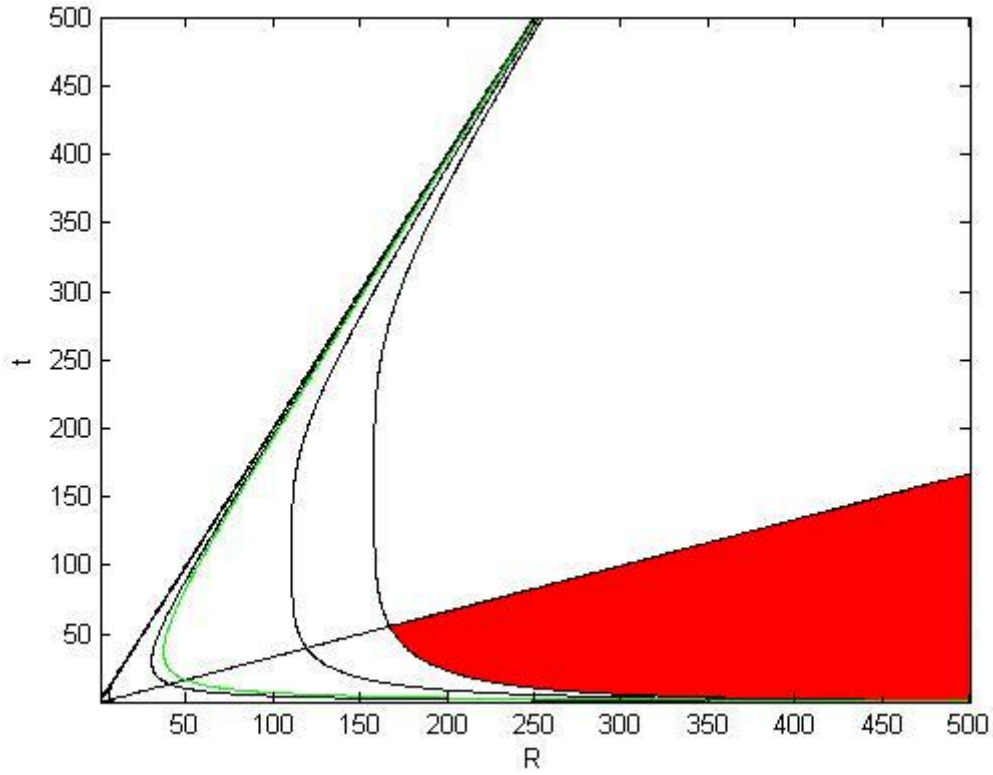
- $$\begin{cases} g_1 = \dfrac{M \times R}{I} - 86 \le 0 \\ g_2 = \dfrac{F_x}{A} - 86 \le 0 \\ g4 = \dfrac{\sqrt{(M_y L)^2 + (0.5F_z L)^2}}{EI} - 0.1 \le 0 \\ g5 = \dfrac{\sqrt{\left(0.5M_y L^2\right)^2 + \left(\dfrac{F_z L^3}{3}\right)^2}}{EI} - 1 \le 0 \\ g_6 = 3t - b \le 0 \end{cases}$$

Excel & Matlab





Graphical Solution 3



f=4281.59 mm^2

r=500mm

t=1.36mm

결과값 비교

1. Bar의 외접원 해 도출

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

2. Bar의 외접원 측면 해 도출

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

3. Bar측 바퀴 해 도출

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

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

고 찰

- [illegible] 2[illegible] bar[illegible] [illegible].
- r[illegible] [illegible] bar[illegible] [illegible].
  ➔ Constraint [illegible]
- t[illegible] [illegible] bar[illegible] [illegible] ➔ Constraint [illegible]

THANK YOU

한 학기 수고 많으셨습니다 ^^