08 Dec. 9th

최적설계 2차 프로젝트 발표

Optimum design of killing roller considering Bauschinger effect

Design Optimization

Secondary project presentation

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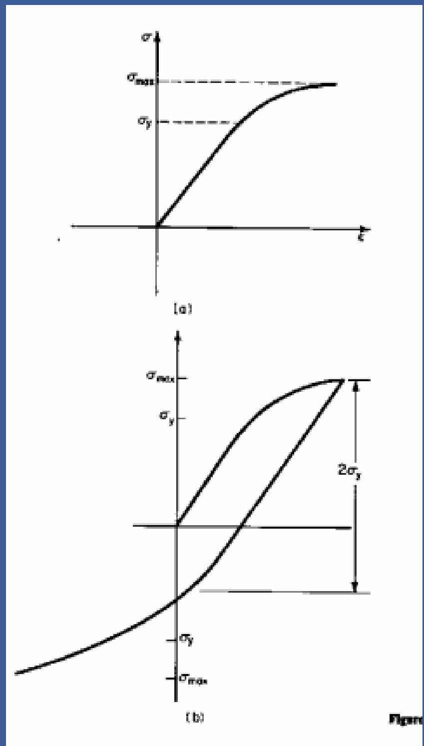
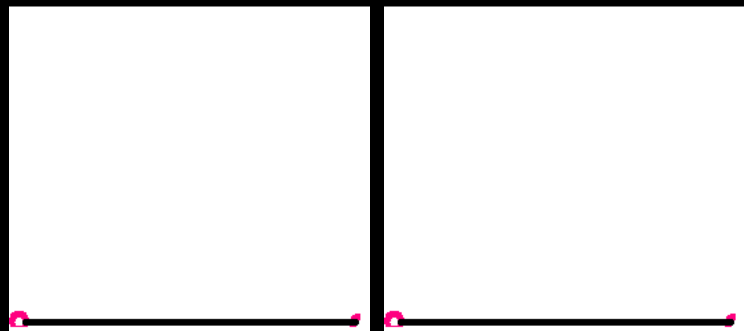
목차

이전 설계 요약



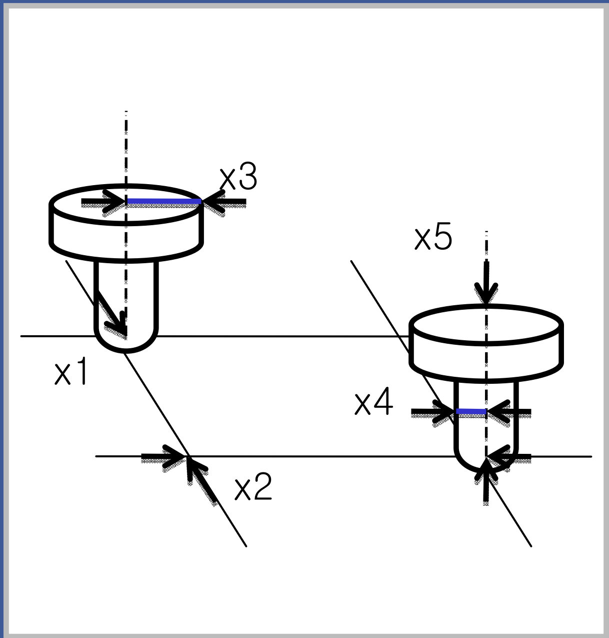
Bauschinger effect



Good case

Bad case

수정 설계 소개



5변수

롤러 반경

샤프트 가로위치

샤프트 세로위치

샤프트 반경

샤프트 길이

2변수

롤러 반경

롤러 위치 (거리는 고정)

덕여조

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수정 설계 소개

목적함수 및 변수

$$f = (100 \cdot 10000 / 3.3) \cdot (5x_1x_2 + 2x_1x_3 + 10x_2x_3 + 4{x_3}^2)$$
$$+(6 \cdot 7850 \cdot 1000 \cdot \pi \cdot {x_4}^2 x_5)$$

x_1 = Vertical length

x_2 = Horizontal length

x_3 = Radius of killing roller

x_4 = Radius of Shaft

x_5 = Shaft Length

경기도 공장부지
평균 땅값
3.3 m^2 당 100
만원

철강 봉재 원가
1kg 당 약 1천원

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설계 고려 사항

$W_f = x_3 / V$	Forced friquency
$f.ratio_{tor} = W_{n\_tor} / W_f$	Frequency Ratio for torsional vibration
$f.ratio_{whirl} = W_{n\_whirl} / W_f$	Frequency Ratio for shaft whirling
$M_{shaft} = P_{air\ bend} \cdot x_5$	Bending moment on shaft
$\sigma_{shaft} = M_{shaft} \cdot x_4 / I$	Bending stress on shaft
$\tau_{roller} = P_{air\ bend} / (t_{roller} \cdot x_4)$	Direct shear stress on roller
$\sigma_{e'} = 0.5 \cdot \sigma_{U:shaft} U\_shaft$	Uncorrected endurance limit
$C_{load} = 1$	Load factor (for bending)
$C_{size} = 1.189 \cdot (x_4 * 1000)^{-0.097}$	Size factor (for 8~250 mm)
$C_{surf} = 4.51 \cdot \sigma_{U:shaft}^{-0.265}$	Surface factor (machined)
$C_{temp} = 1$	Temperature (room temperature)
$C_{reliab} = 0.814$	99% reliability
$\sigma_e = C_{load} C_{size} C_{surf} C_{temp} C_{reliab} \sigma_{e'}$	Corrected endurance limit
$q = 1/(1 + \sqrt{x_5 / (12/1000)})$	Peterson's notch-sensitivity factor
$K_f = 1 + q(K_t - 1)$	Fatigue stress-concerntration factor
$\sigma_a = K_f \cdot \sigma_{shaft}$	Alternating stress of shaft

$J = \dfrac{\pi R_{shaft}^{\ 4}}{2}$	Polar second moment of inertia
$I = \dfrac{\pi R_{shaft}^{\ 4}}{4}$	Moment of inertia;
$k_{spring} = \dfrac{GJ}{L_{shaft}}$	Spring constant of shaft
$\alpha = -\cos^{-1}[2x_3 / \sqrt{x_1^{\ 2} + x_2^{\ 2}}] + \pi/2 + \tan^{-1}(x_1/x_2)$	Punch angle
$\varepsilon_T = 0.5 \ln \sqrt{1 + \dfrac{t_{wire}}{R_{roller}}}$	Ture strain of wire
$\sigma_T = K \varepsilon_T^{0.25}$	Ture stress of wire
$P_{air\ bend} = \dfrac{x_2 1000^2 (\sigma_T t_{wire}^{\ 2} (\cos\alpha)^2}{(x_2 - 2(x_3 + t_{wire}) \sin\alpha)}$	Air bending load
$\delta_{shaft} = \dfrac{P_{air\ bend} L_{shaft}^{\ 3}}{3EI}$	Shaft's displacement
$m_{roller} = t_{roller} \cdot x_3 \cdot \rho_{roller}$	Roller's mass
$I_m = \dfrac{m_{roller} \cdot x_3^{\ 2}}{2}$	Roller's mass moment of inertia
$W_{n\_tor} = (30/\pi) \sqrt{k_{spring} / I_m}$	Natural friquency for tortion
$W_{n\_whirl} = (30/\pi) \sqrt{9.806 \cdot \delta}$	Natural friquency for shaft whirling

And some geometrical limitation

초기값

x0 = [1; 0.1; 0.05; 0.02; 0.2]

알고리즘 변경 → 결과값 비교

– Matlab 을 이용한 최적해의 계산

Active set

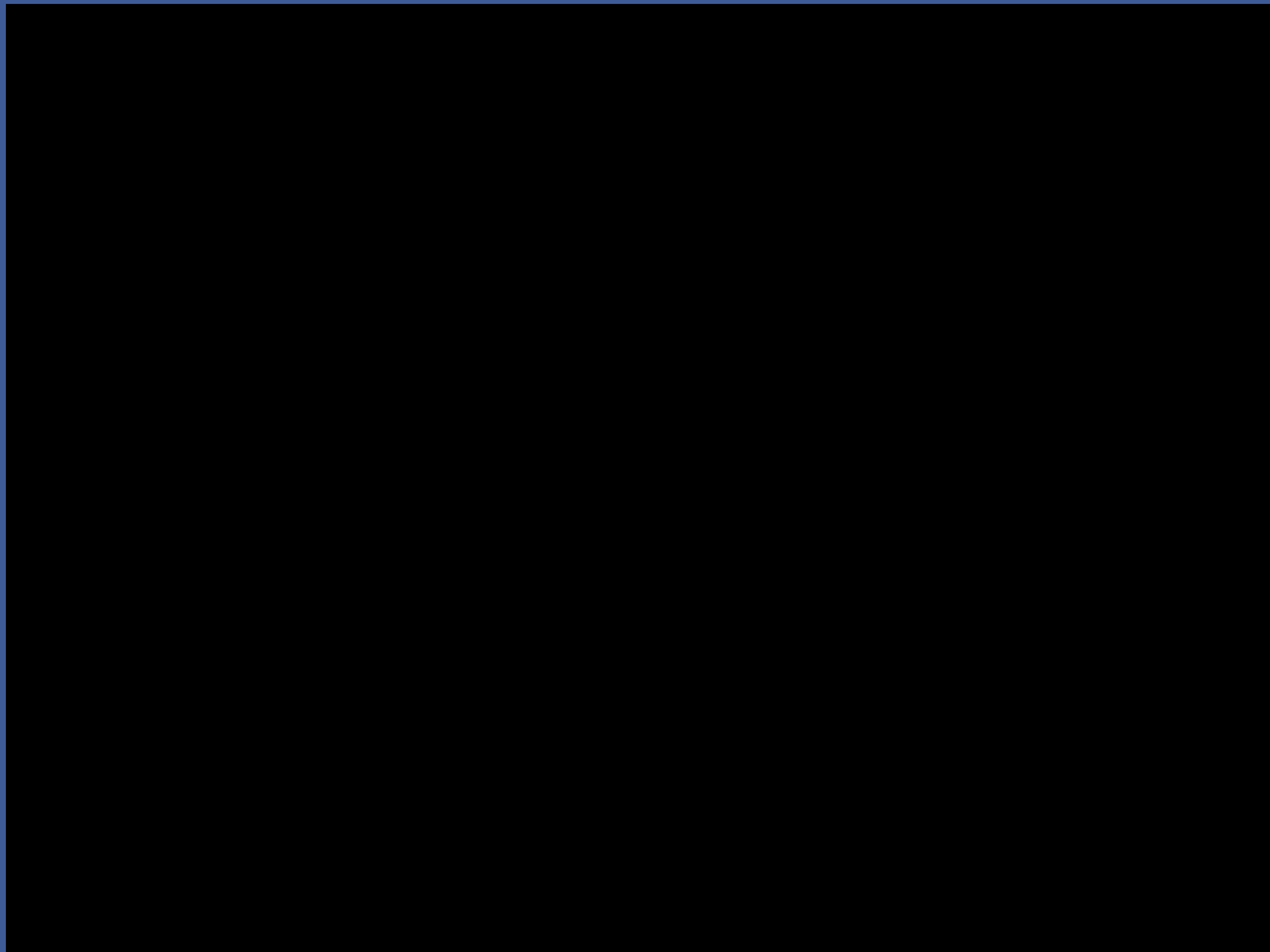
Interior Point

Always Honor Constraints– bound, none

G.A.

Pattern Search

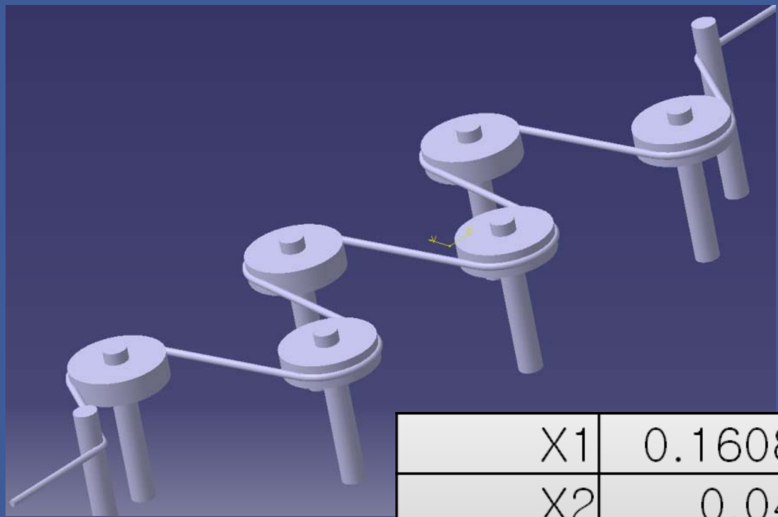
Matlab 을 이용한 최적해의 계산



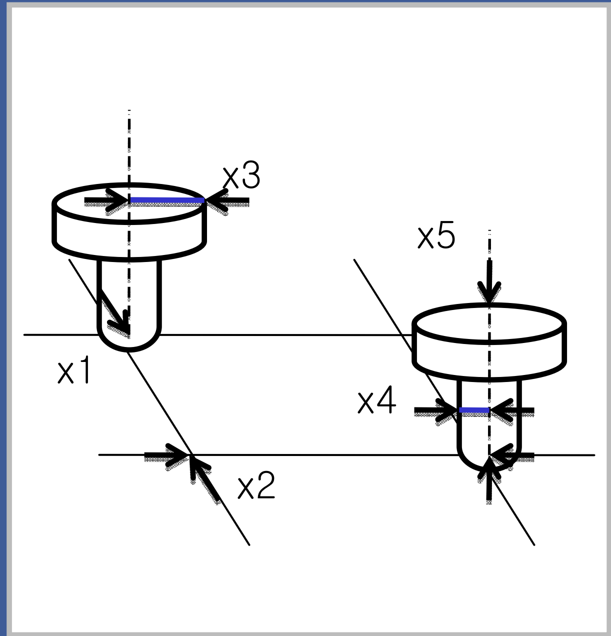
초기값의 영향

알고리즘 적용 및 비교

설계 제안



X1	0.1608
X2	0.04
X3	0.02
X4	0.0132
X5	0.0685



All dimensions in meter

기존 설계와의 비교

기존 설계 값 [0.075; 0.060; 0.03; 0.02; 0.1]
제안 설계 값 [0.1608; 0.04; 0.02; 0.0132; 0.0685]

목적함수 변동
26101 → 16400

바우싱거 효과

알루미늄 부분 응력	9.8906e+007 Pa →	1.0833e+008 Pa
강철 부분 응력	3.8404e+008 Pa →	4.1071e+008 Pa

Any Question?

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