차체구조 Project

대학생 자작 자동차 대회 차량 설계 (Baja 부문)

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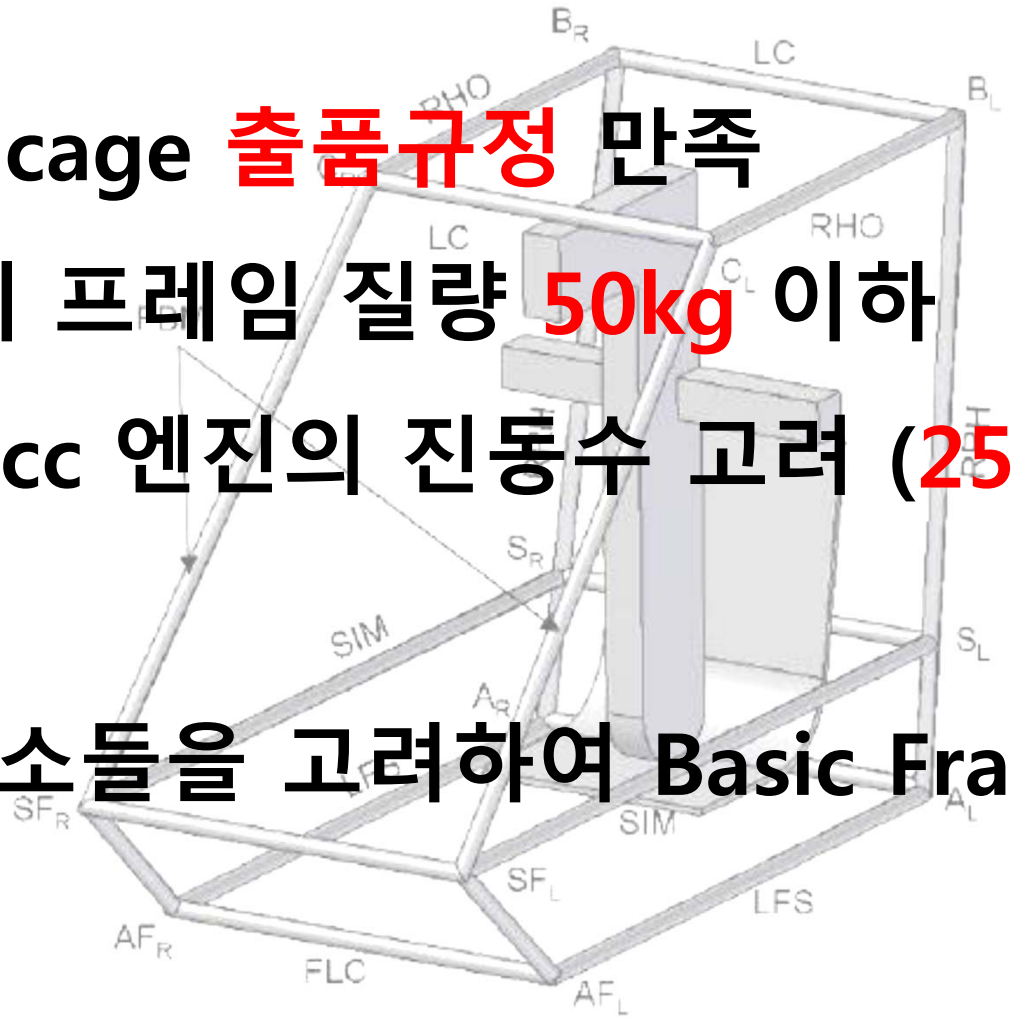
목 차

- ✓ 설계 목표
- ✓ 운전자 및 차량 제원
- ✓ 위상최적설계
- ✓ 치수최적설계
- ✓ Reinforced Frame 해석
- ✓ 결론

1 설계 목표

- ✓ Rollcage **출품규정** 만족
- ✓ 전체 프레임 질량 **50kg** 이하
- ✓ 125cc 엔진의 진동수 고려 (**25Hz** 이상)

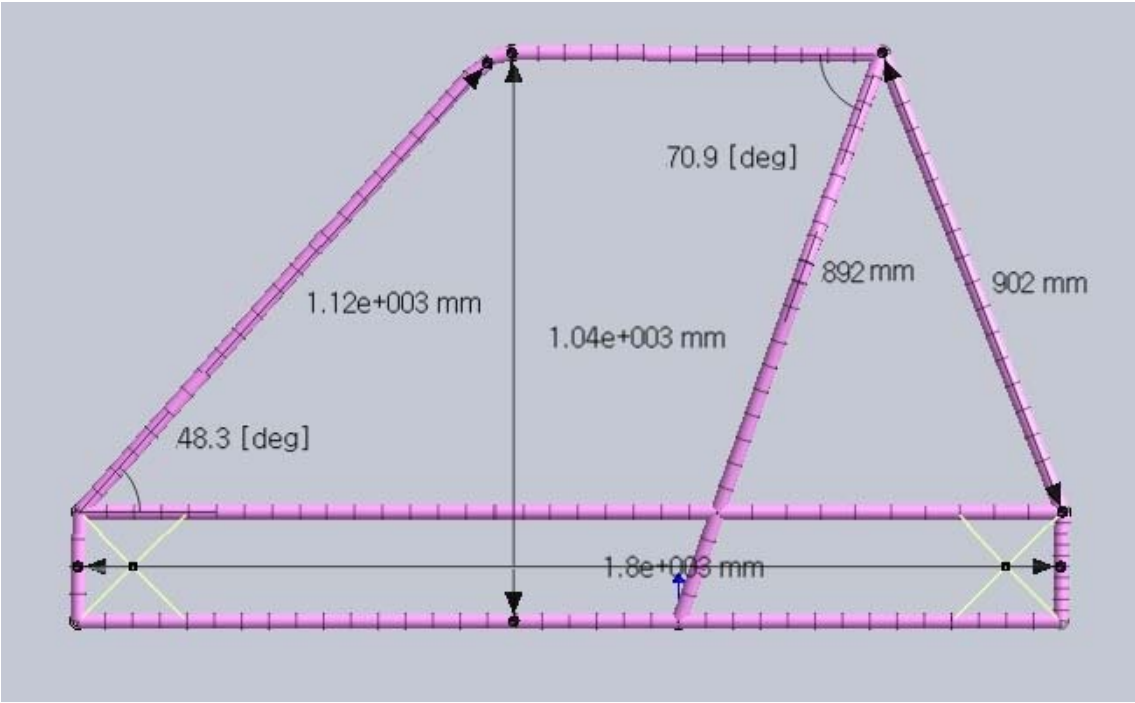


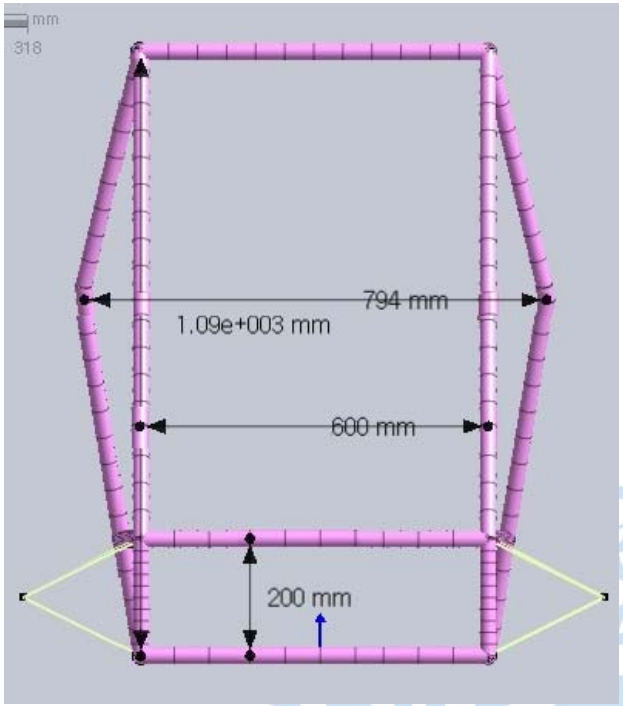
이상 요소들을 고려하여 Basic Frame 보강

2 운전자 제원

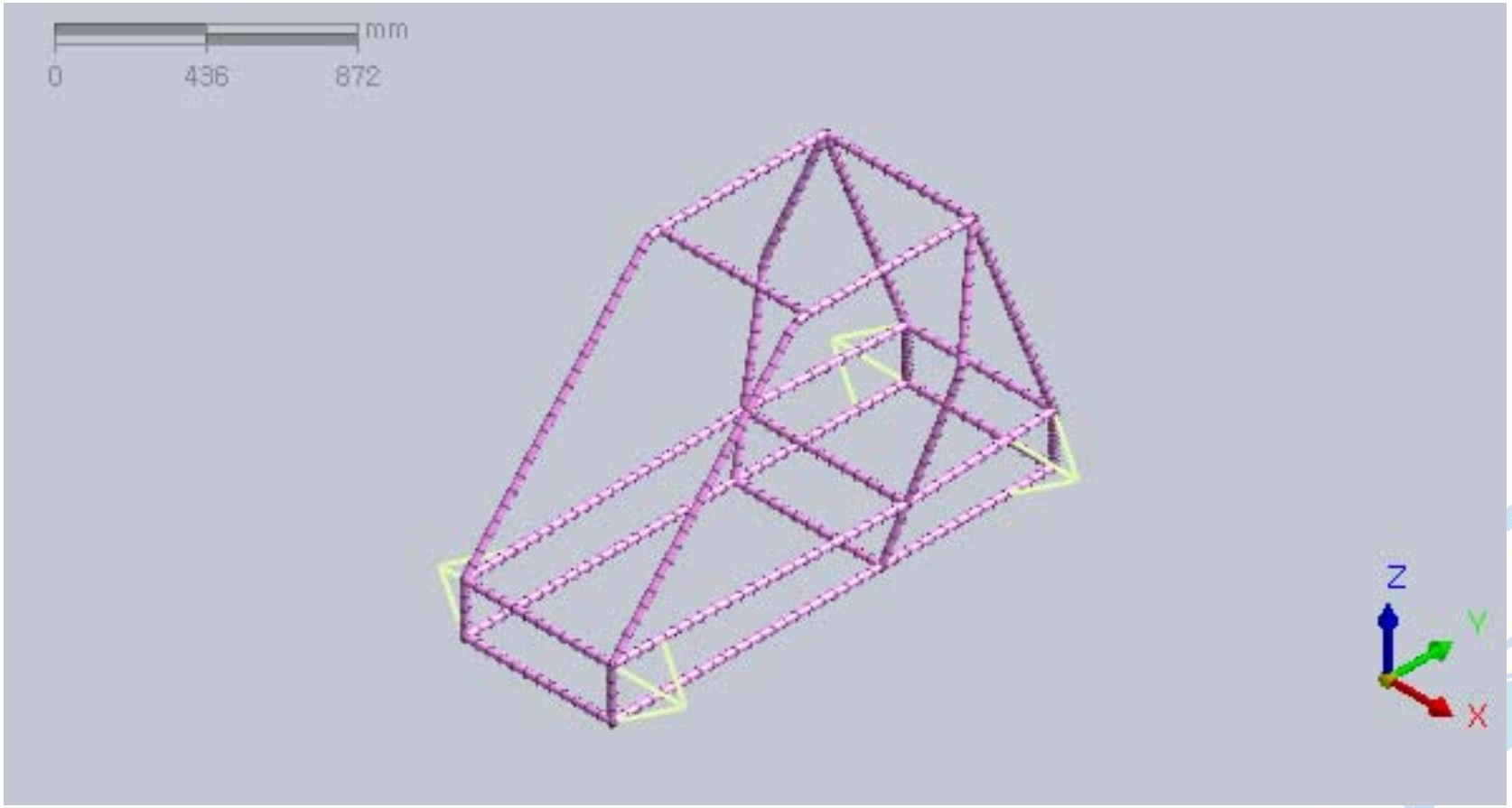
① 어깨 너비 : 450mm
② 어깨 높이 : 620mm
③ 엉덩이 너비 : 370mm
④ 앉은키 : 900mm
⑤ 허벅지 : 391mm (460mm 31.7°)
⑥ 종아리 : 367mm (440mm 33.4°)
⑦ 무릎 높이 : 242mm
⑧ 목 : 80mm
⑨ 머리 : 측 200mm
⑩ 질량 : 80kg (780N)

2 차량 제원

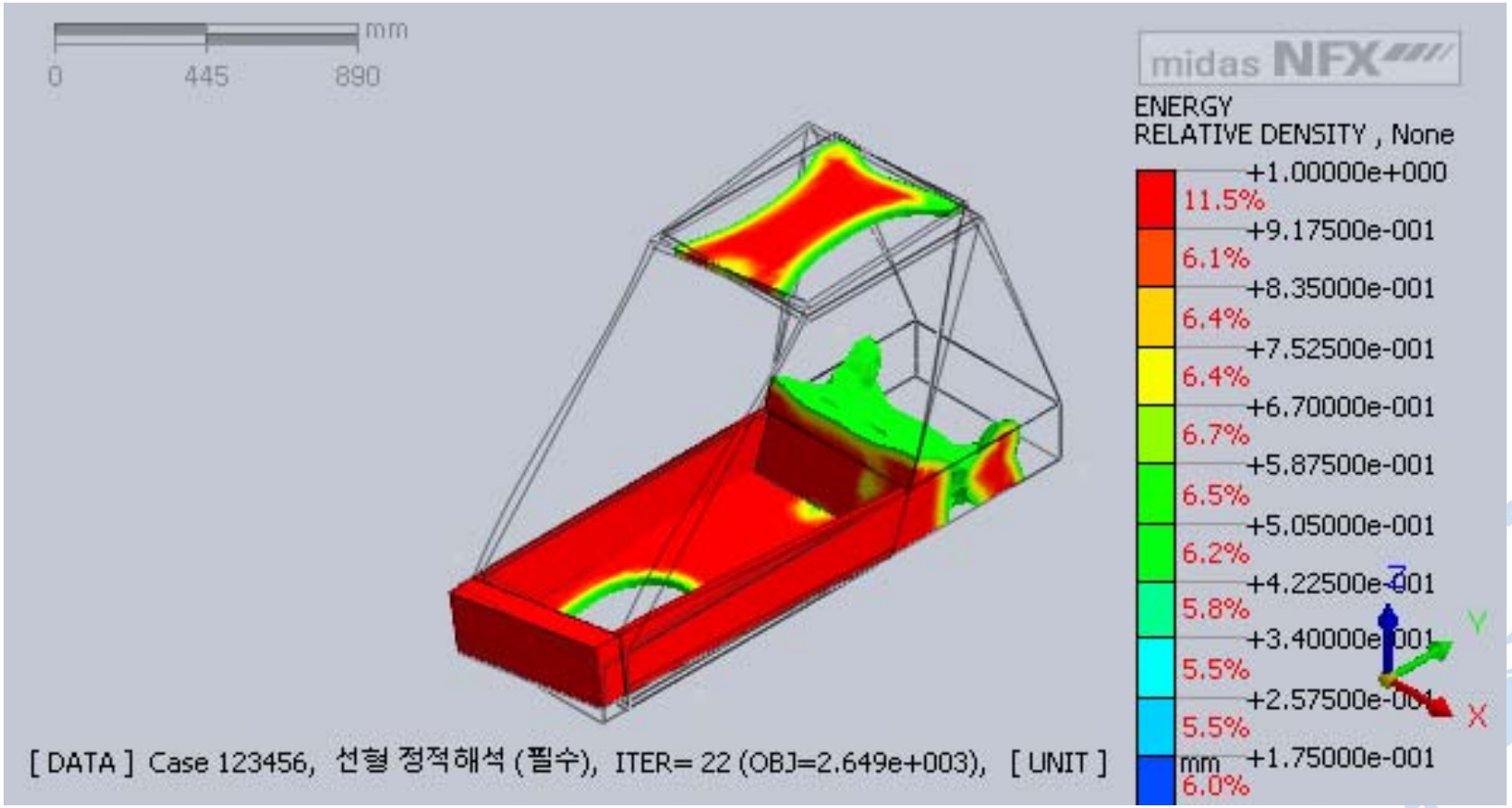

70.9 [deg]
892 mm
902 mm
1.12e+003 mm
1.04e+003 mm
48.3 [deg]
1.8e+003 mm


mm
318
794 mm
1.09e+003 mm
600 mm
200 mm

3 Basic Frame Model

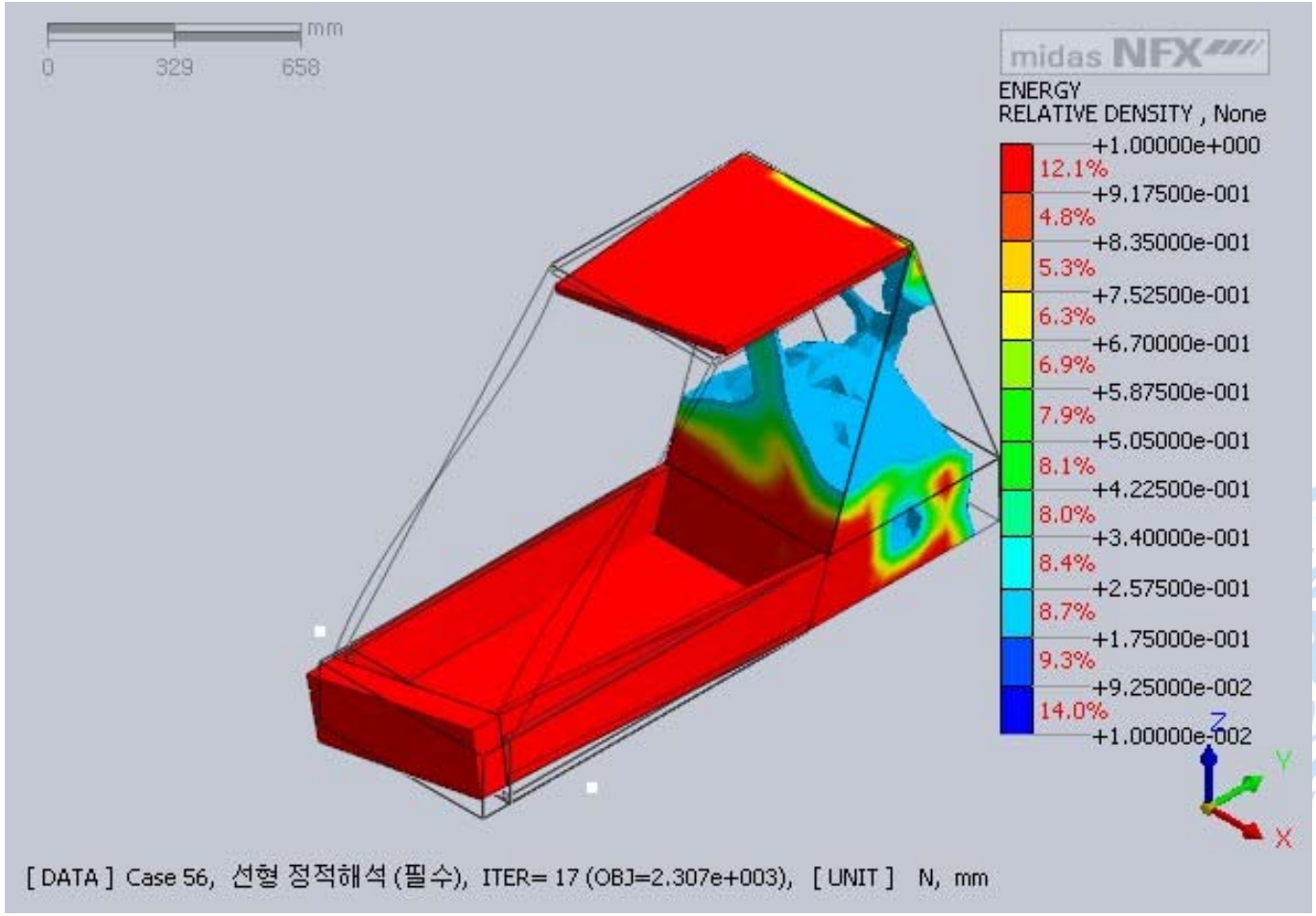


4 Topology Optimum Design

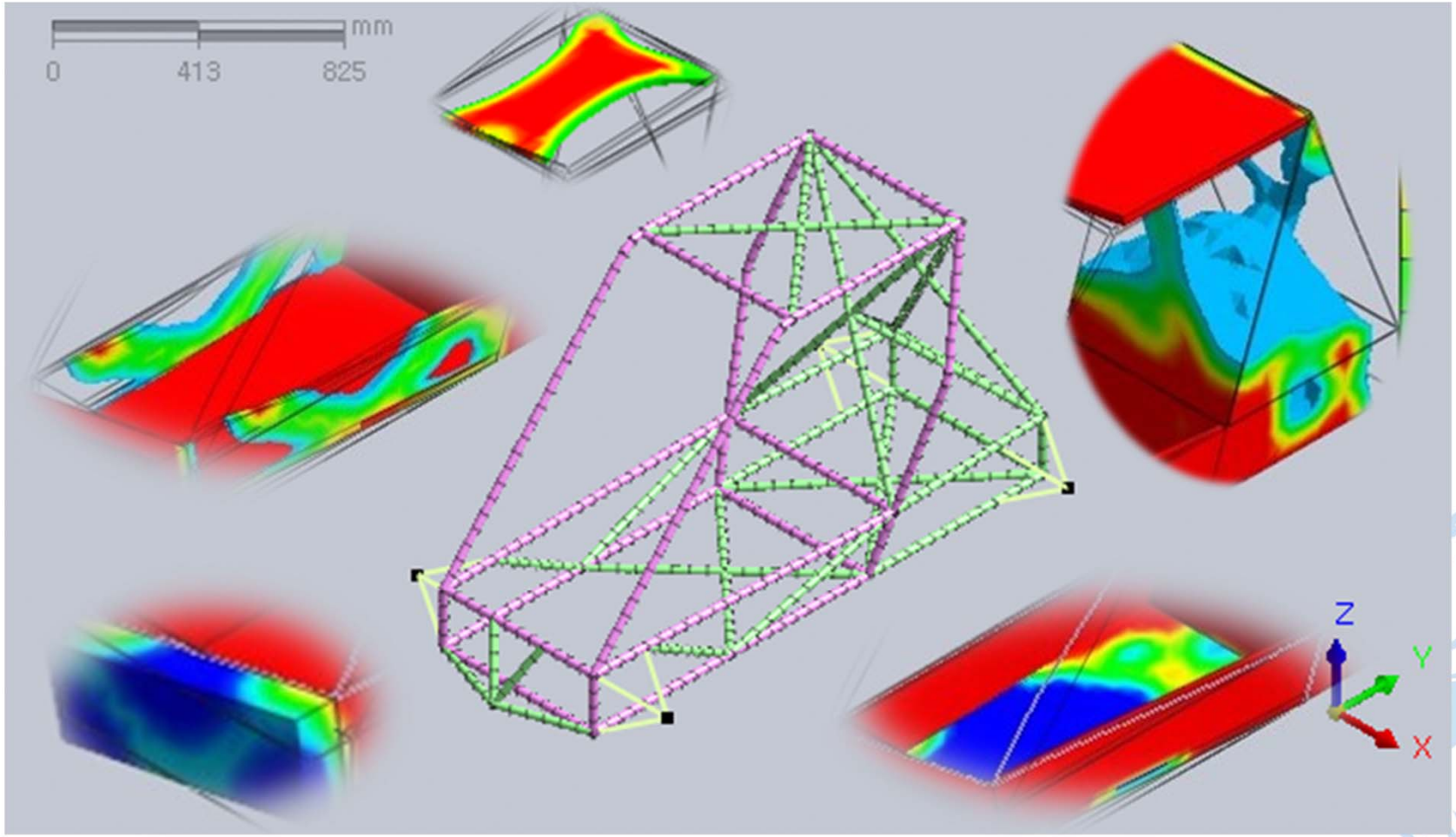


4 Topology Optimum Design

목표부피 30% 감소율 70% 동일조건



4 Topology Optimum Design



5 Size Optimum Design

최적설계 결과 요약

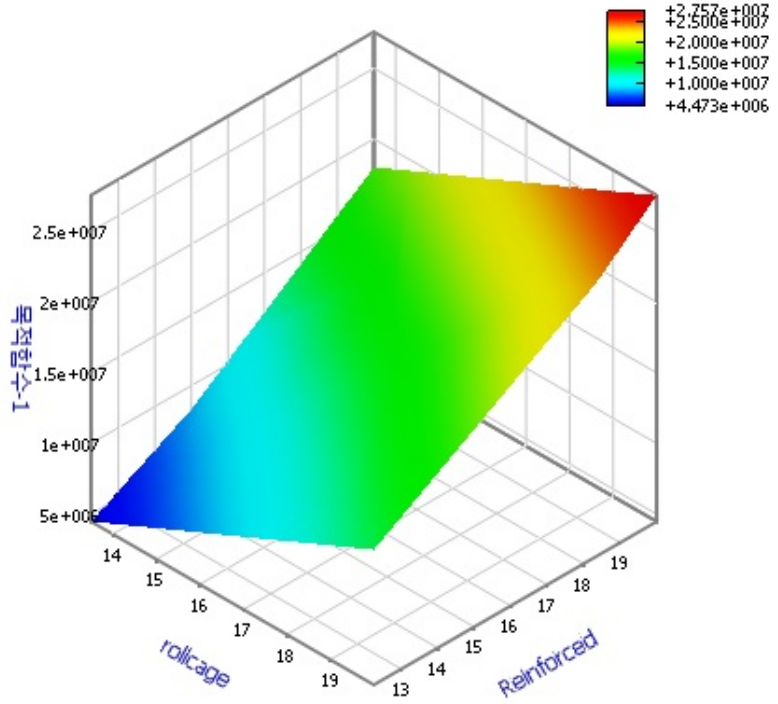
최적화 케이스 치수

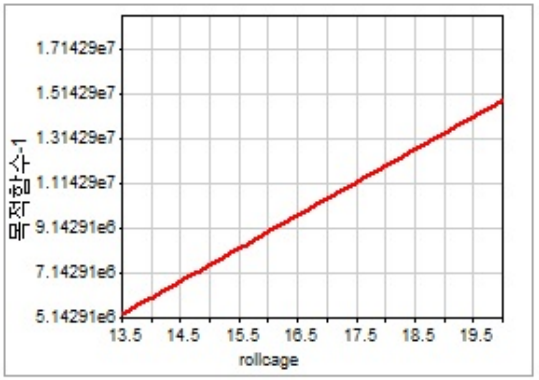
	설계변수 이름	초기값		최소값	최대값	설계안 1		설계안 2		설계안 3		사용자 설계안	
	입 력												
	rollcage	14		14	20	14		14		14		14	
	Reinforced	13		12	20	12		12		12		12	
	출 력 (예상값 / 해석값)												
	목적함수 변화율 (%)	0				-4.6		-4.6		-4.6		-4.6	-13
	제약조건 최대위배율 (%)	33				40		40		40		40	59
	목적함수-1	4.7e+006				4.5e+006		4.5e+006		4.5e+006		4.5e+006	4.1e+006
▶	제약조건-1	27		40		24		24		24		24	17
*													

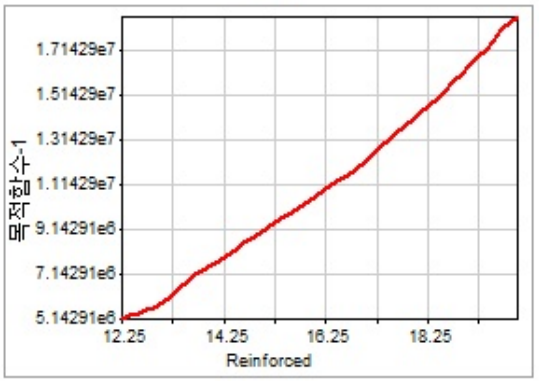
5 Size Optimum Design

최적화 케이스 치수 실험점 표시

축 설정	
x축	rollcage
y축	Reinforced
z축	목적함수-1
설계변수	
rollcage	13.955
Reinforced	13.1025
설계응답	
목적함수-1	5.98531e+006
제약조건-1	27.7798



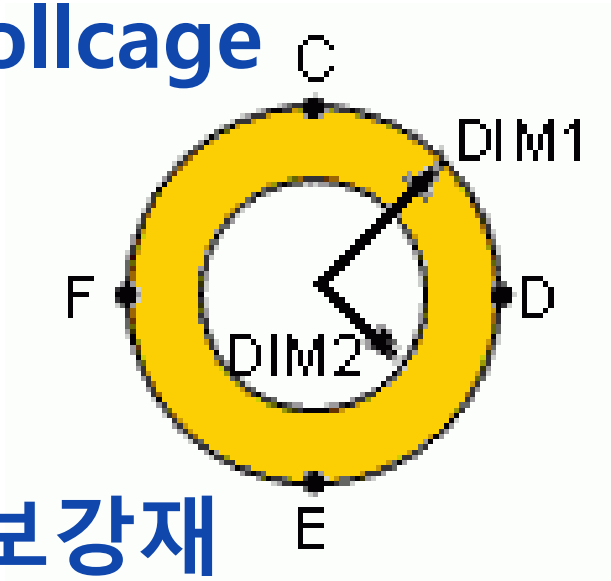




5 Size Optimum Design

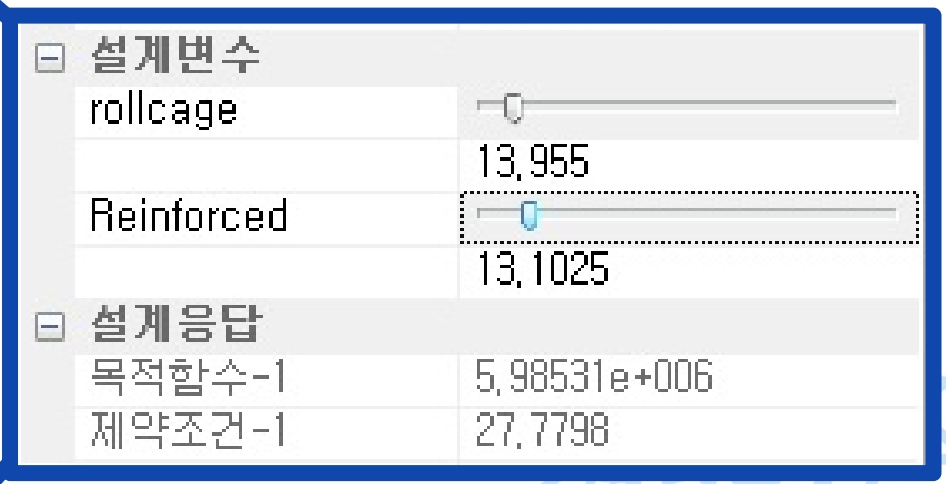
DIM1	13.955	mm
DIM2	10.6	mm

Rollcage

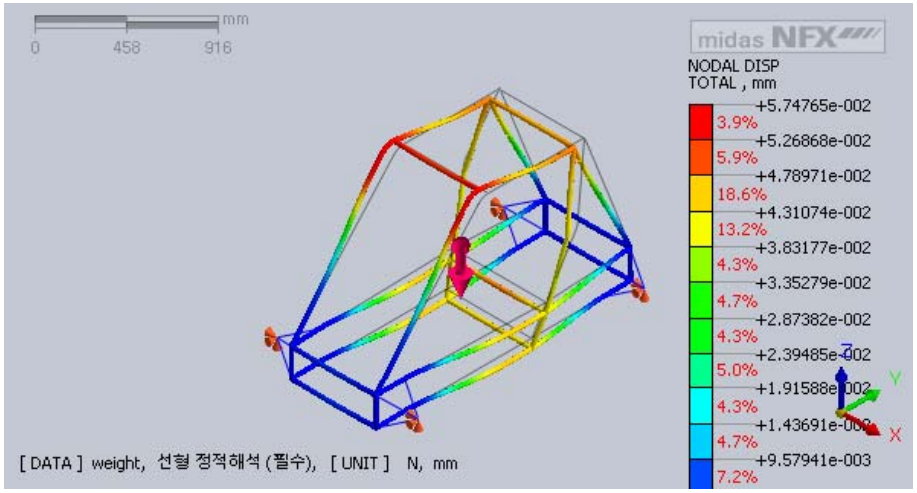


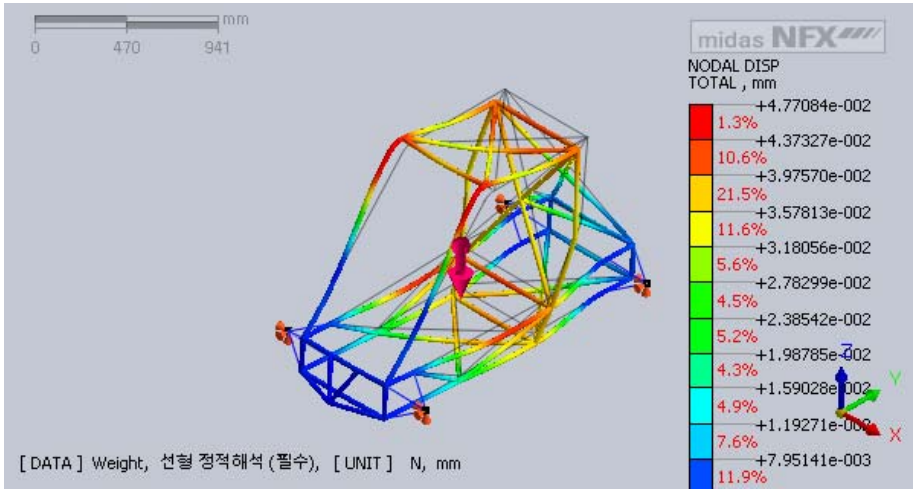
보강재

DIM1	13.1025	mm
DIM2	11.6	mm



6 Reinforced Frame
(Weight)





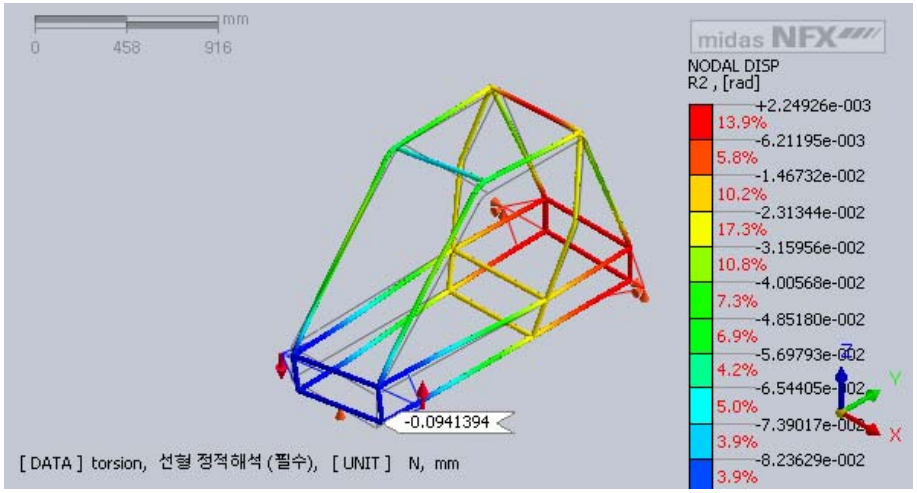
	방향	하중	반력
1	FX	0.0000	0.0000
2	FY	0.0000	0.0000
3	FZ	-345.8603	345.8603

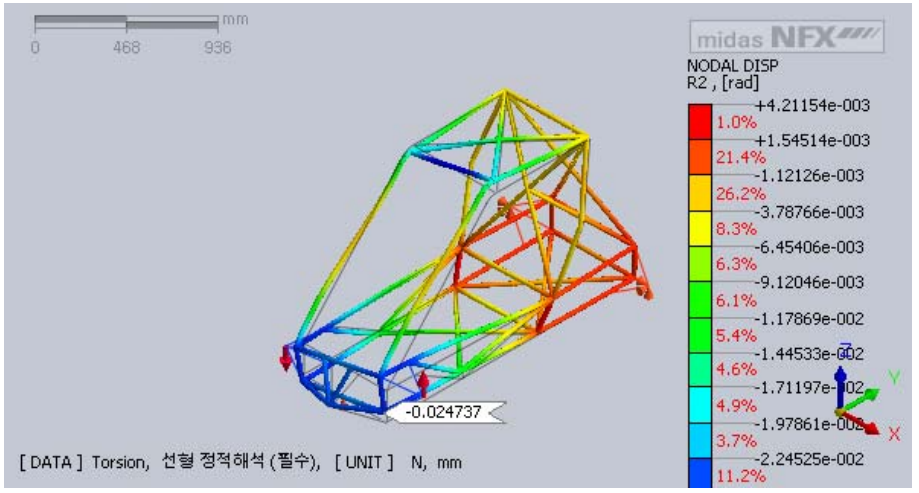
$$m = \frac{345.8603\ N}{9.806\ m/s^2} = 35.27\ kg$$

	방향	하중	반력
1	FX	0.0000	0.0000
2	FY	0.0000	0.0000
3	FZ	-453.0707	453.0707

$$m = \frac{453.0707\ N}{9.806\ m/s^2} = 46.20\ kg$$

6 Reinforced Frame
(Torsional Stiffness)

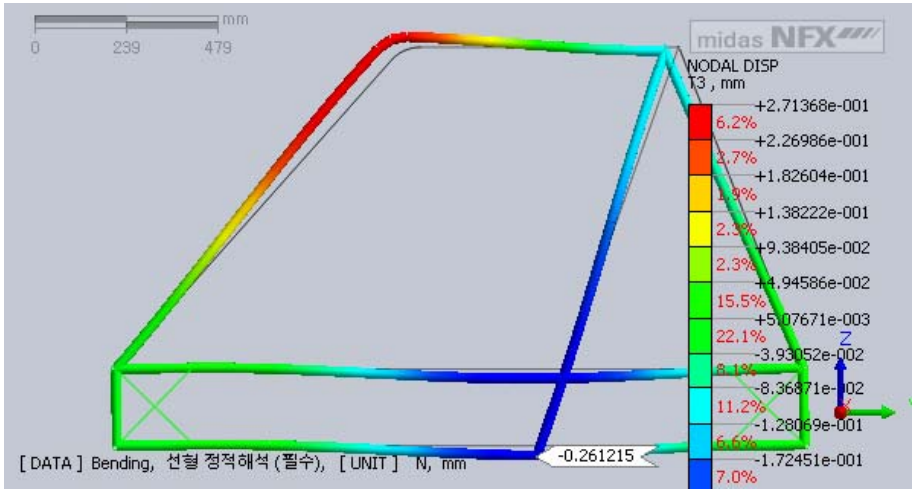


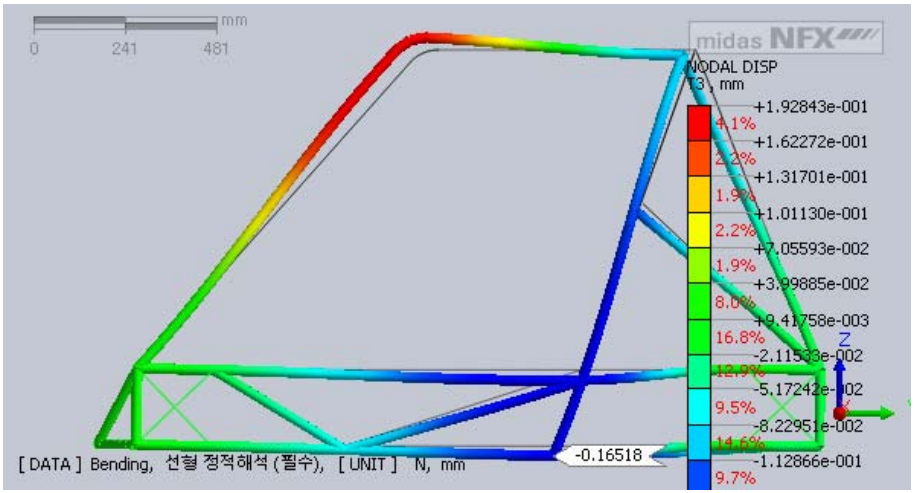


전 $K = \frac{T}{\theta} = \frac{4000N \times 300mm}{0.0941394\,rad} = 12.7 \times 10^6\ Nmm/rad$

후 $K = \frac{T}{\theta} = \frac{4000N \times 300mm}{0.024737\,rad} = 48.5 \times 10^6\ Nmm/rad$

6 Reinforced Frame
(Bending Stiffness)

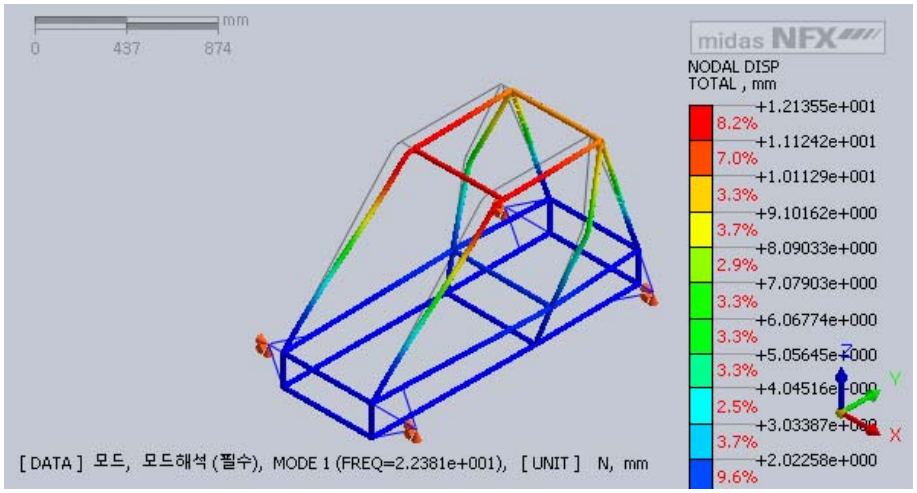


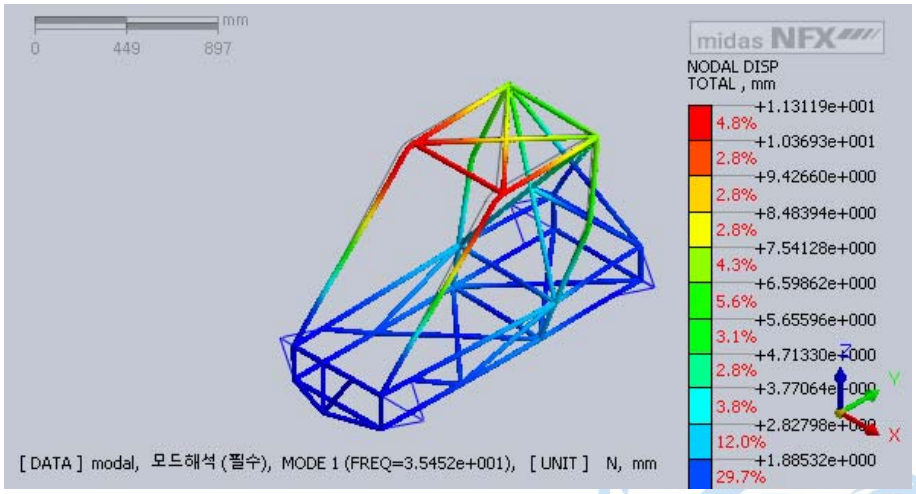


전 $K = \frac{F}{\delta} = \frac{(780N + 700N)}{0.26122mm} = 5.67 \times 10^3\ N/mm$

후 $K = \frac{F}{\delta} = \frac{(780N + 700N)}{0.16518mm} = 8.96 \times 10^3\ N/mm$

6 Reinforced Frame
(Modal Analysis)





전 22.38 *Hz*

후 35.45 *Hz*

7 결과 비교

항목	전	후	%
Weight	35.27 kg	46.20 kg	31.0 %
Torsional Stiffness	12.7×10^6 Nmm/rad	48.5×10^6 Nmm/rad	282 %
Bending Stiffness	5.67×10^3 N/mm	8.96×10^3 N/mm	58.0 %
1st Modal Frequency	22.38 Hz	35.4 Hz	58.2 %

감사합니다