

AOC 2019
[Optimization of Cup Holder]



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개요



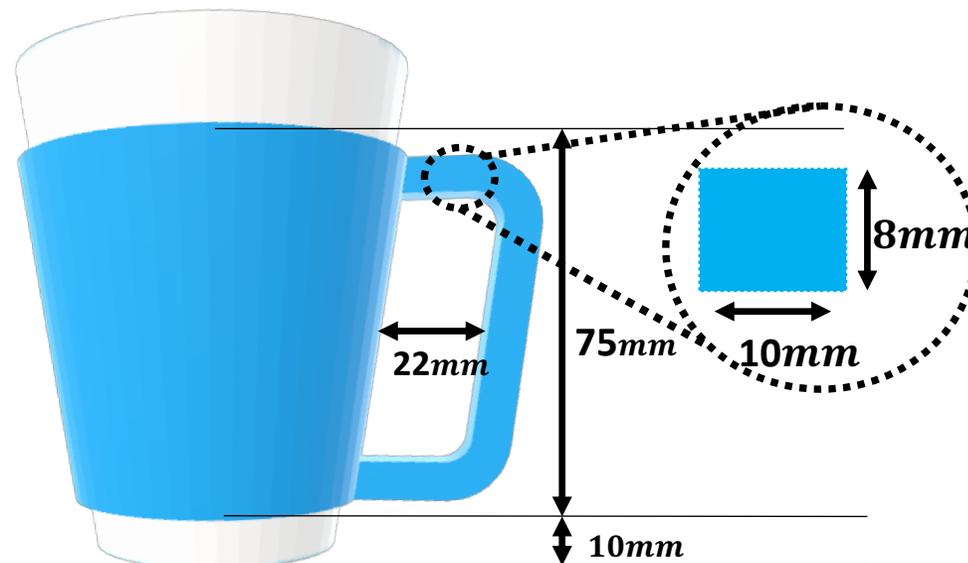
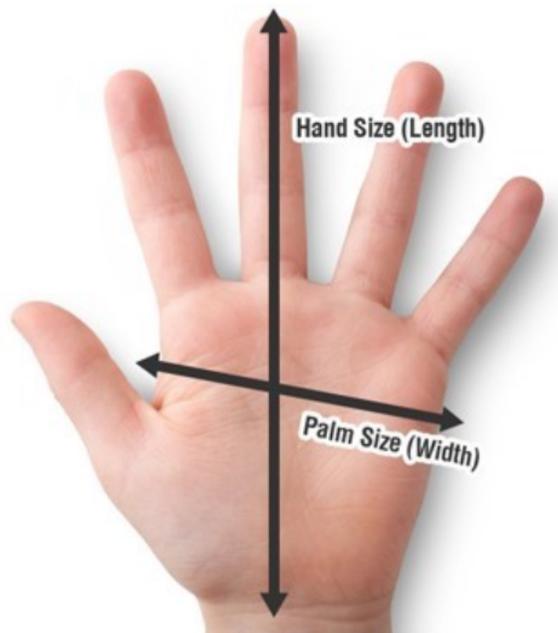
초기 디자인

- 사용자 편의
- 최적화를 위해 단순한 형상으로 설계
- 재질 선정





초기 형상 설계



Average Hand Size (Width)	
Male	Female
84 mm (3.30 inches)	74 mm (2.91 inches)

- ✓ 성인 남성, 여성 손가락 4개 여유
- ✓ 컵 홀더와 손잡이의 거리 조절
- ✓ PC/ABS 재질 플라스틱 선정

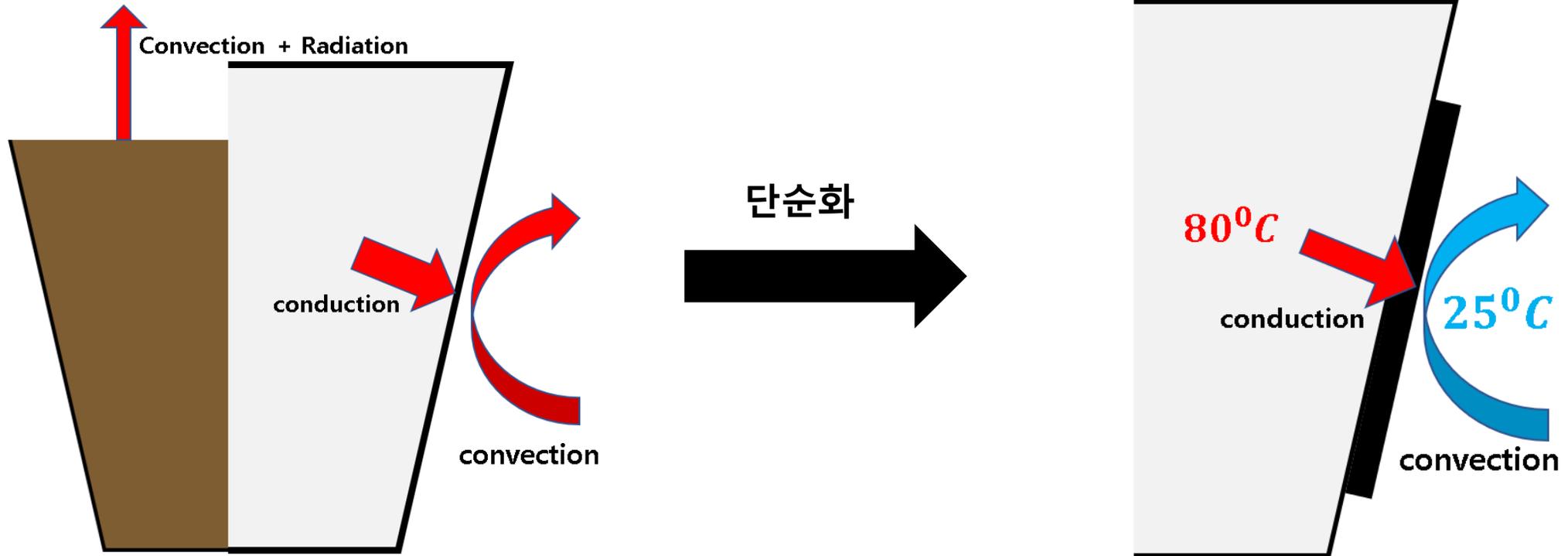


열전달 경로

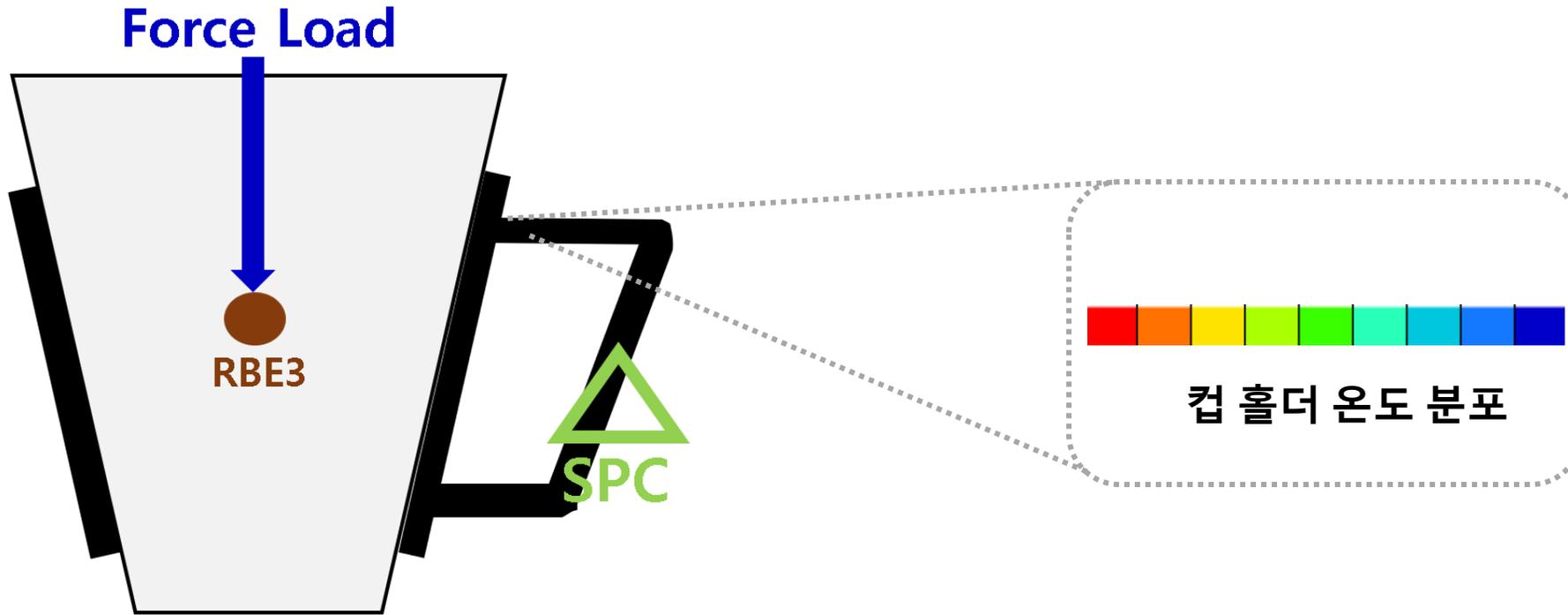




열전달 상황 가정



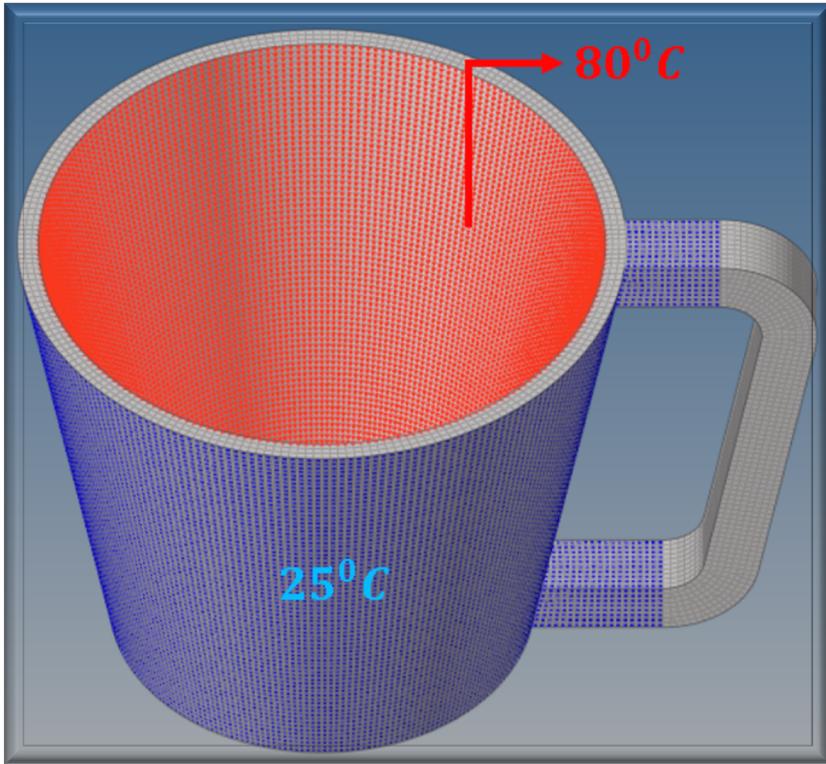
- 커피와 공기 간 대류와 복사 열 전달 무시, 컵 홀더를 통한 전도 열 전달
- 커피의 온도 80°C, 상온 온도 25°C 일정하게 유지
- 더 이상 온도변화가 없는 정상상태의 열전달



- 손잡이를 쥐는 부분은 고정 점
- RBE3의 무게중심에 Force Load로 유체의 무게를 가함
- 열 해석의 온도분포를 반영한 열 응력 중첩

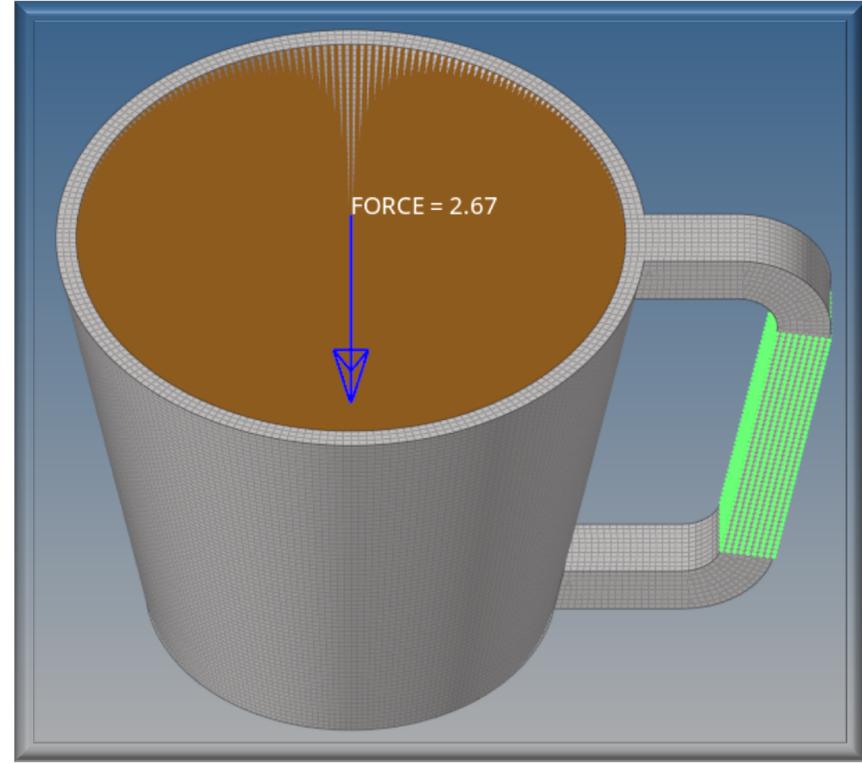
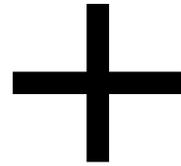


경계 조건



열 해석

응력 중첩



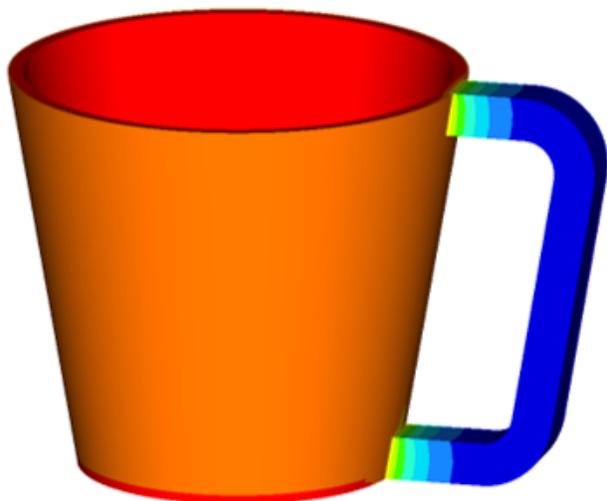
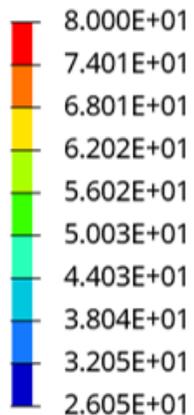
구조 해석



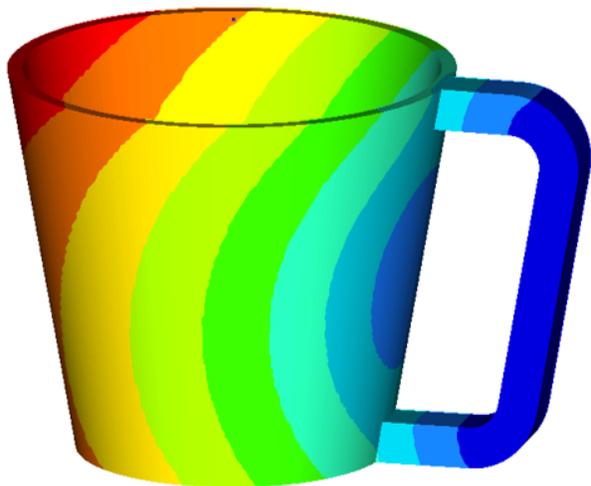
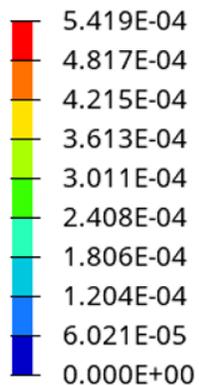
초기 디자인 해석 결과



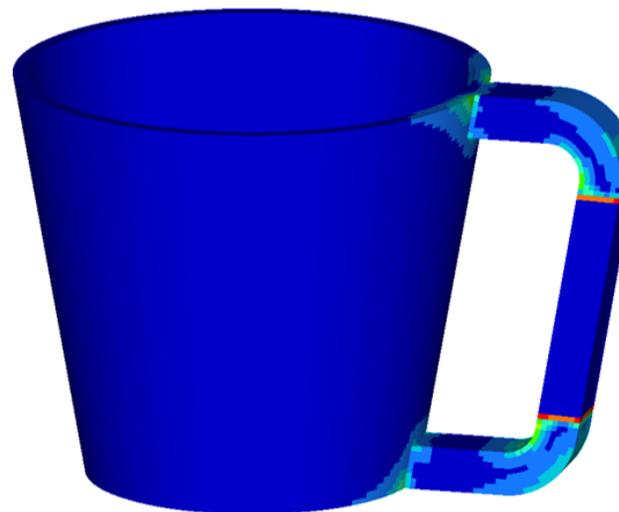
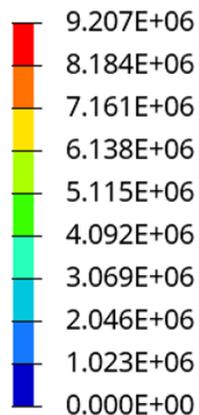
Grid Temperature



Displacement(Mag)
Analysis system



Element Stresses
Analysis system



초기 모델	
질량 (g)	21
최대 응력 (Mpa)	9.2
안전 계수	5.9
최대 변위 (mm)	0.54
손잡이 온도 (℃)	26-38

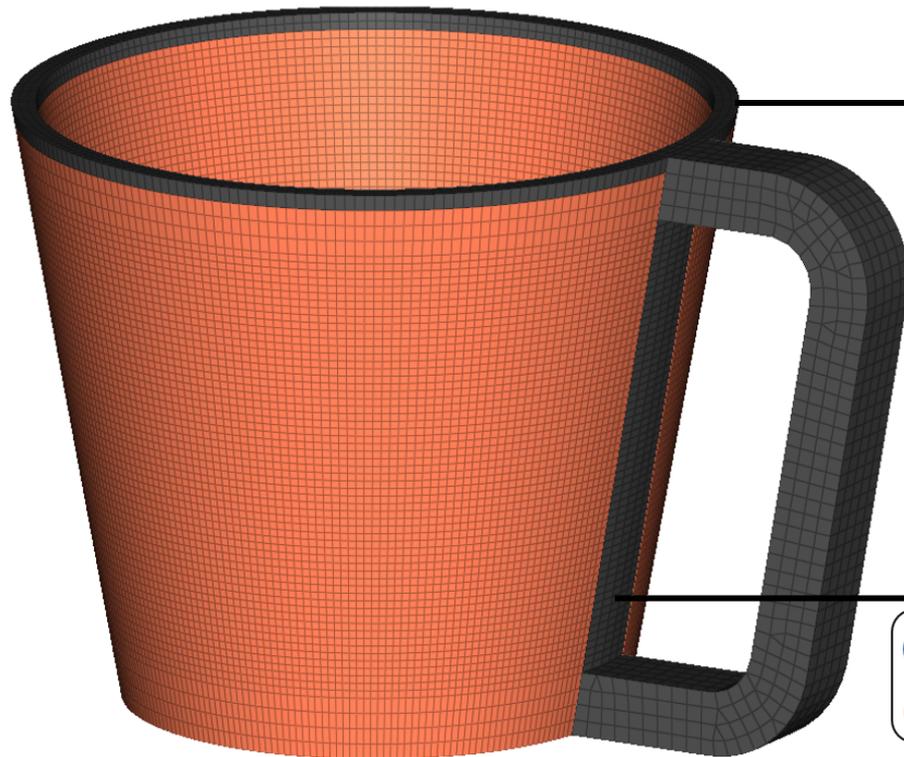
옆면 최적화

- 옆면 최적위상 도출
- 응력, 온도, 변위 제한조건
- 불필요한 부재를 제거하는 질량 목표 경량화





옆면 최적화



손잡이 Non-design 영역

+

→ 컵을 지지하기 위함

+

→ 손이 옆면에 닿지 않기 위함



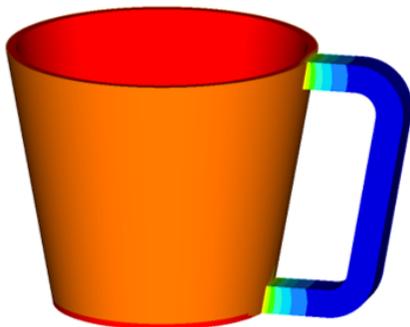
- XY 평면 대칭

- Min dim = 6mm

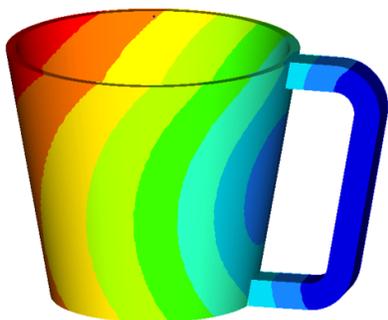


제한 조건

온도



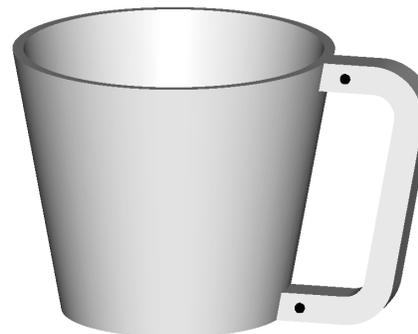
편위



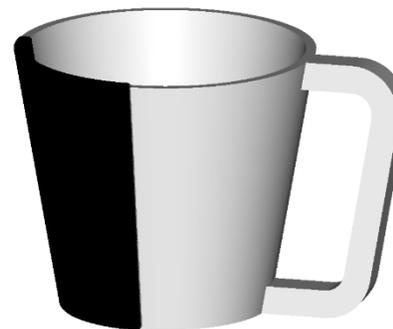
응력



● Constraints node



< 35°C



< 0.5mm



< 18Mpa

안전계수 3



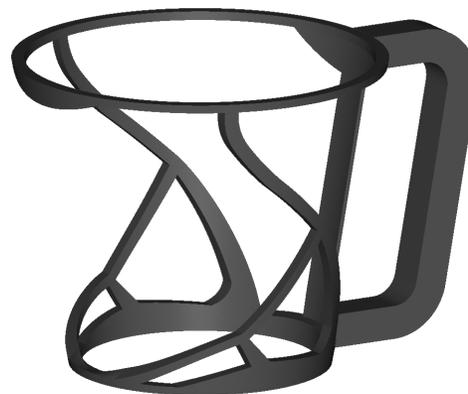


질량 최소화

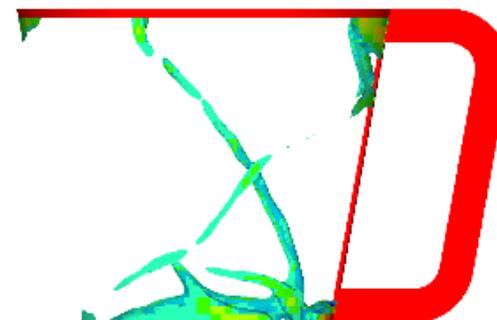
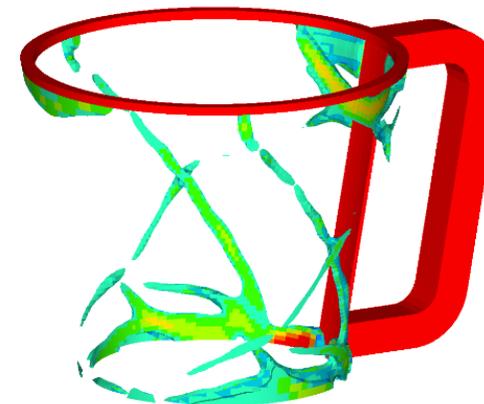


21g

70.5 %
감소
→



6.2g

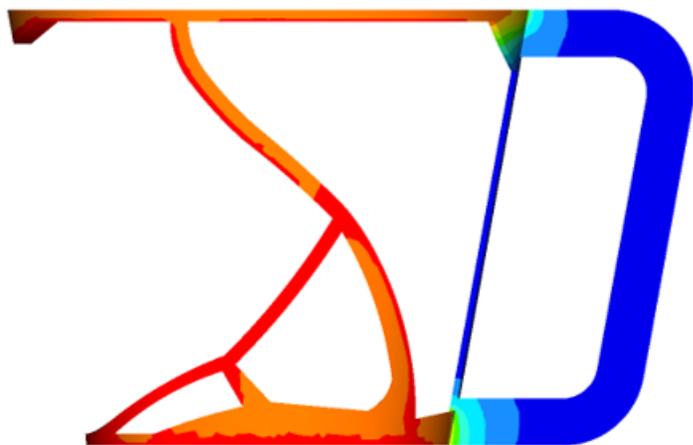
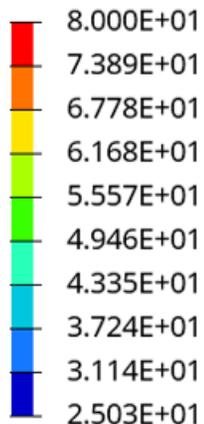




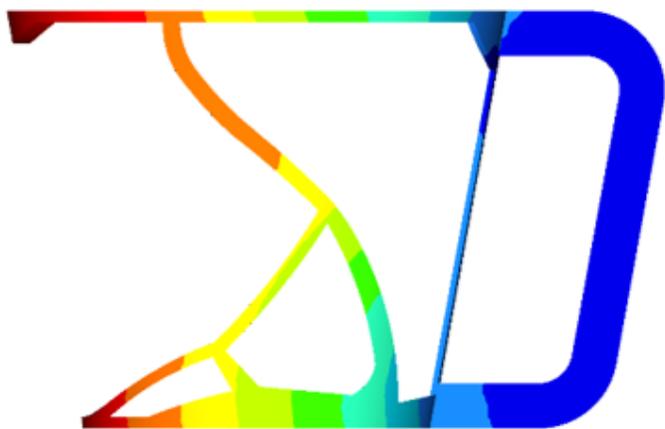
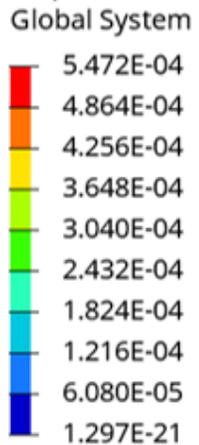
옆면 최적화 해석 결과



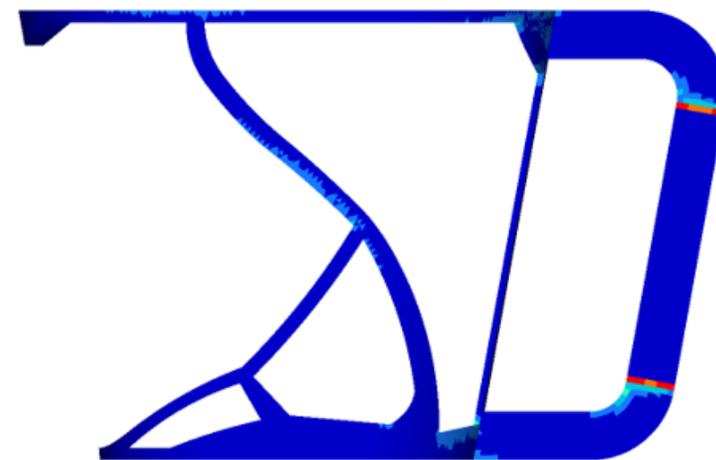
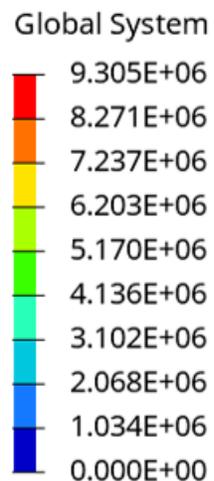
Grid Temperature



Displacement(Mag)



Element Stress



옆면 최적화 모델

질량 (g)	6.2
최대 응력 (Mpa)	9.3
안전 계수	5.86
최대 변위 (mm)	0.55
손잡이 온도 (℃)	25~31

손잡이 최적화

- 조건에 부합하지 않는 부재를 제거
- 최소한의 부재만 남김으로써 경량화 시도





손잡이 최적화



● Non-design
● Design

옆면 Non-design 영역

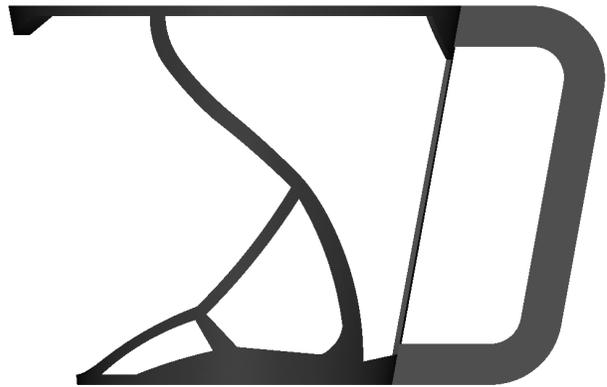
+

→ 손잡이의 두께를 유지하기 위함

- Draw z-방향
- XY 평면 대칭
- Min dim = 3mm

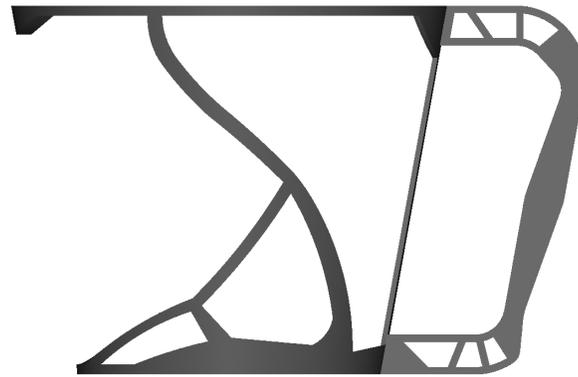


손잡이 최적화

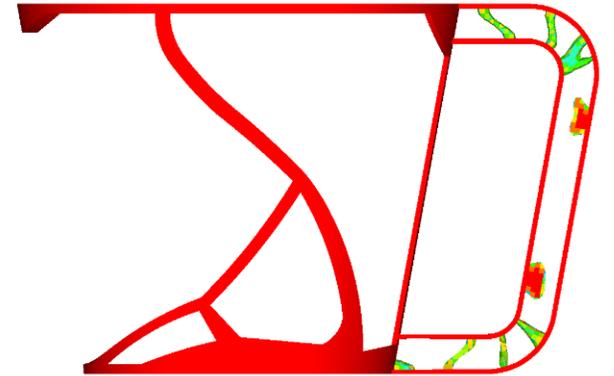


6.2g

16.7%
감소
→



5.17g

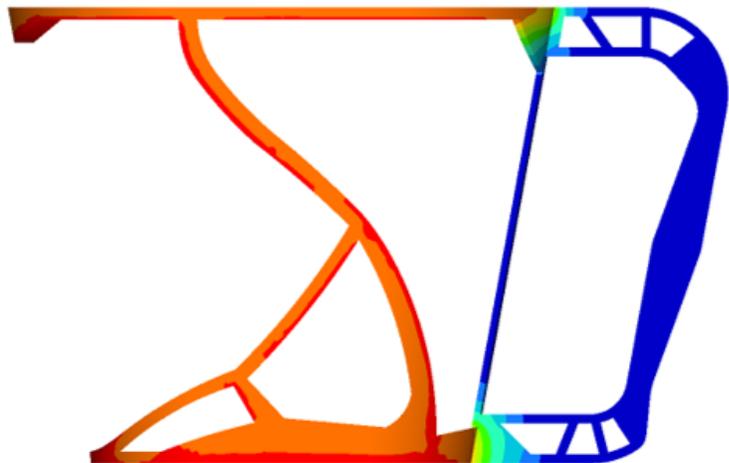
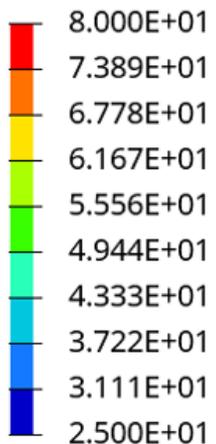




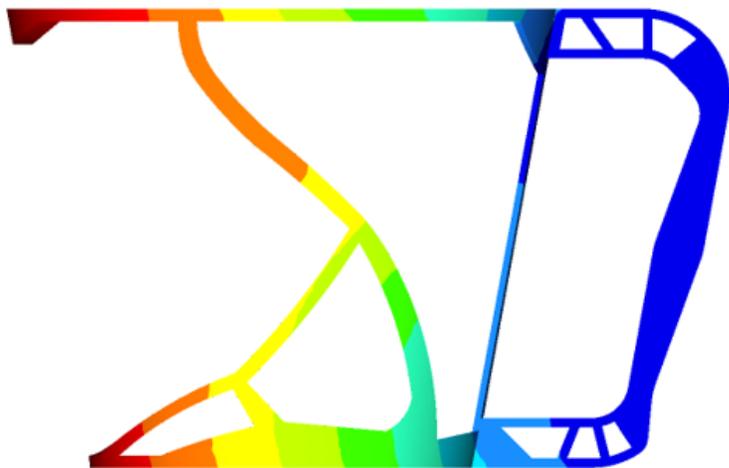
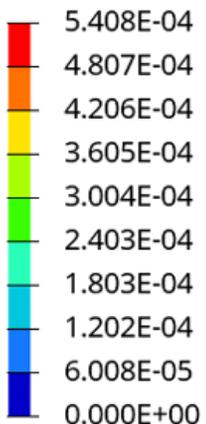
손잡이 최적화 해석 결과



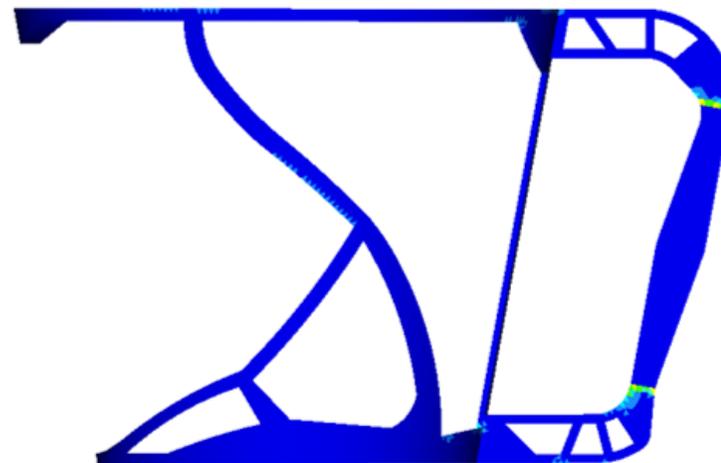
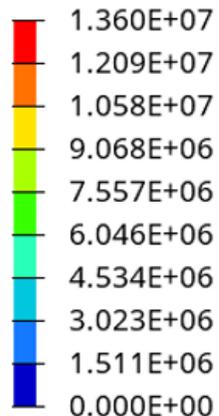
Grid Temperature



Displacement(Mag)
Global System



Element Stresses
Analysis system



손잡이 최적화 모델	
질량 (g)	5.17
최대 응력 (Mpa)	13.6
안전 계수	4.0
최대 변위 (mm)	0.54
손잡이 온도 (℃)	25~31

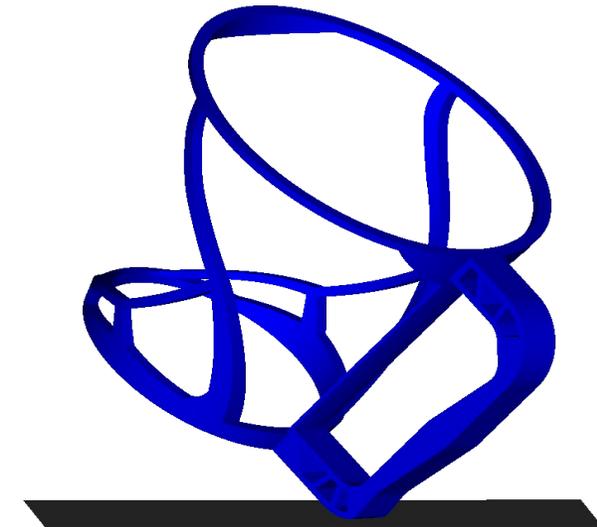
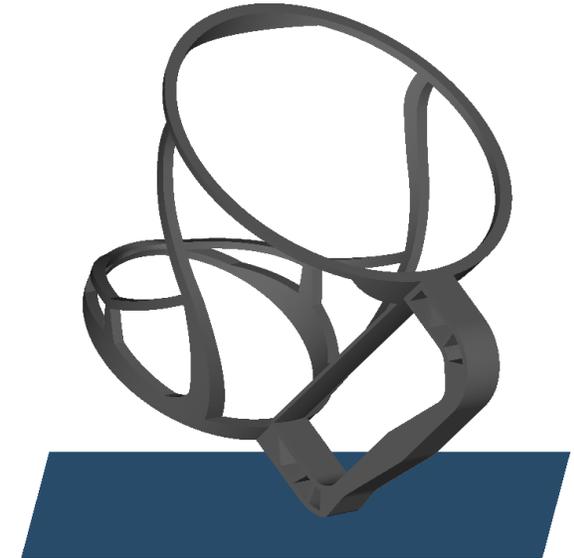
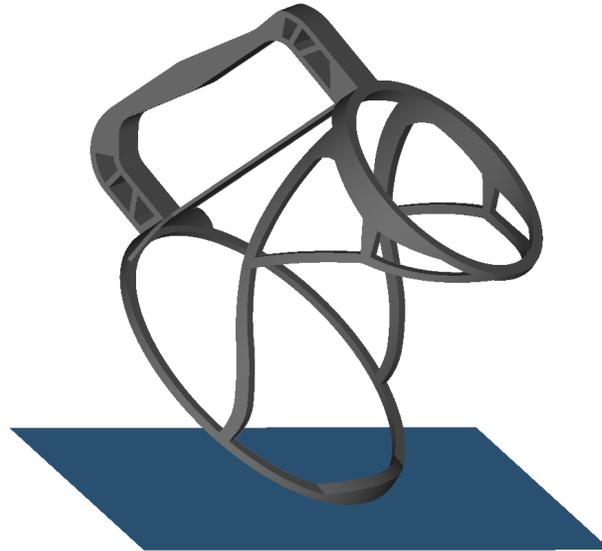
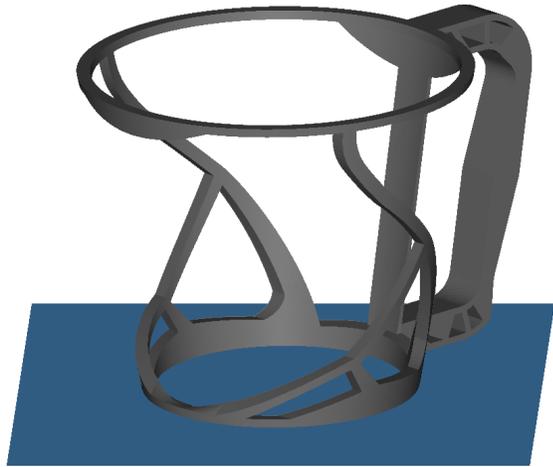
내구성 및 생산성

- 낙하 시험을 통한 내구성 강화
- 플라스틱 사출성형 생산성 검토





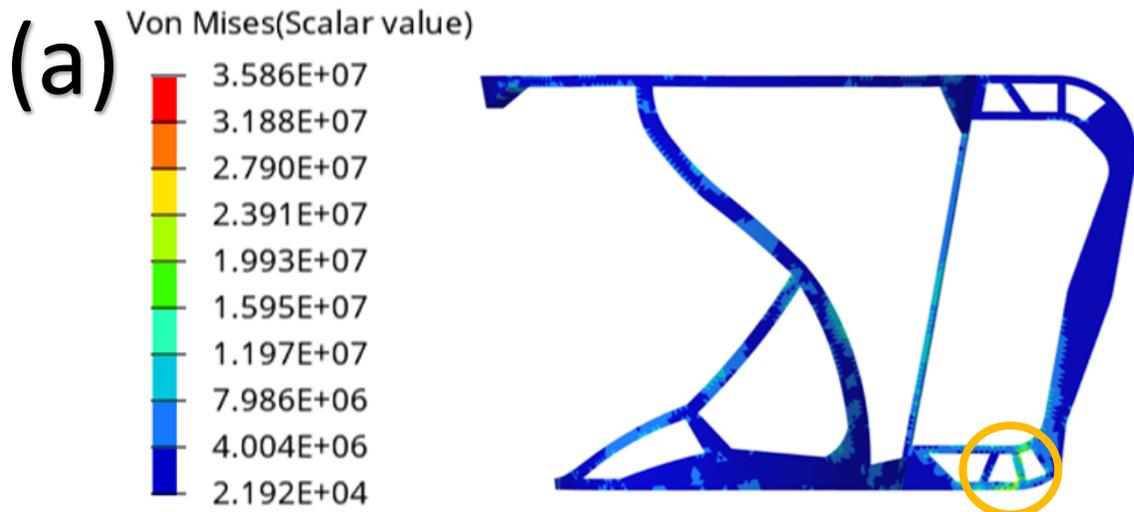
Radioss 낙하시험



낙하 높이	1.5m
충돌 직전 속도	5.42m/s
충돌 시간	2ms
시간 간격	0.2ms

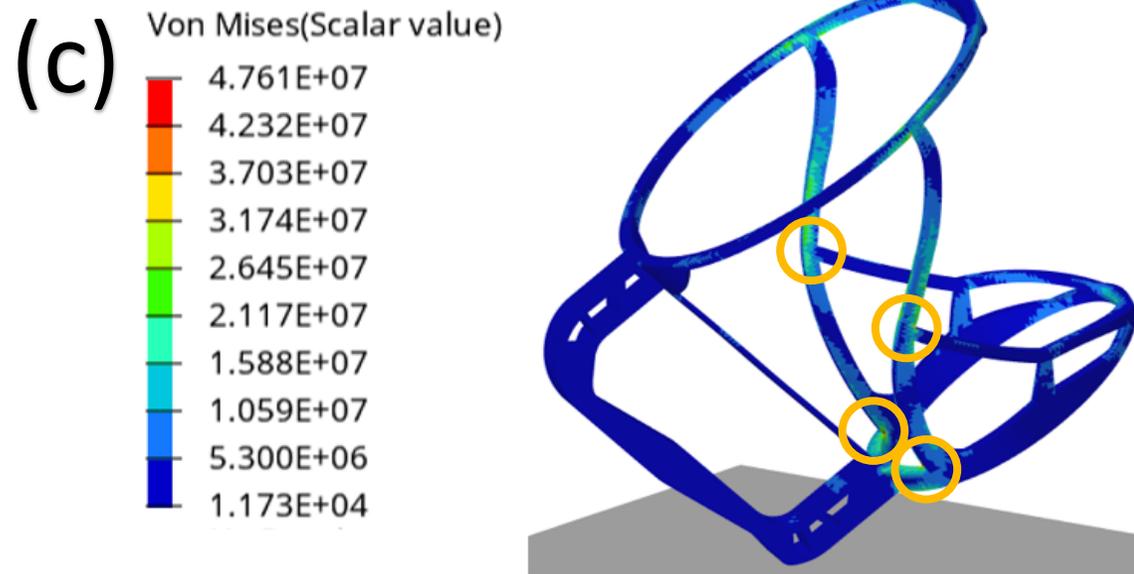
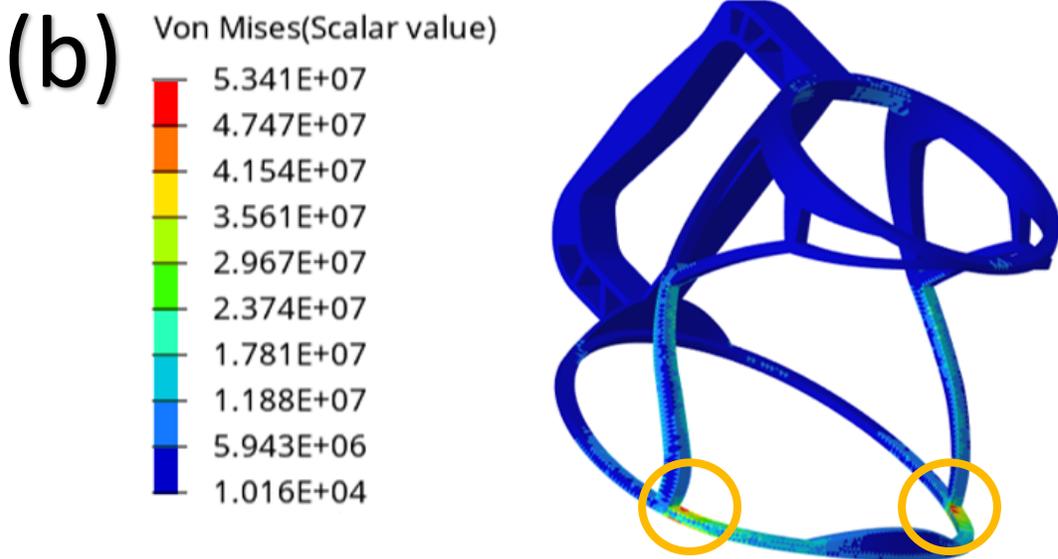


낙하시험 해석결과



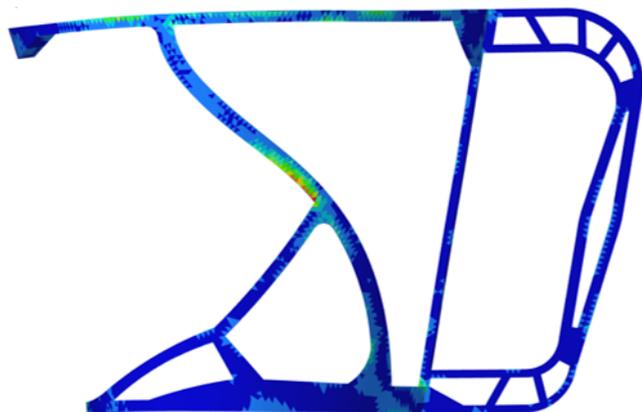
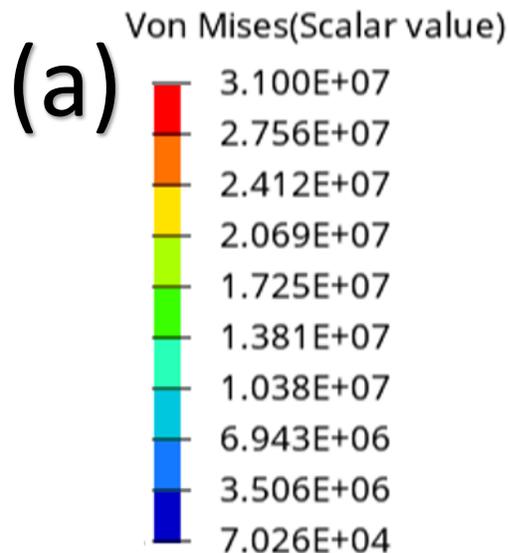
	최대 응력 (Mpa)	안전 계수
(a)	35.86	1.52
(b)	53.41	1.02
(c)	47.61	1.14

○ 응력이 몰리는 위치





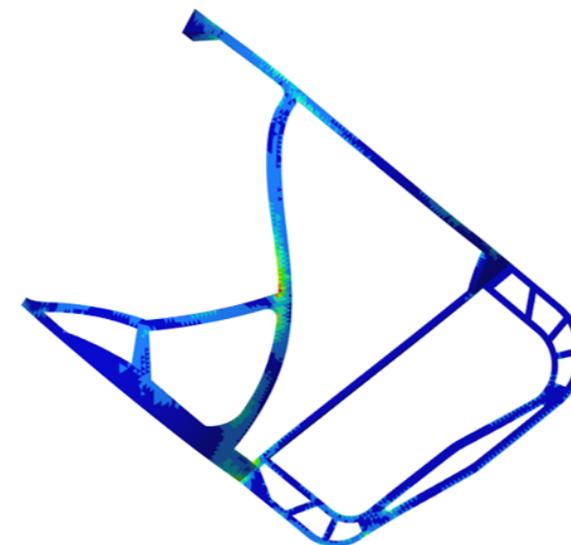
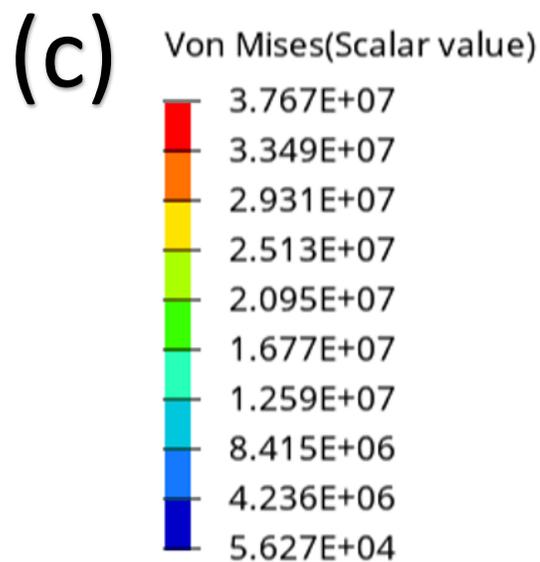
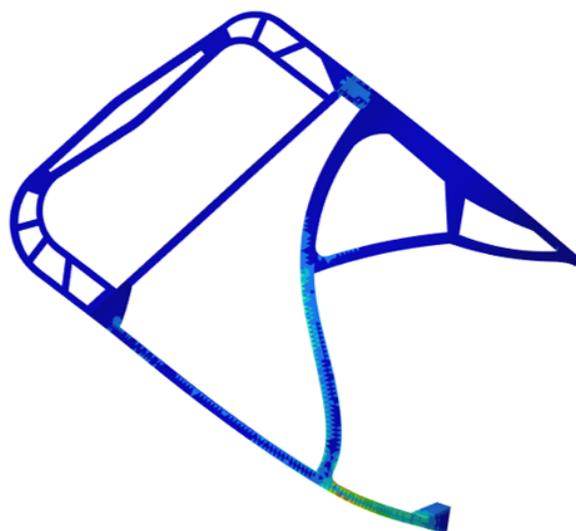
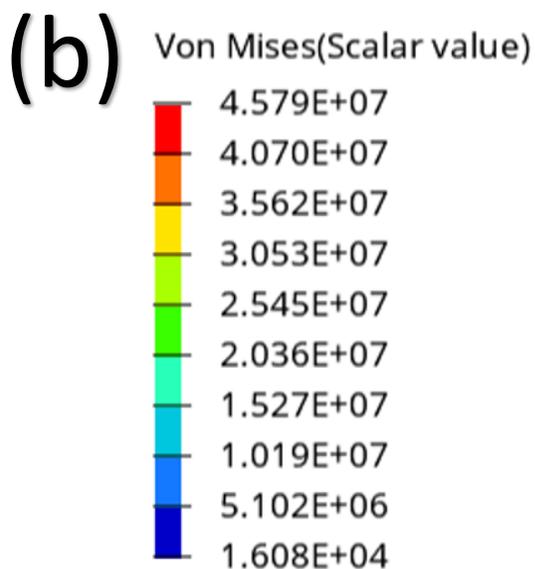
개선모델 낙하시험



	최대 응력 (Mpa)	안전 계수
(a)	35.86	1.52
(b)	53.41	1.02
(c)	47.61	1.14

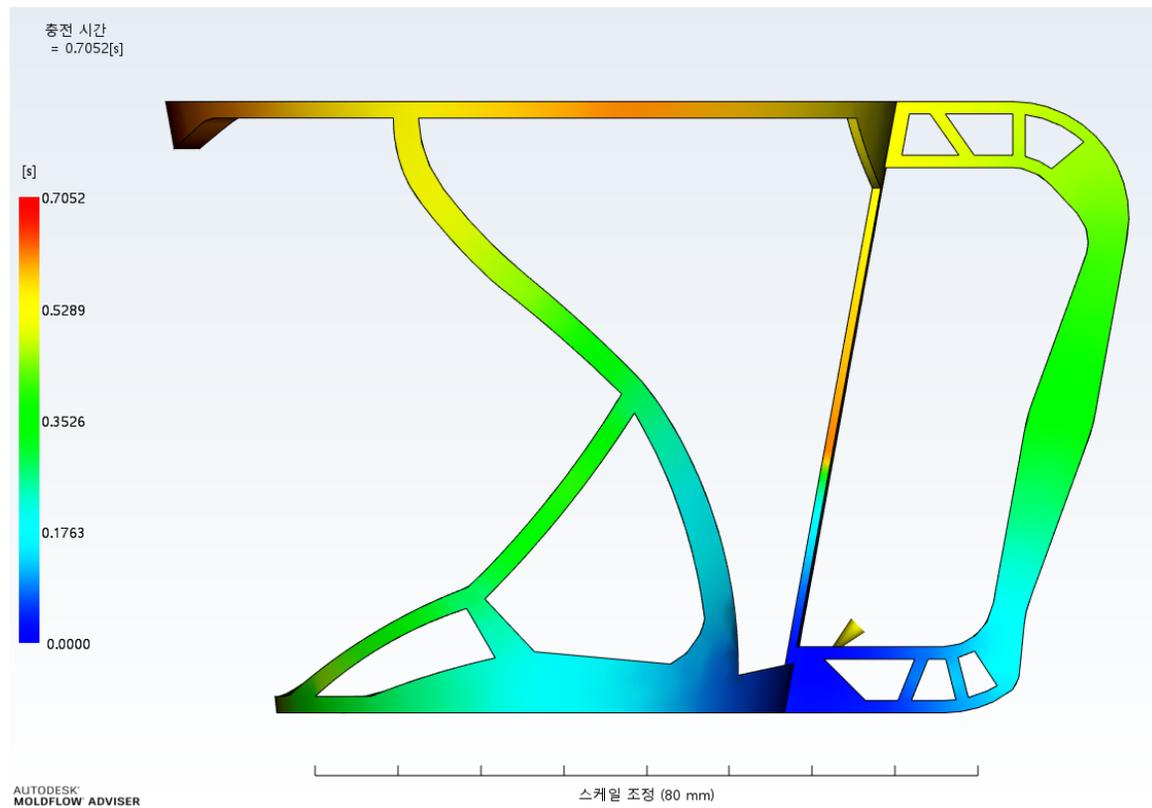
	최대 응력 (Mpa)	안전 계수
(a)	31	1.75
(b)	45.79	1.19
(c)	37.67	1.44

↓
응력 감소





PC-ABS 플라스틱 사출성형



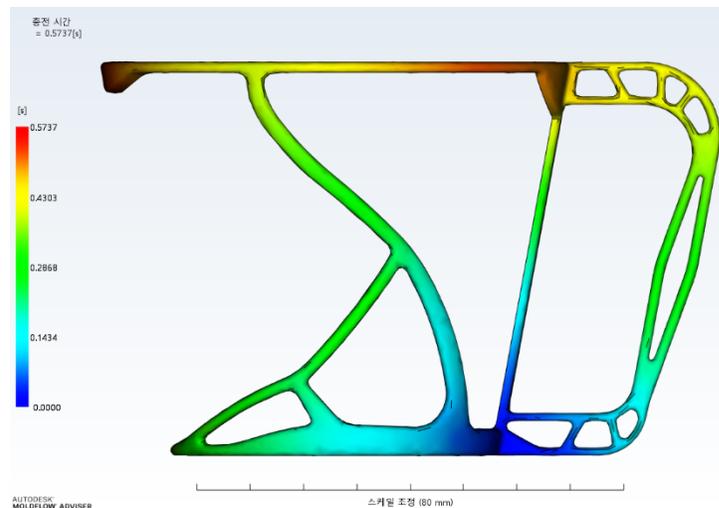
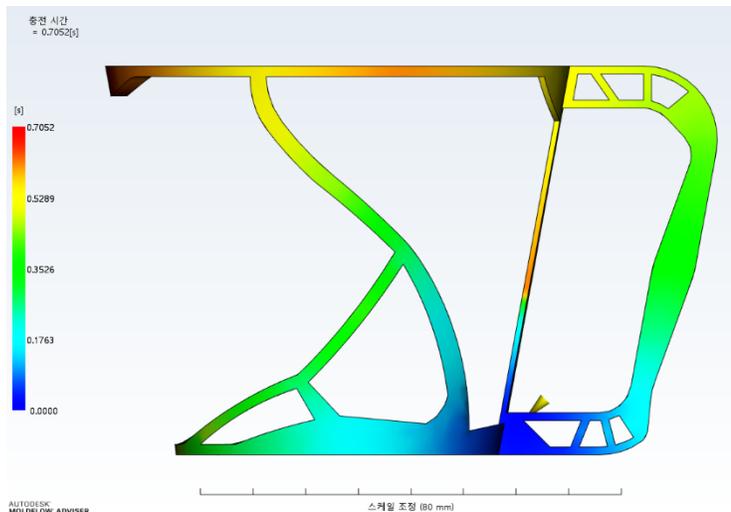
충전 시간 0.7052 초



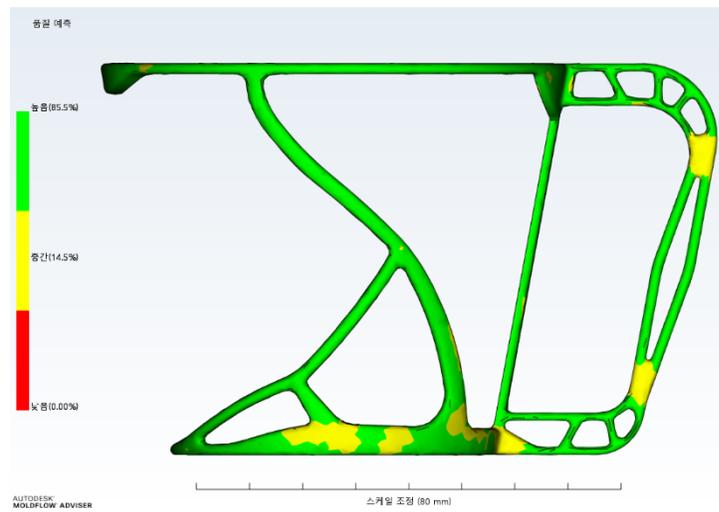
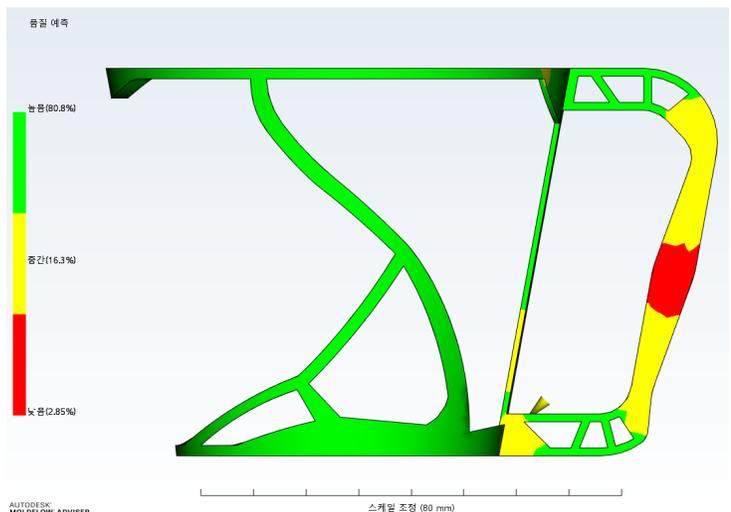
높은 품질	80.8%
중간 품질	16.3%
낮은 품질	2.85%



사출성형 품질 개선 결과



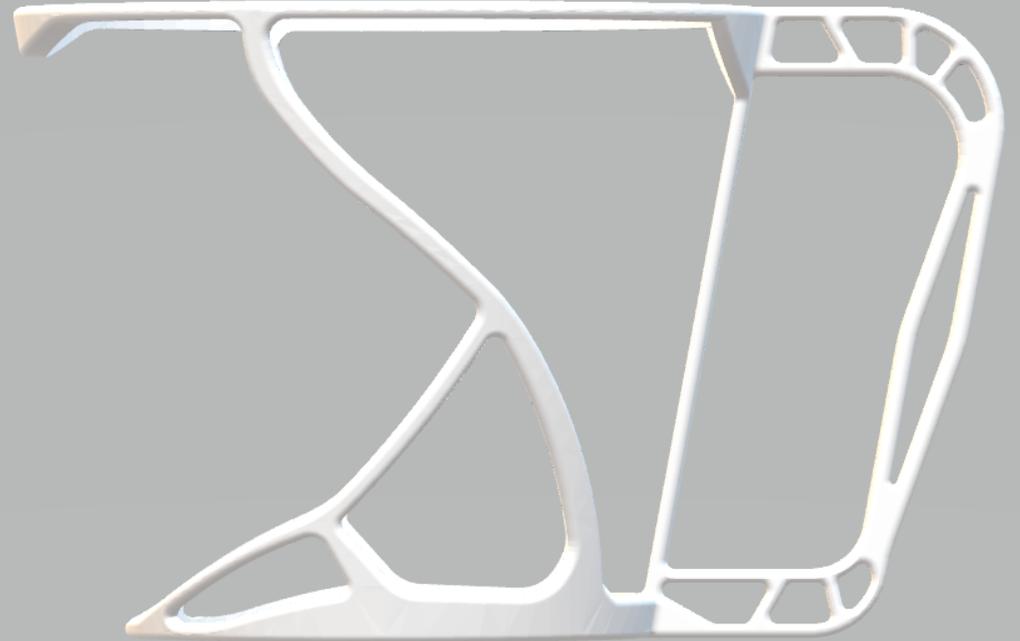
충전 시간 0.5737 초



높은 품질 85.5%
중간 품질 14.5%
낮은 품질 0%

최종 모델

- 최종 모델 검토
- 초기 모델 대비 최적화 결과

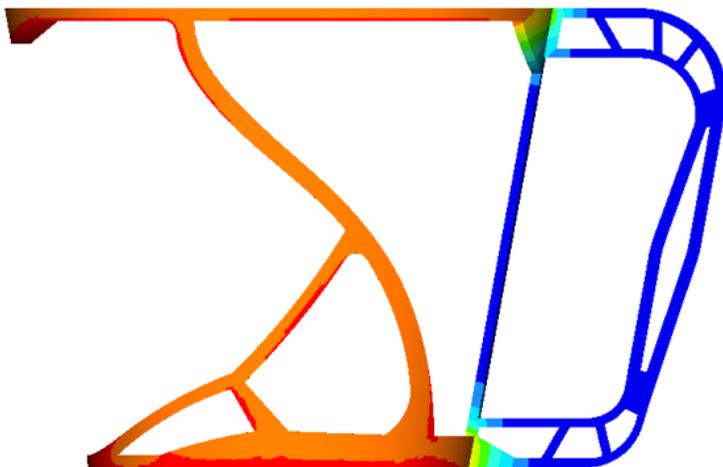
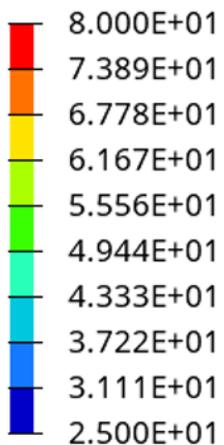




최종 모델 해석 결과

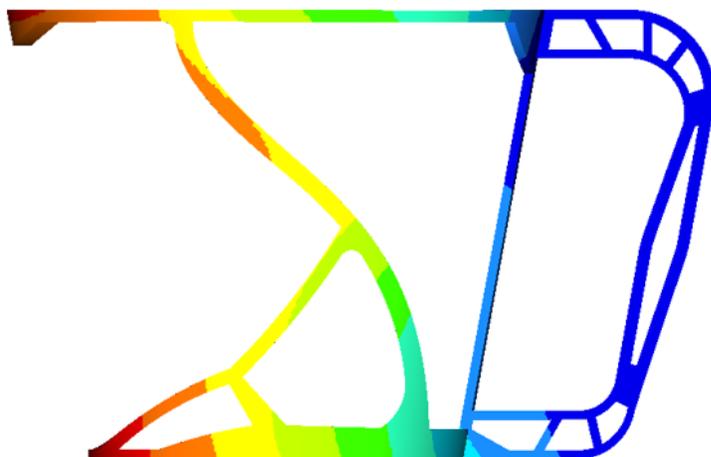
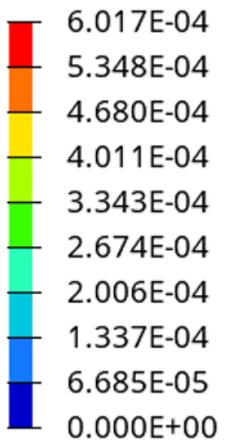


Grid Temperature

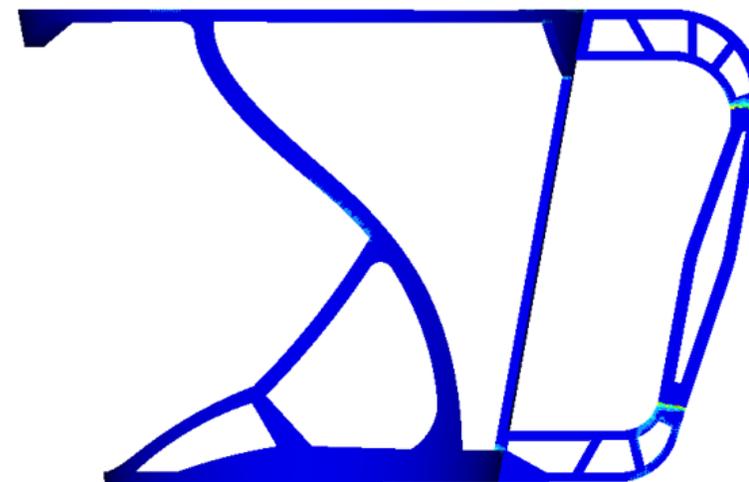
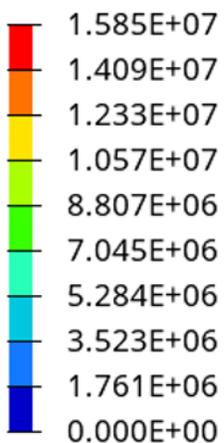


최종 모델	
질량 (g)	4.5
최대 응력 (Mpa)	15.85
안전 계수	3.43
최대 변위 (mm)	0.6
손잡이 온도 (°C)	25-31

Displacement(Mag)
Global System



Element Stress
Global System

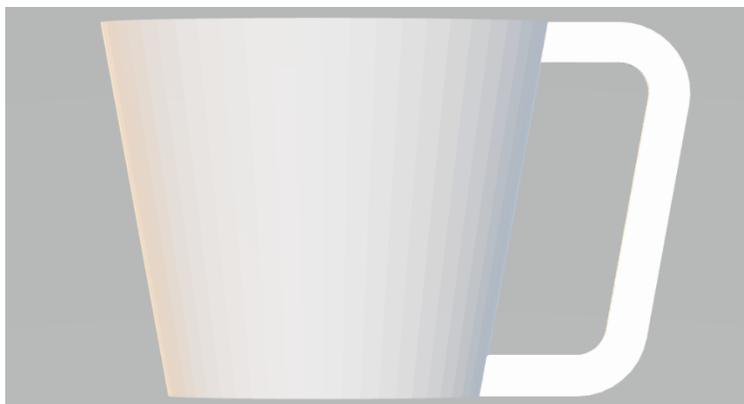




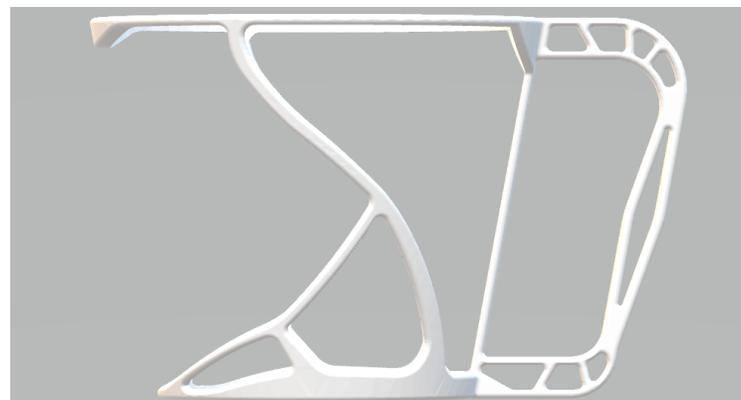
최적화 결과

① 안전 계수 3.43 ② 최대 변위 0.6mm ③ 손잡이 온도 25-31 °C

78.6% 질량 감소



초기 모델	
질량 (g)	21
최대 응력 (Mpa)	9.2
안전 계수	5.9
최대 변위 (mm)	0.54
손잡이 온도 (°C)	26-38



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최대 변위 (mm)	0.6
손잡이 온도 (°C)	25-31



사용 결과 적당한 그립감

AOC 2019
Team Friends
Thank You

