

Rocker panel optimization for crash worthiness

2021160801

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Motivation

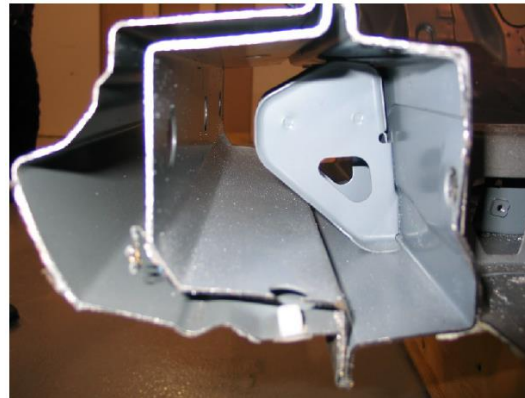


Rocker

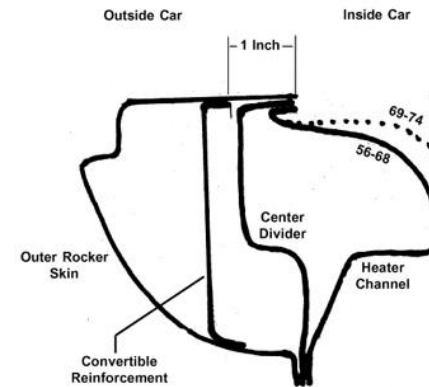
Rocker panel cross section



Hyundai XG350



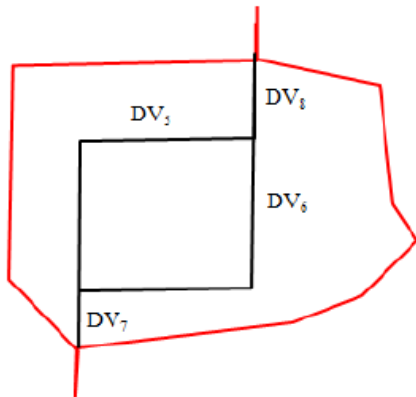
Toyota Camry



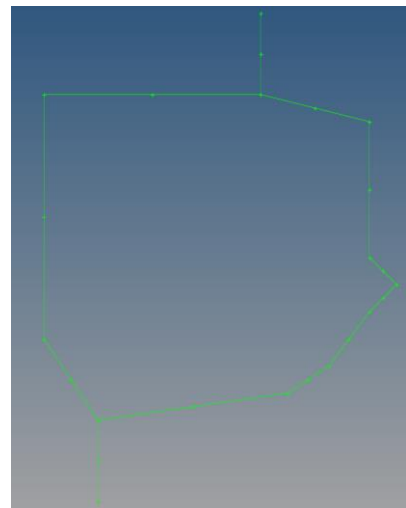
Volkswagen Karmann

The shape of the rocker panel is different for each company

Modeling and Topology optimization



reference model

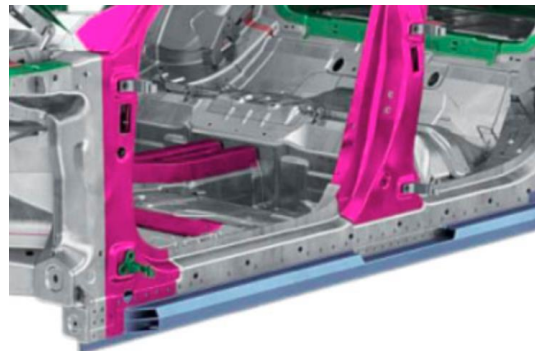


base line

측면충돌 시험방법

- 1) 60km/h±1km/h의 속도로 중량이 1,400kg±20kg인 측면충돌 이동벽을 그 진행방향과 자동차의 길이방향 중심선이 90도가 되도록 자동차의 운전자측 옆면에 충돌중심선에 차량 길이방향과 차량 수직방향으로 ±25mm 안으로 일치되도록 충돌시킨다. 측면충돌 충격흡수용 변형구조물은 붙임-2

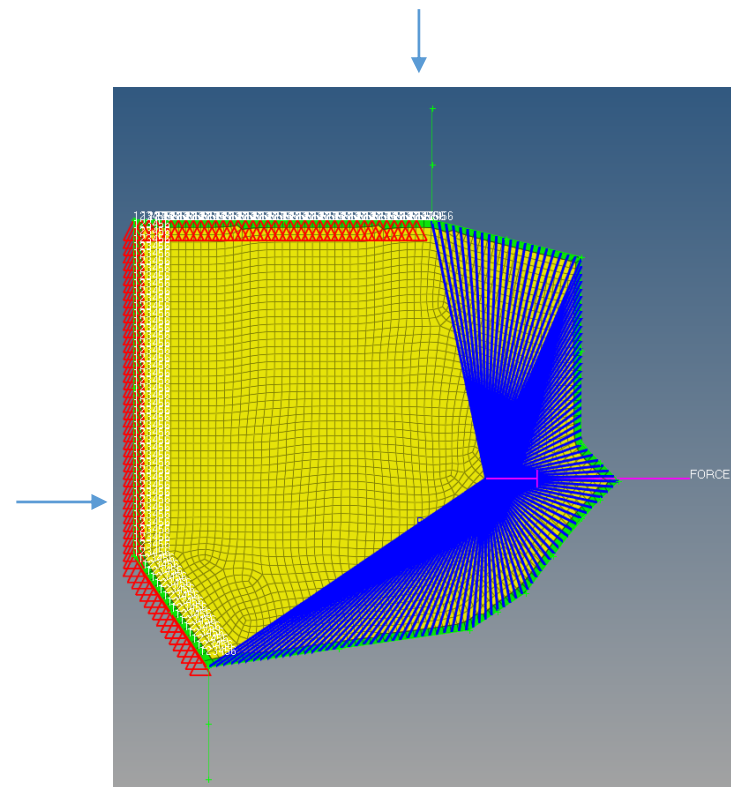
*국토교통부 '측면충돌 안정성 시험방법 및 평가방법'



Boundary condition

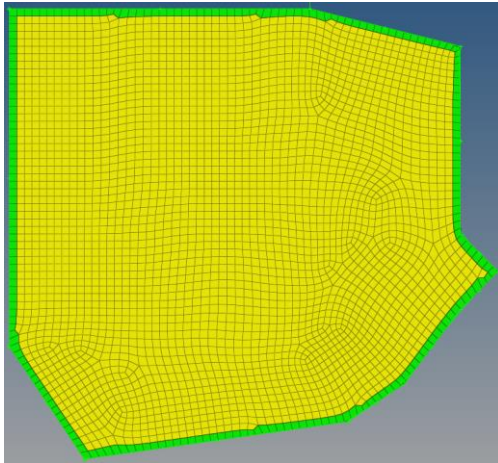
Loading condition

$$F = \frac{\Delta(mv)}{\Delta t} = \frac{(1400\text{kg})(16.67\text{m/s})}{0.1\text{s}} = 233380\text{N} = 233.38\text{kN}$$



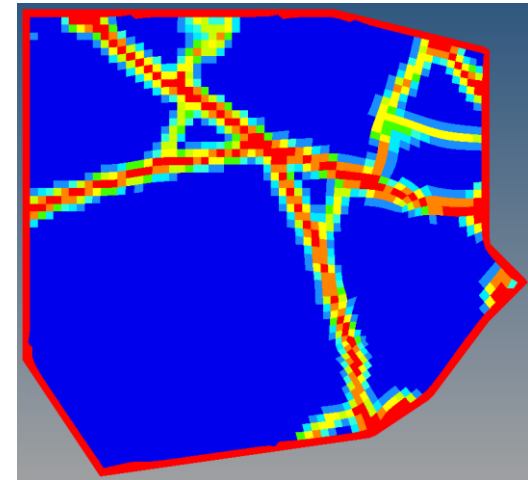
- yellow elements : design area
- green elements : non-design area
- blue line : RBE3 (to give distribution load)

Topology optimization

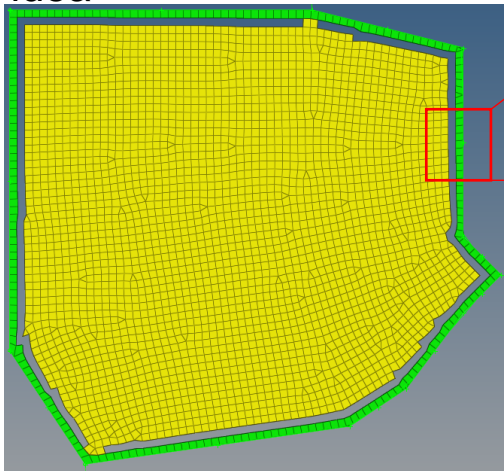


yellow elements : design area
green elements : non-design area

object function : compliance (minimize)
constraint : volume fraction (0.15)

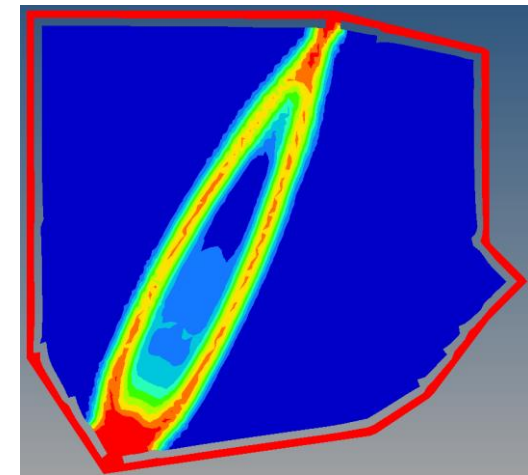


idea



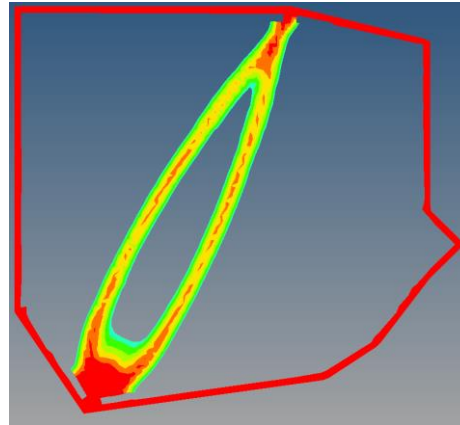
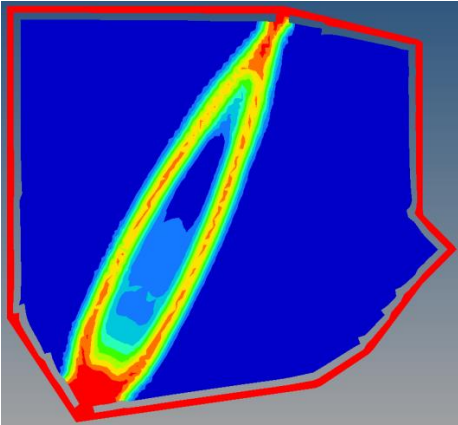
yellow elements : design area
green elements : non-design area

object function : compliance (minimize)
constraint : volume fraction (0.15)
: symmetry constraint



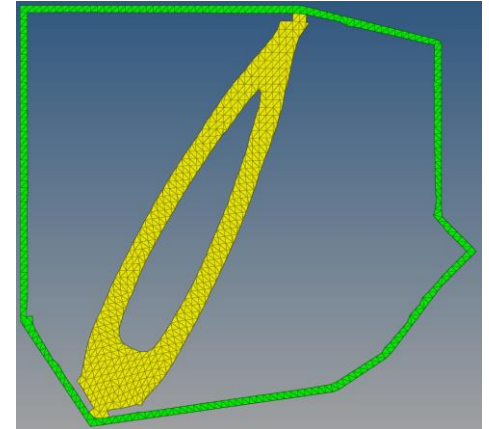
Shape optimization

Topology optimization results

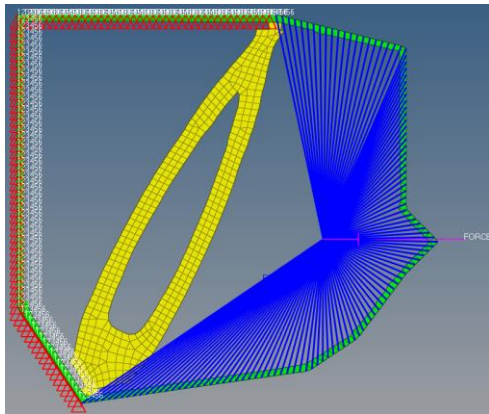


Iso current value 0.38

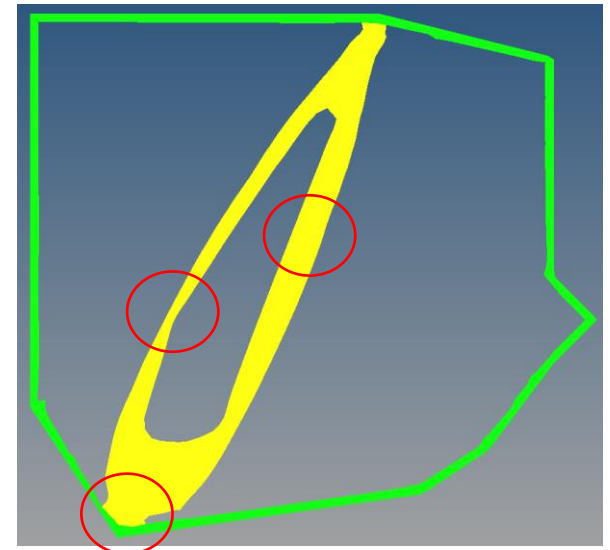
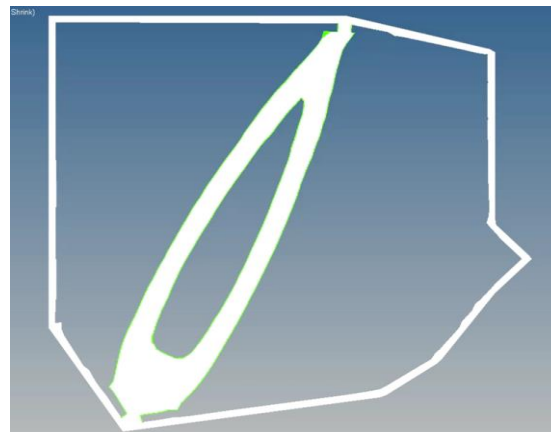
imported results



Shape optimization results



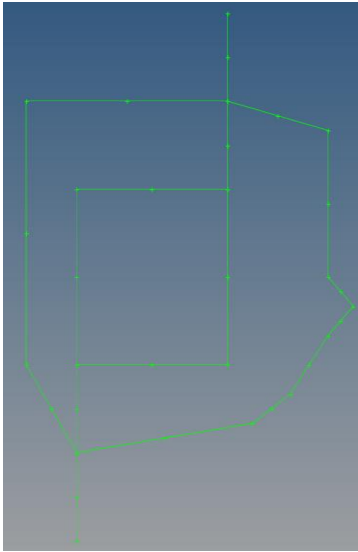
object function : stress (minmax)



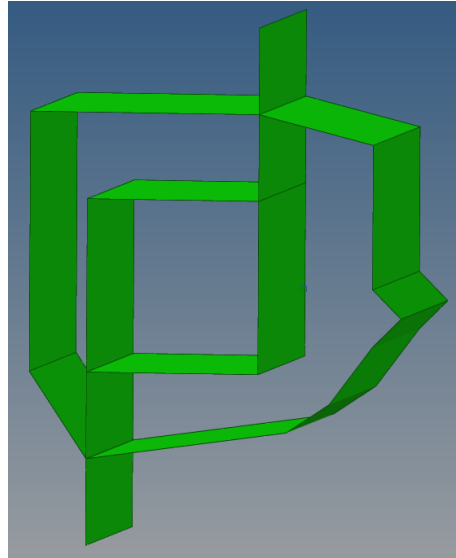


Dynamic analysis

Hypermesh modeling

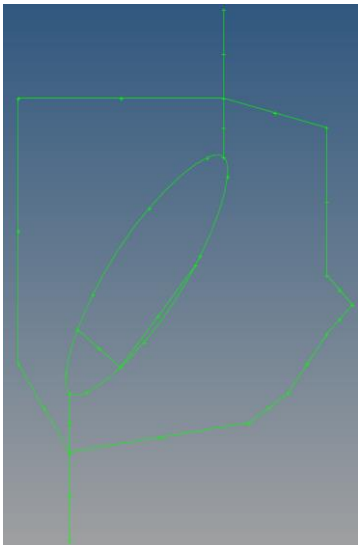
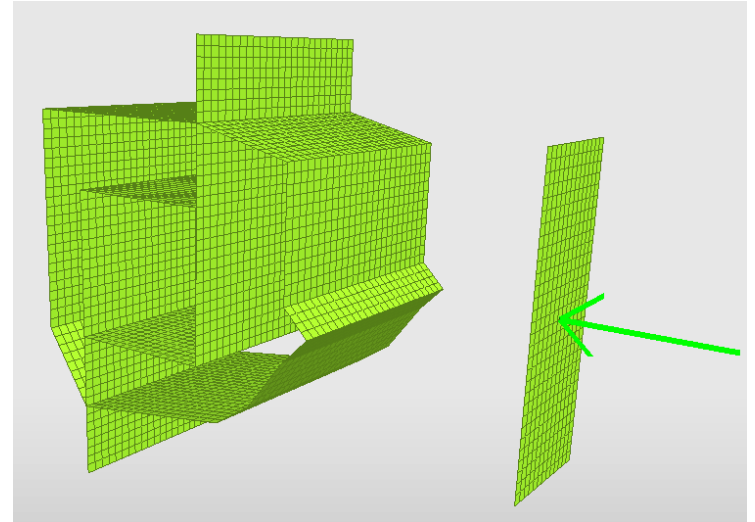


length : 300

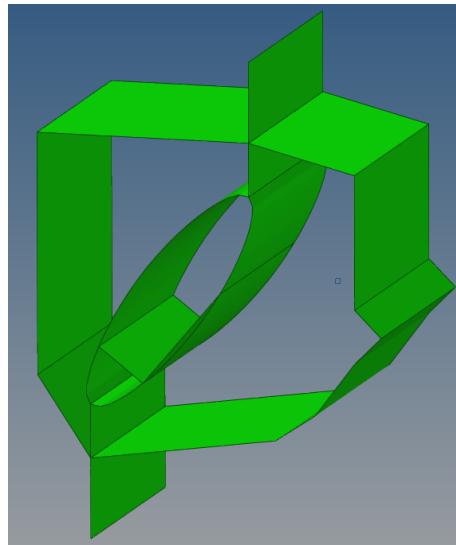


Reference model

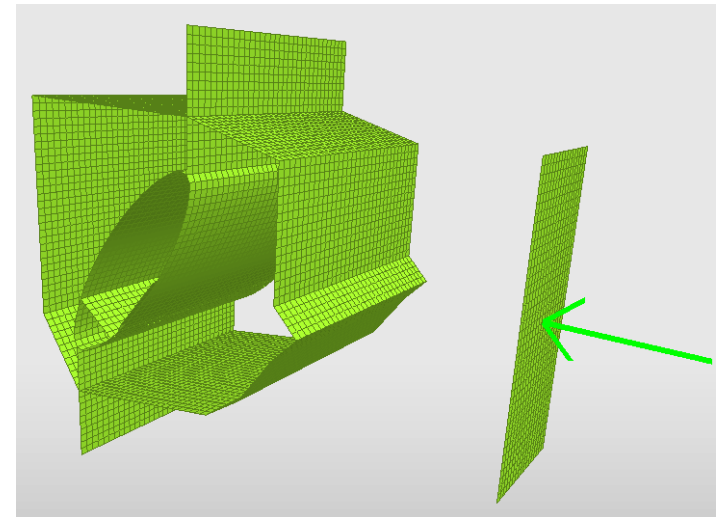
Hypercrash



length : 300

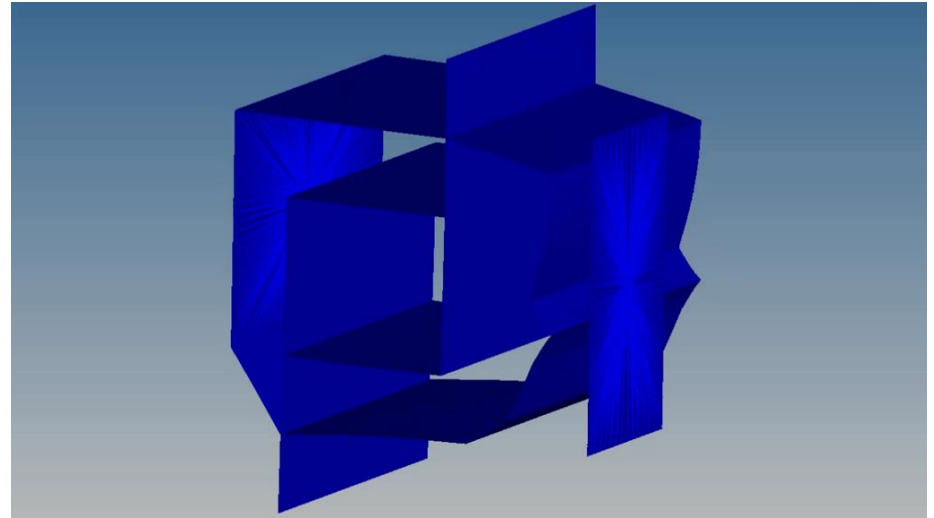
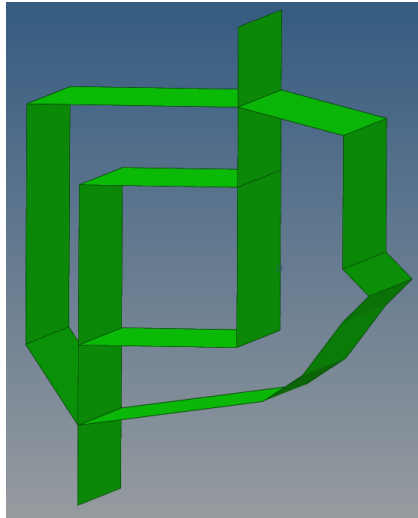


Proposed model

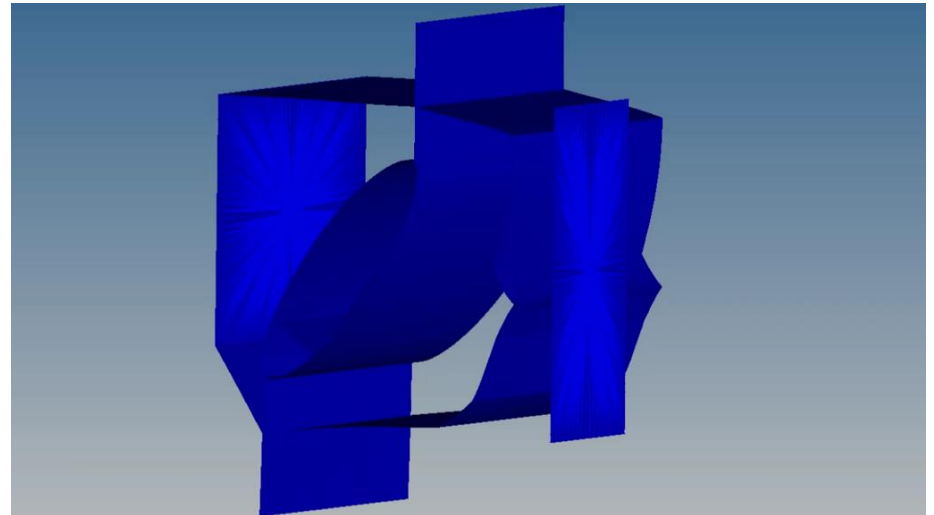
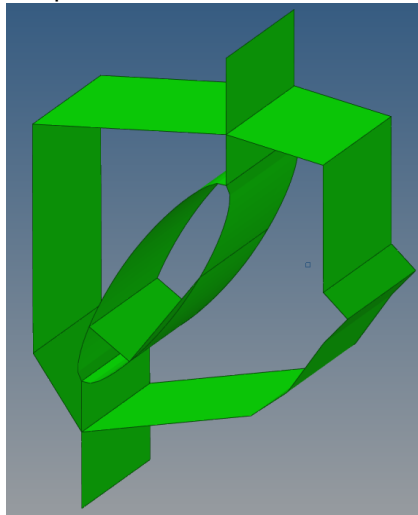


Radios Side Crash Simulation

Reference model



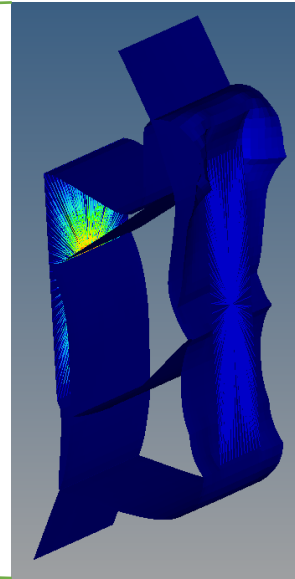
Proposed model



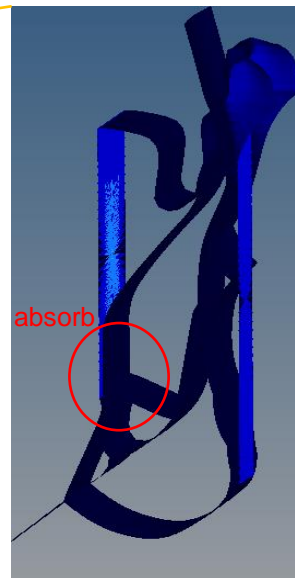
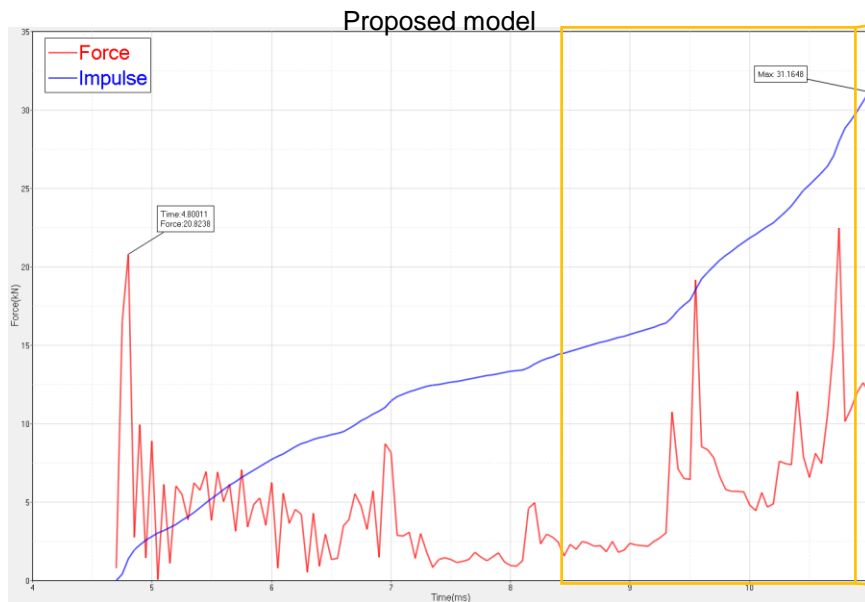
Alloy Steel properties

Properties	Units
Density	7850 Kg/m ³
Melting point	1427°C
Tensile strength	745 MPa
Yield strength	470 MPa
Bulk modulus	140 GPa
Shear modulus	80 GPa
Elastic modulus	190-210GPa

Side Crash Simulation Results



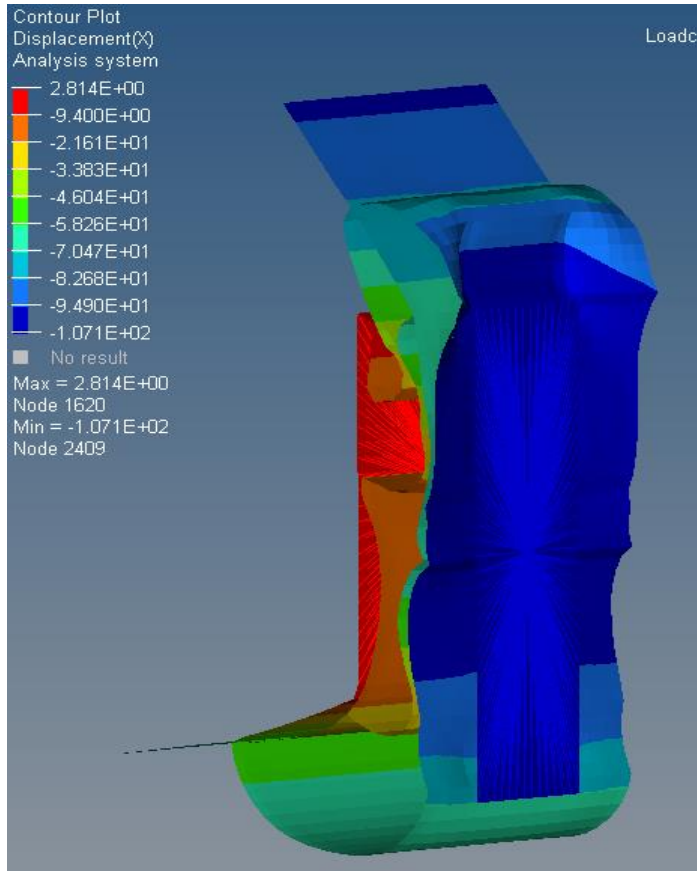
Maximum impulse : 33.5388kN·ms



Maximum impulse : 31.1648kN·ms
(-7%)

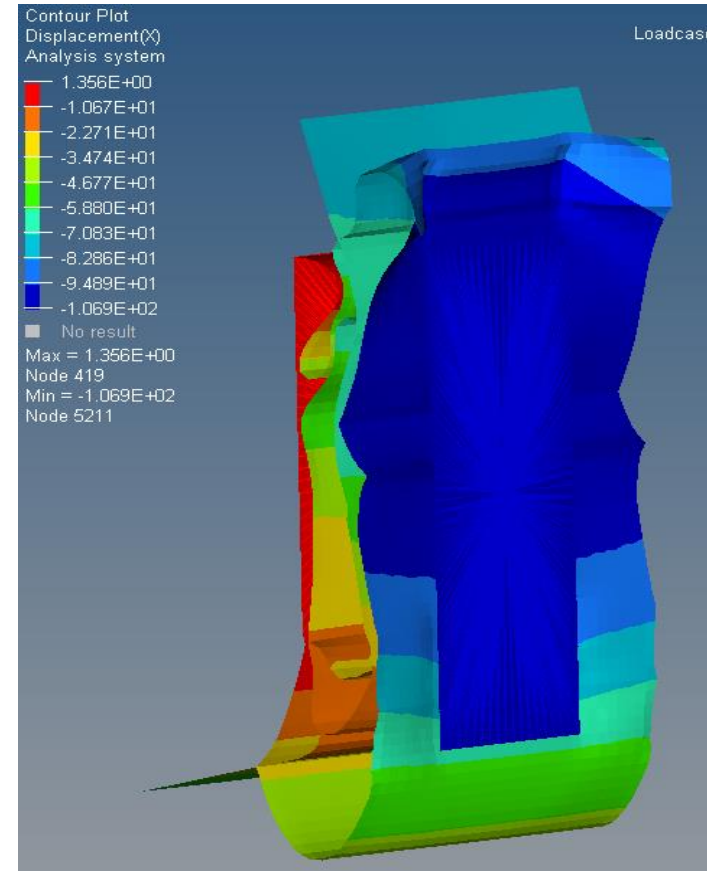
Side Crash Simulation Results

Reference model



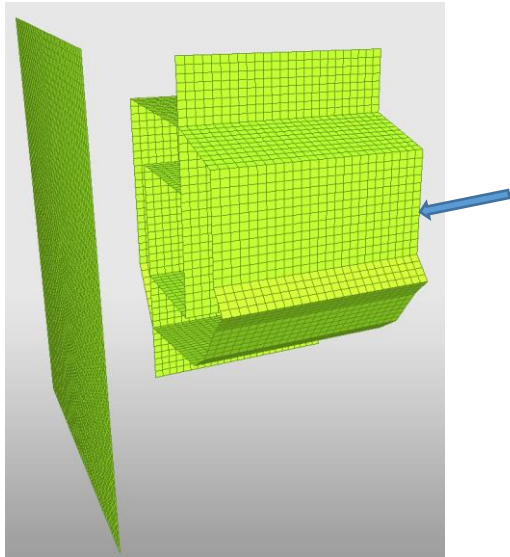
Maximum displacement : 107.1mm

Proposed model

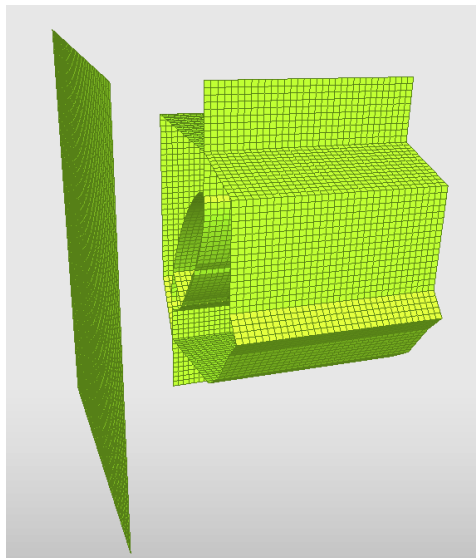
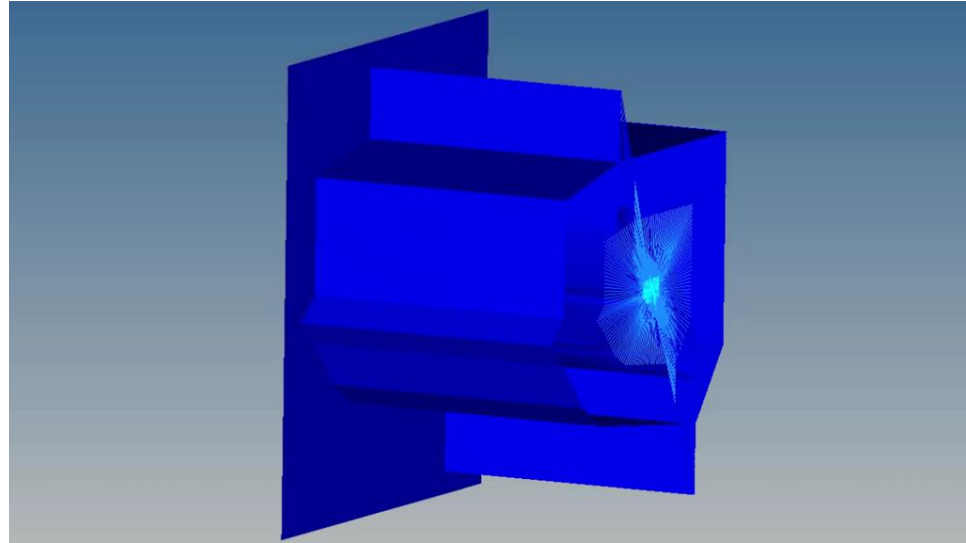


Maximum displacement : 106.9mm
(0.18%)

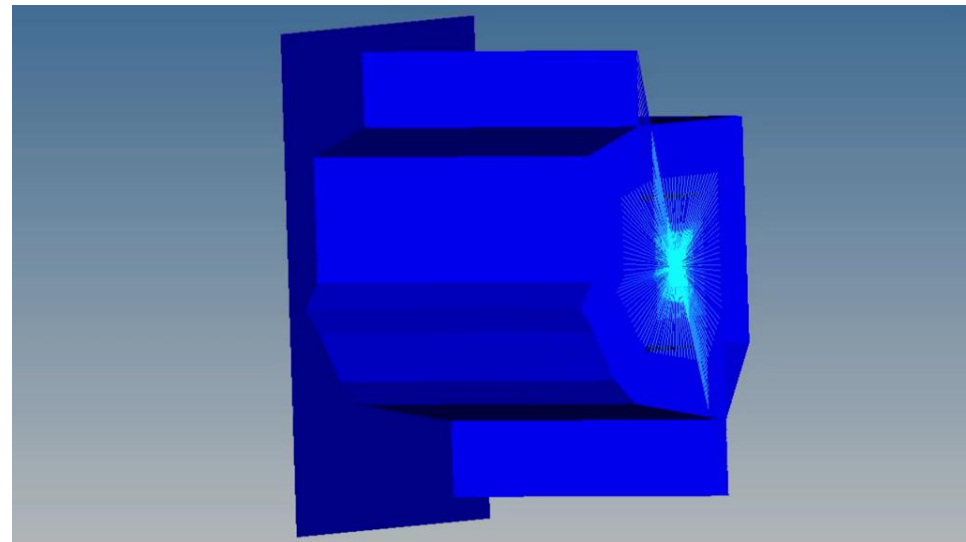
Front Crash Simulation



Reference model

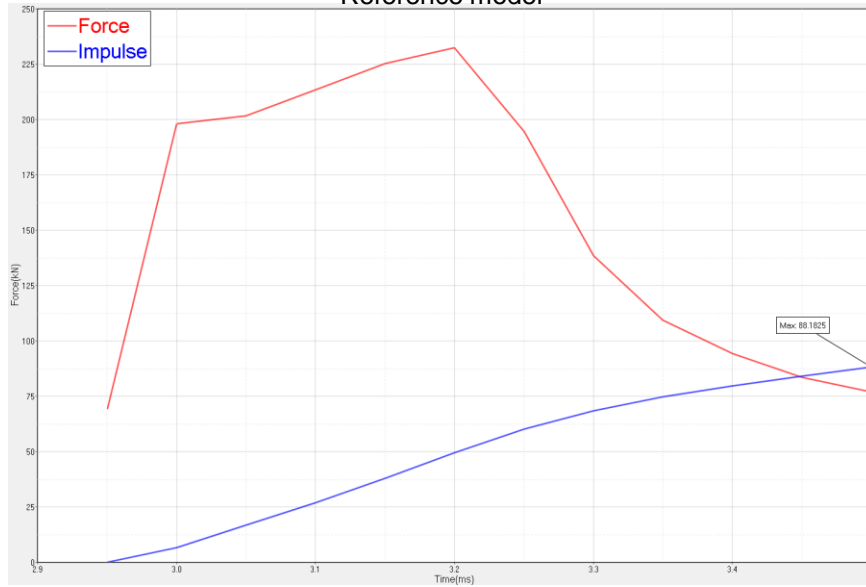


Proposed model



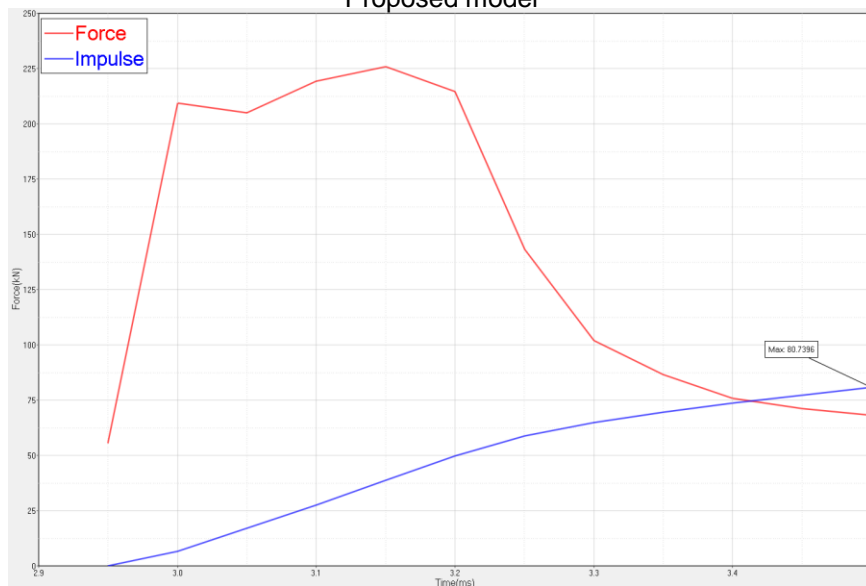
Front Crash Simulation Results

Reference model



Maximum impulse : 88.1825kN·ms

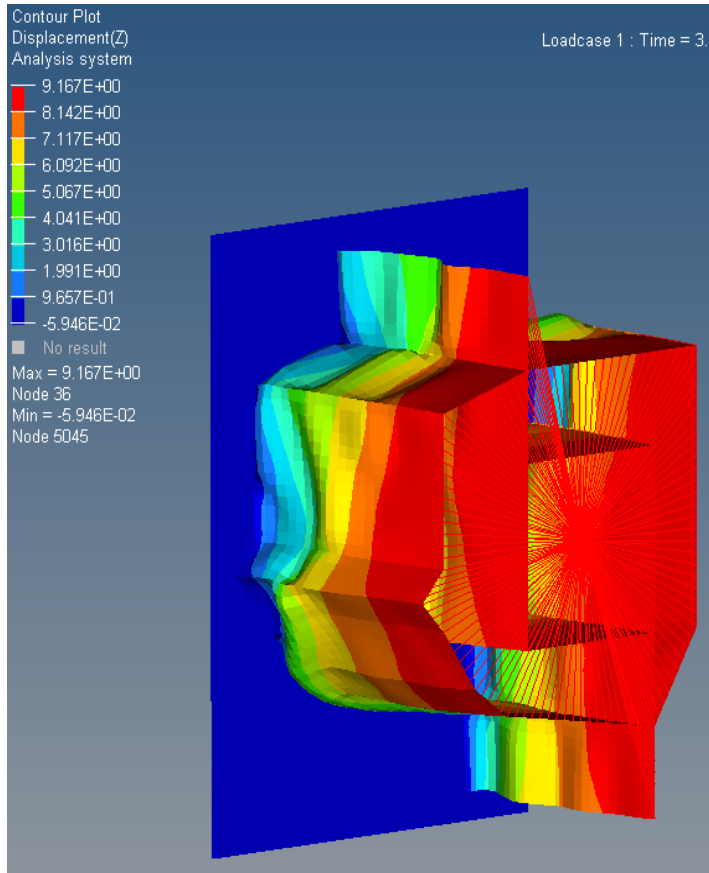
Proposed model



Maximum impulse : 80.7396kN·ms
(-8.4%)

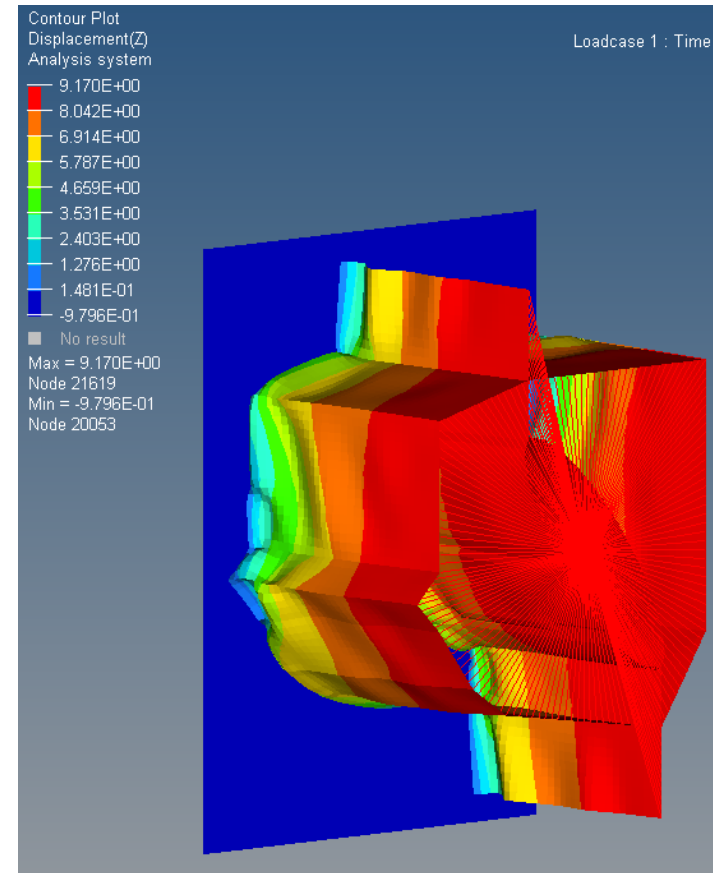
Front Crash Simulation Results

Reference model



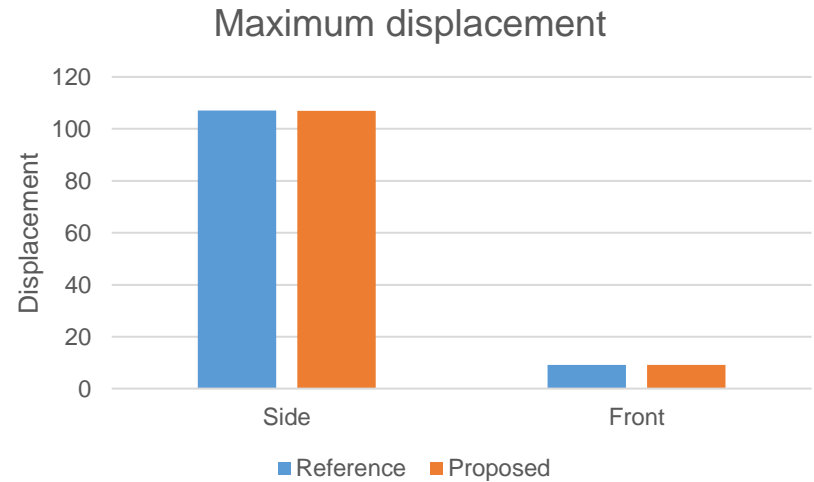
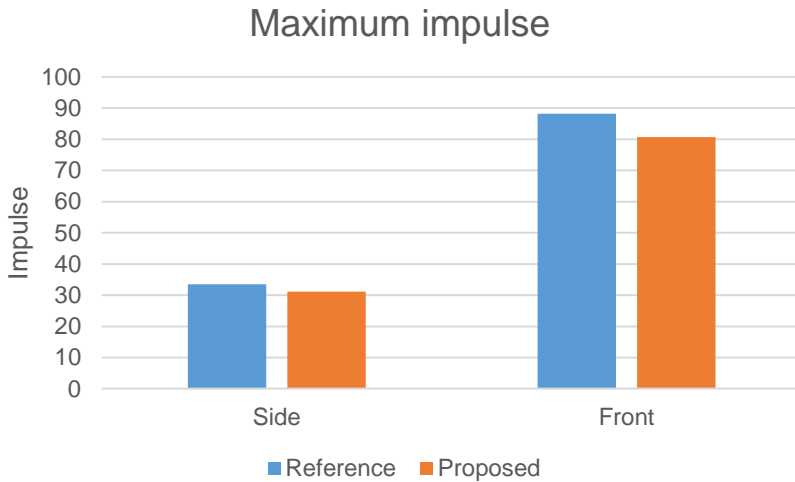
Maximum displacement : 9.167mm

Proposed model



Maximum displacement : 9.170mm
(0.03%)

Conclusions



Impulse (kN·ms)	Side Crash	Front Crash
Reference model	33.5388	88.1825
Proposed model	31.1648	80.7396
Rate	-7%	-8.4%

Displacement (mm)	Side Crash	Front Crash
Reference model	107.1	9.167
Proposed model	106.9	9.170
Rate	-0.18%	0.03%

Proposed model이 Reference model에 비해 동일한 조건에서 더 적은 충격량을 보였다. 변위는 측면충돌인 경우에는 reference model보다 더 적게 나왔지만, 정면충돌인 경우에는 크게 나왔다. 하지만 simulation model의 길이가 짧아 0.2%이내의 차이를 보였다.

Thank you

