

CAE PROJECT

Hydraulic Brake System Modeling & Analysis

MEMBERS

최성원 이병훈 장준

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1. Motivation

자동차사고 종결안내

2018. 6. 12. 19:02

최성원님귀하

저희 롯데손해보험을 이용하여 주셔서 감사드리며, 이번 사고에 대한 보상처리 결과를 아래와 같이 안내하오니 참고하시기 바랍니다.

[사고사항]

◎ 접수번호 : 20180312720

◎ 사고일자 : 2018.03.26

[지급내역]

위자료: 원, 기타손배금: 0원,
휴업손해액: 0원, 간병비: 0원, 자녀간병비:
0원, 치료비(병원): 원, 직불치료비:
0원, 향후치료비: 원, 상실수익액:
0원, 장례비: 0원, 치료비과실상계:
■ 원, 기타: 원

[피해자]

◎합의금: 원

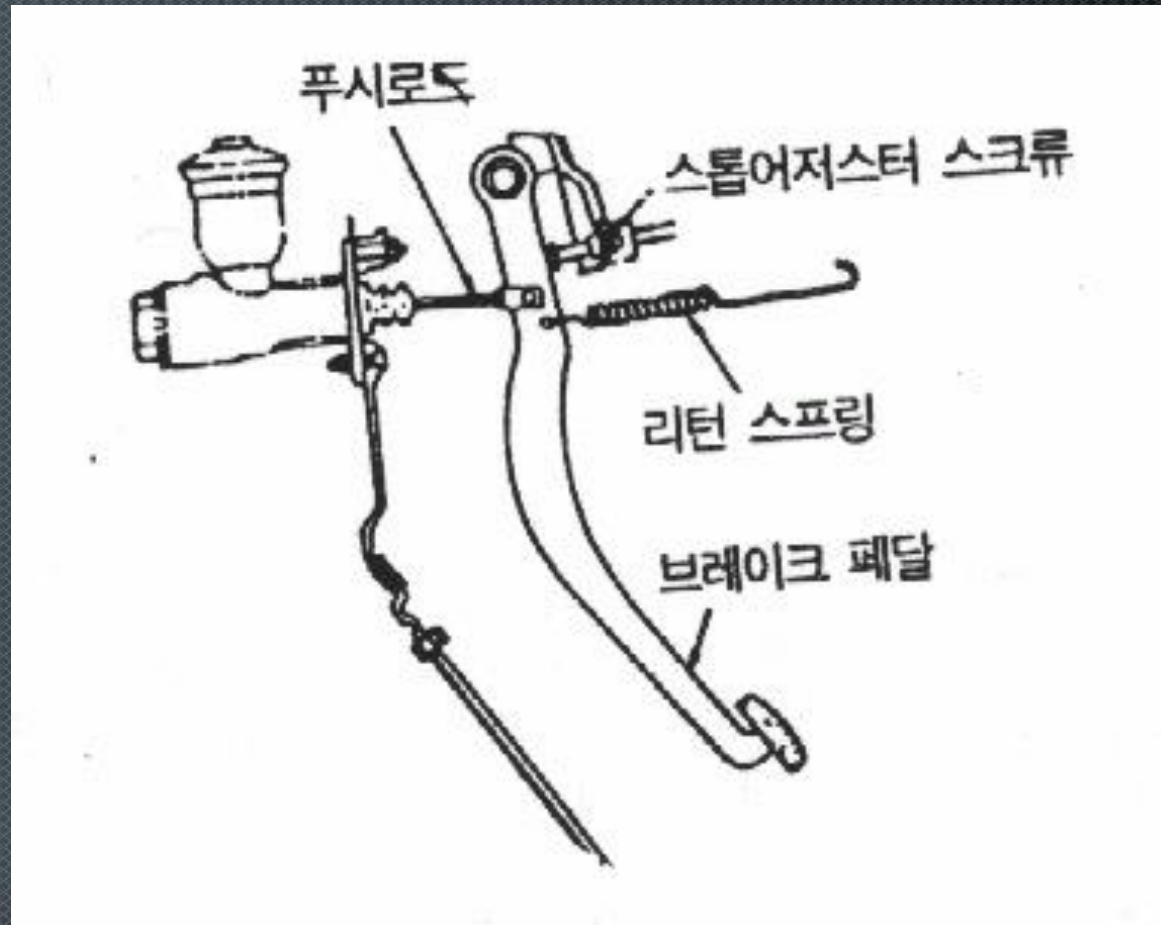
◎치료비: 원

◎소계: 원

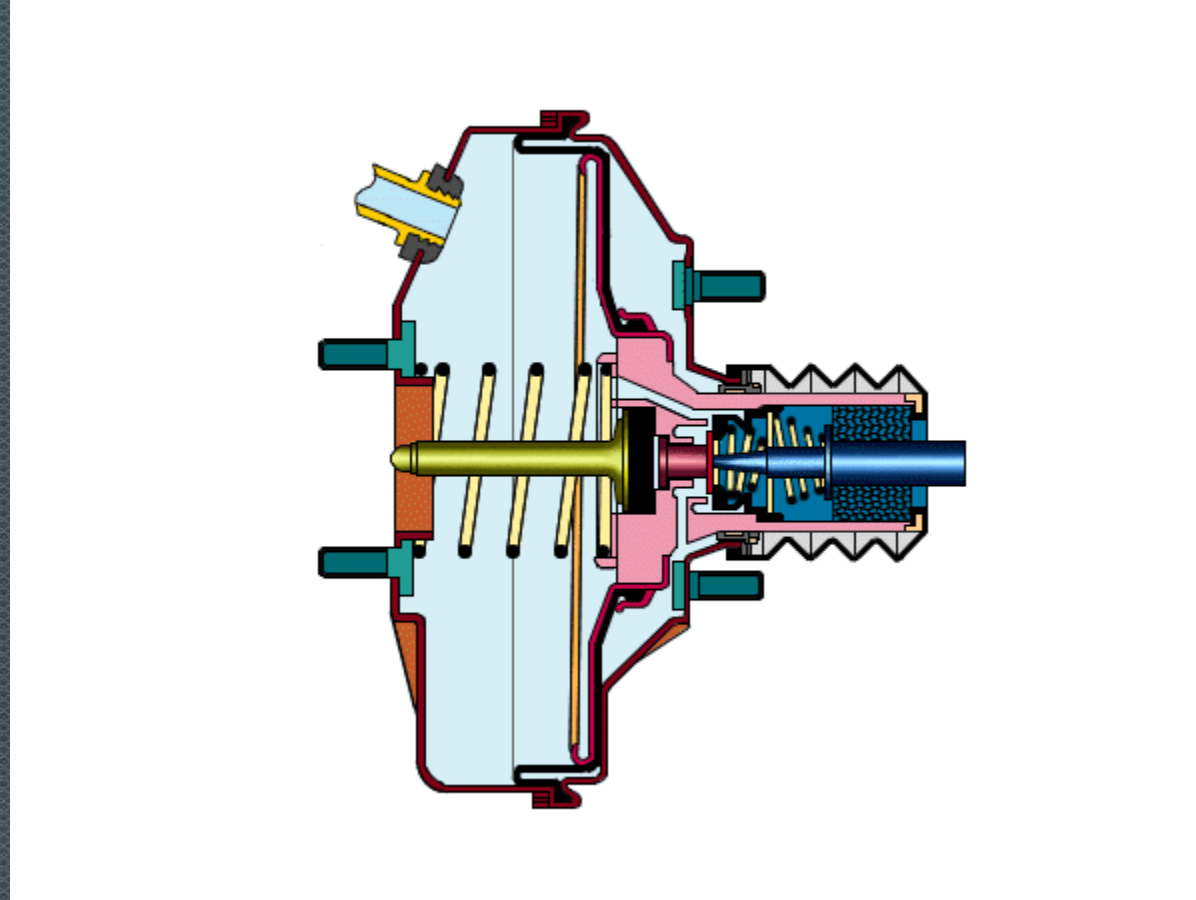
1. Motivation



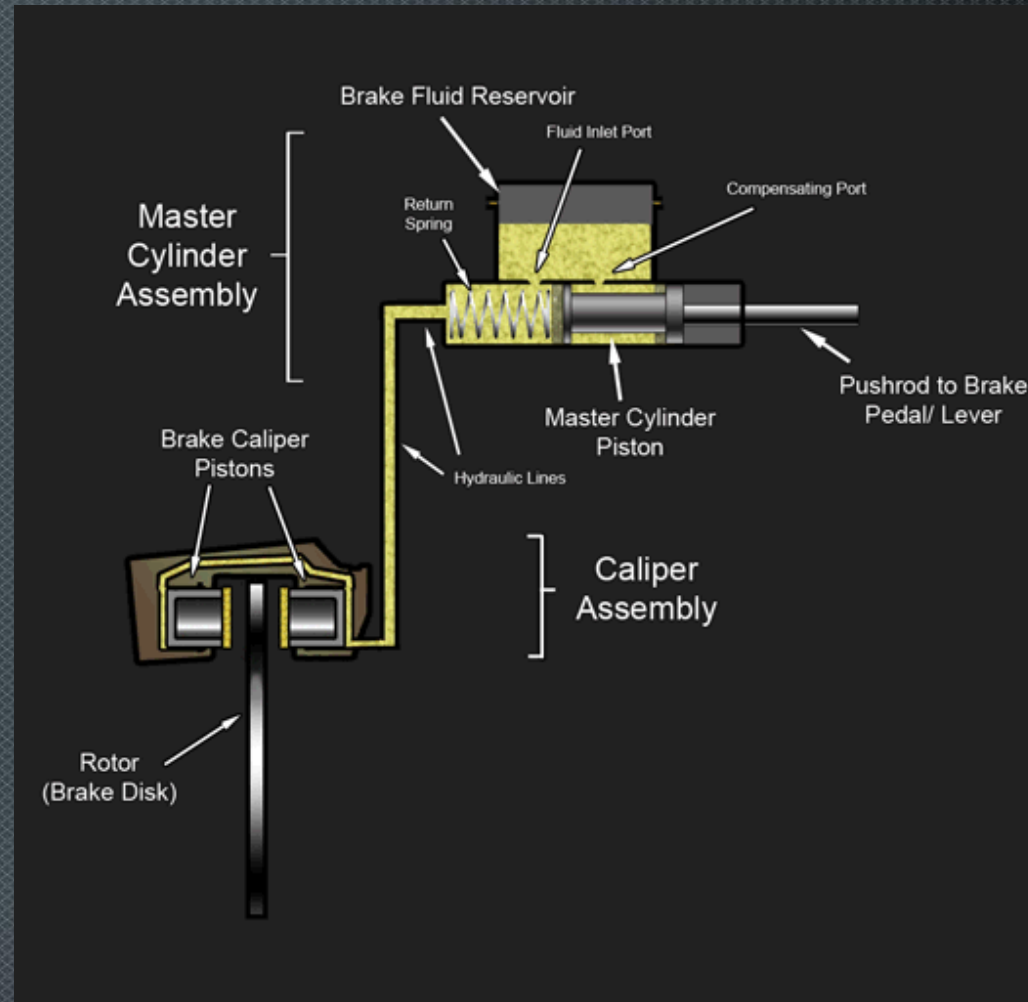
2. Hydraulic Brake Concept



2. Hydraulic Brake Concept

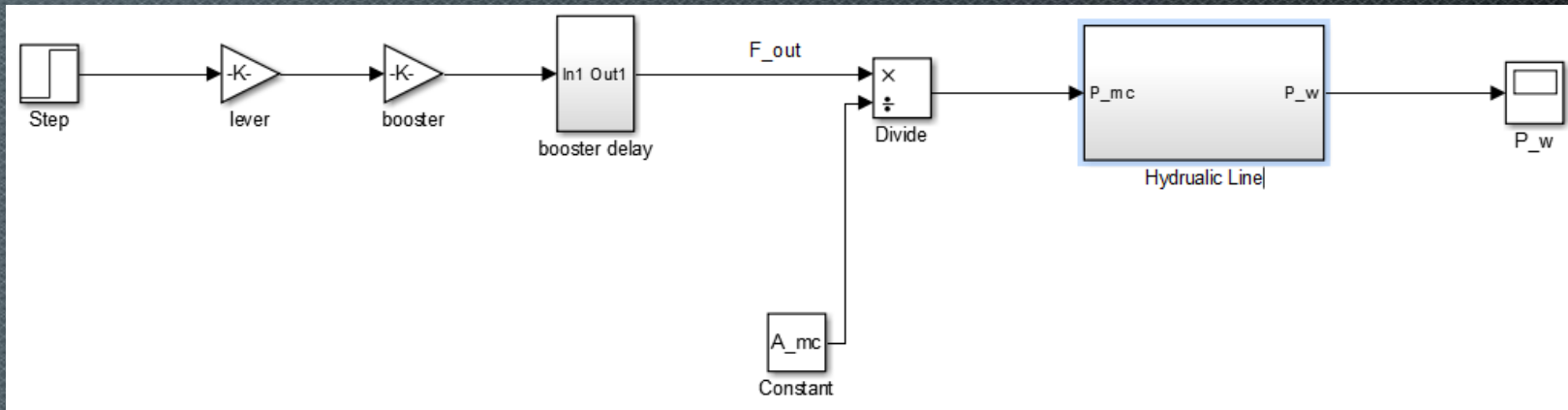


2. Hydraulic Brake Concept



3. Hydraulic Brake System Modeling & Analysis

Entire Brake System



- Input

운전자의 힘 (Step)

- Output

캘리퍼 피스톤 압력

- Parameter

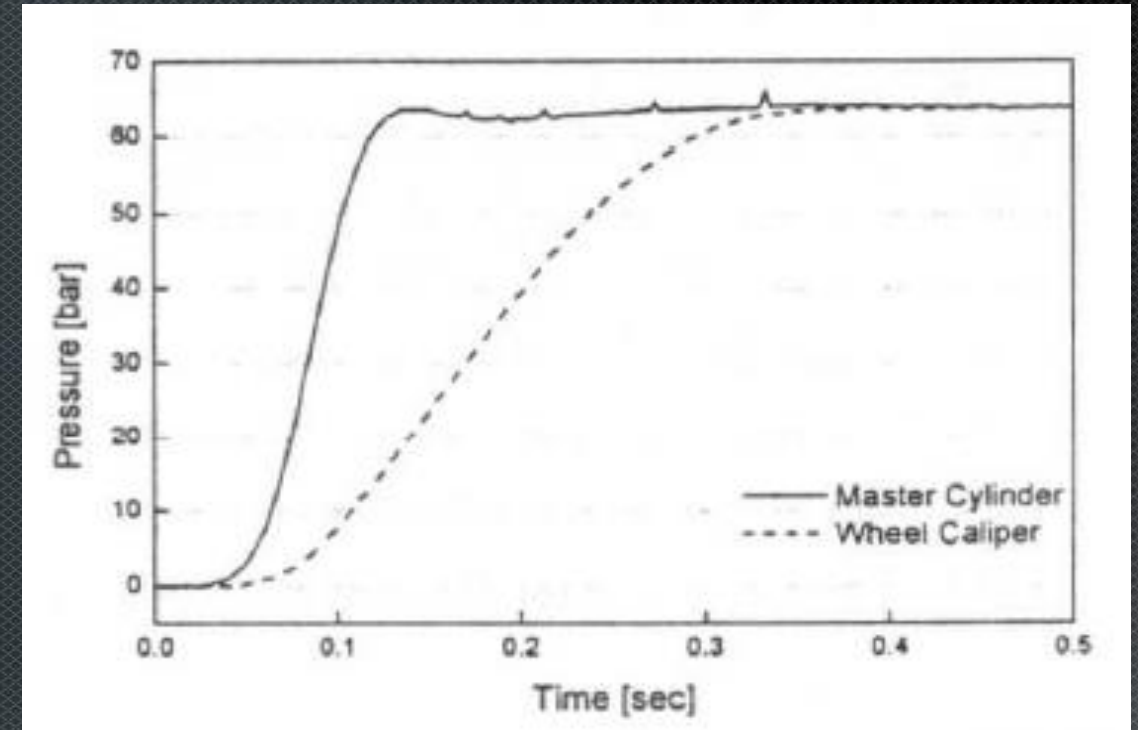
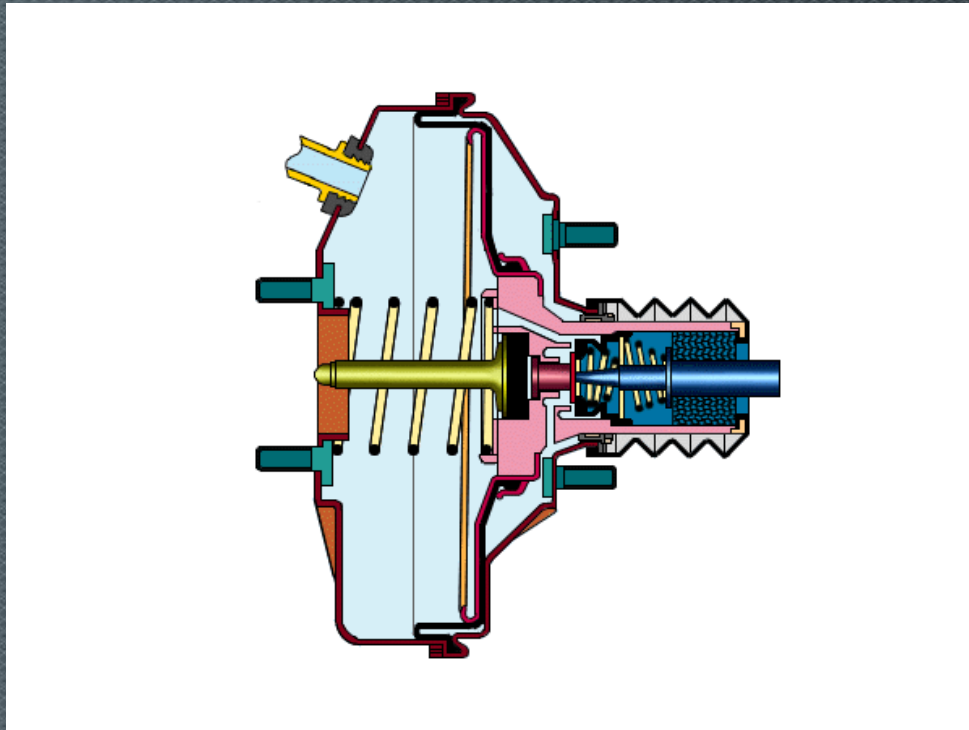
마스터 실린더 피스톤 면적 = 0.0015 m^2

Lever gain = 3

Booster gain = 8

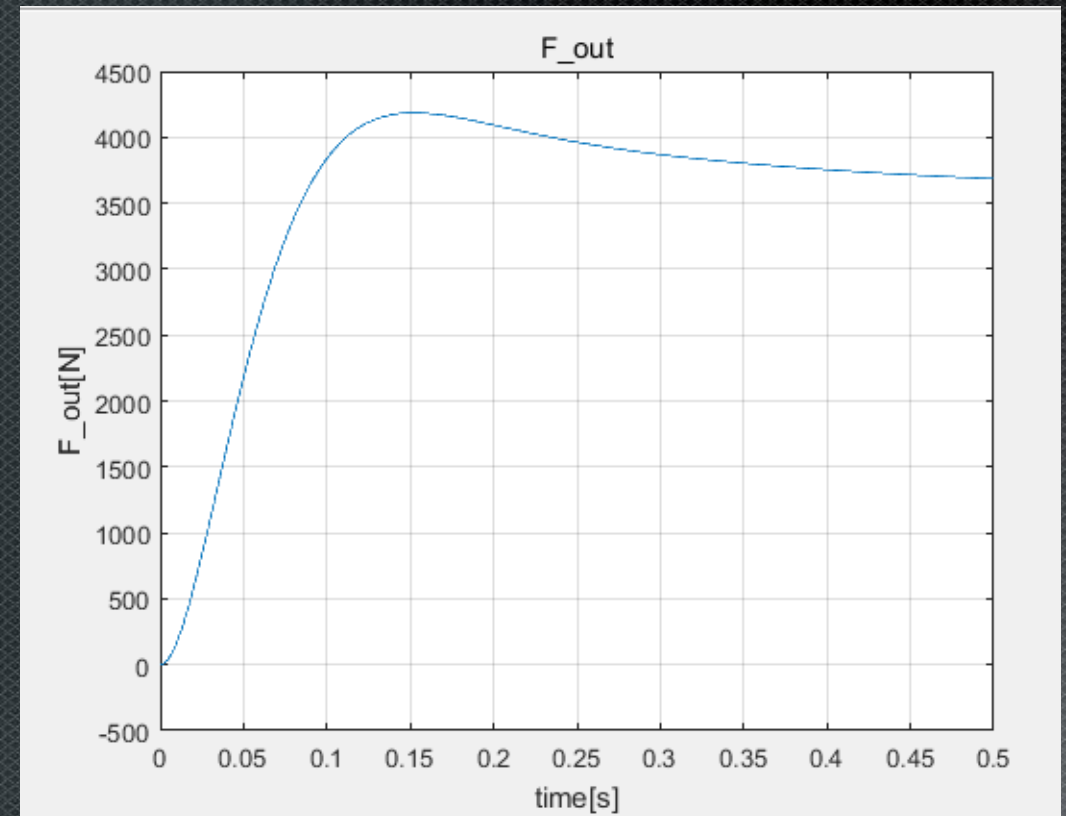
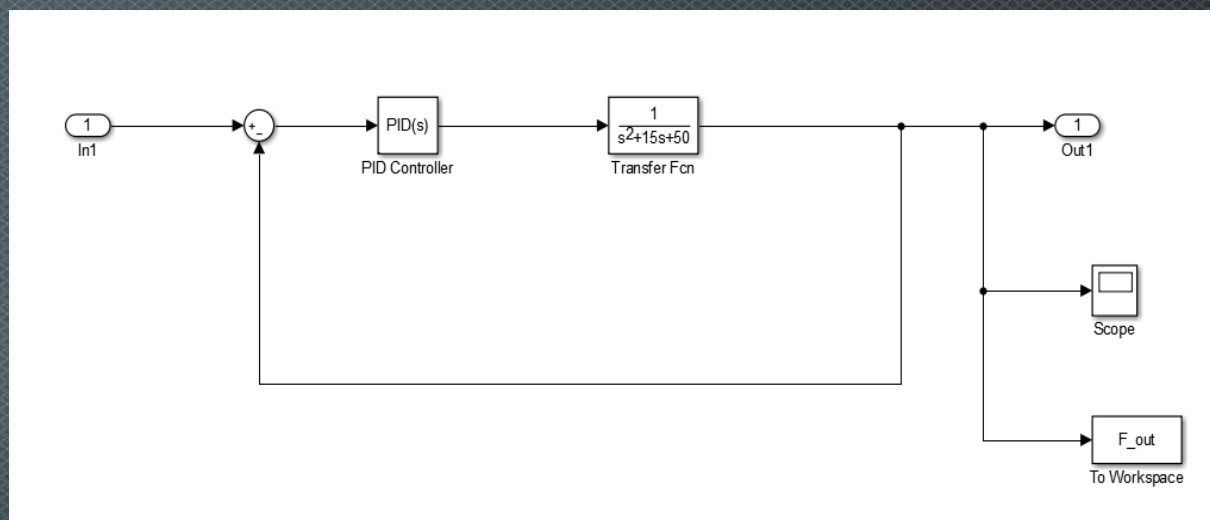
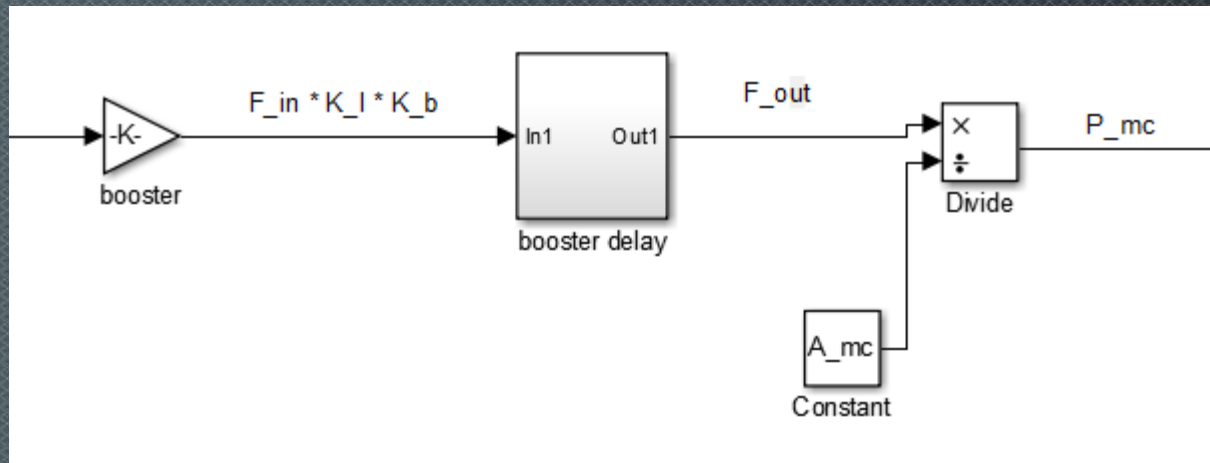
3. Hydraulic Brake System Modeling & Analysis

Vacuum Booster



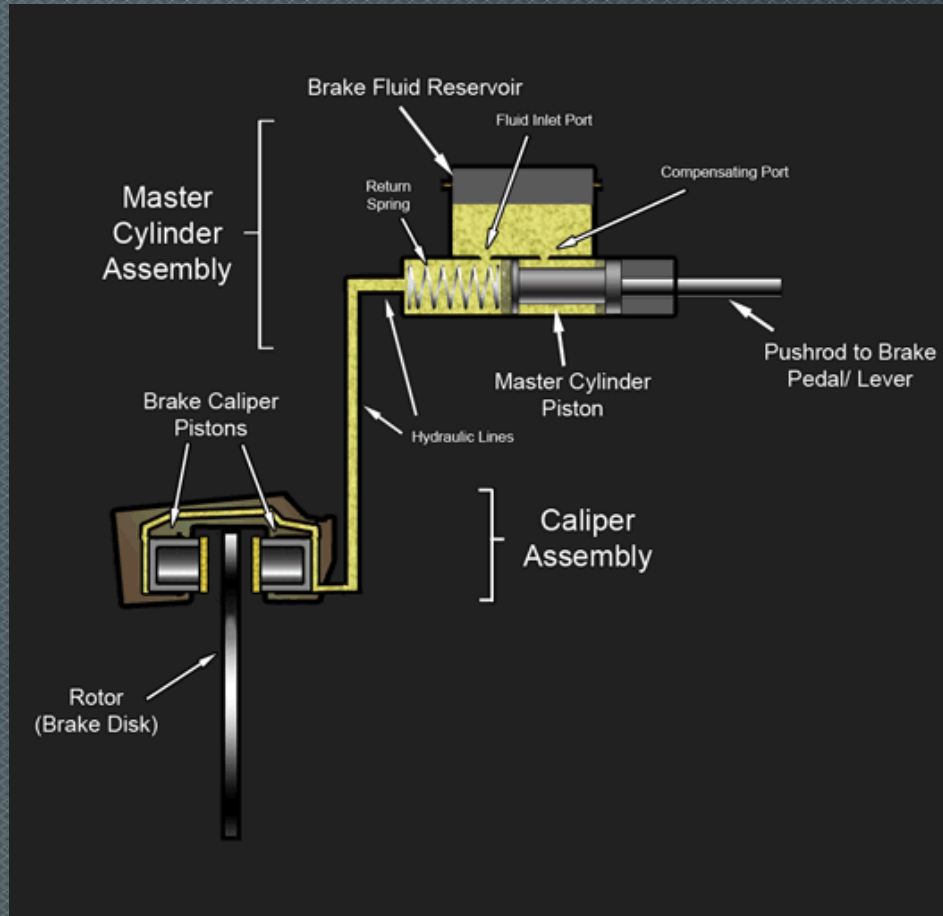
3. Hydraulic Brake System Modeling & Analysis

Vacumm Booster



3. Hydraulic Brake System Modeling & Analysis

Master cylinder



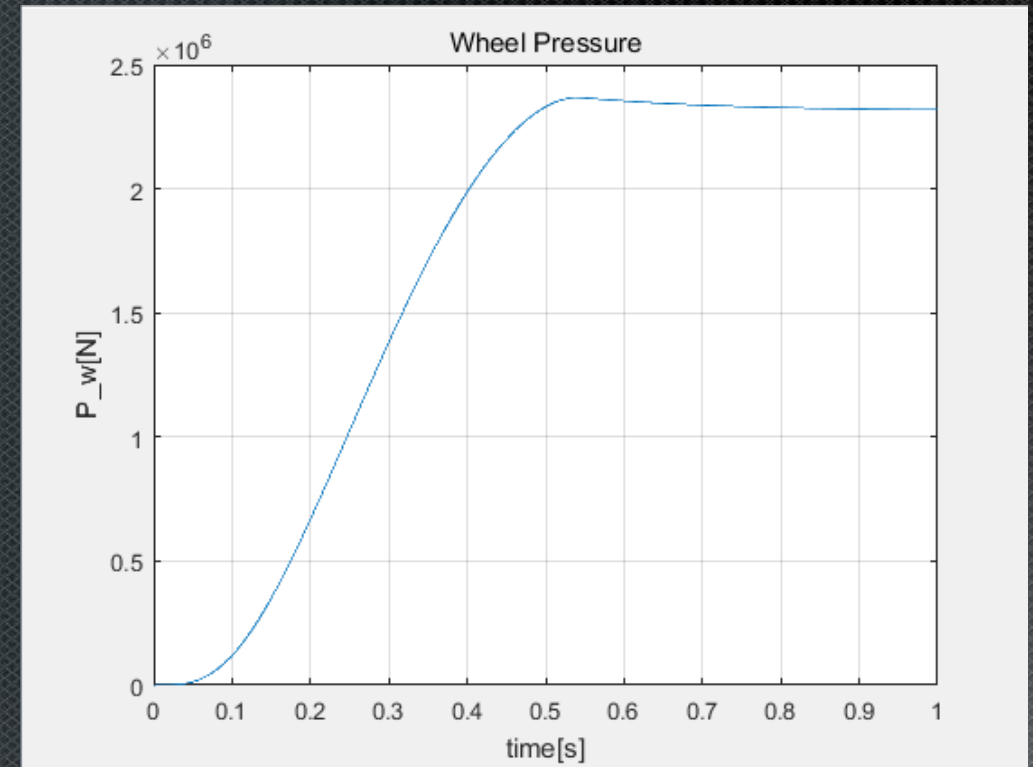
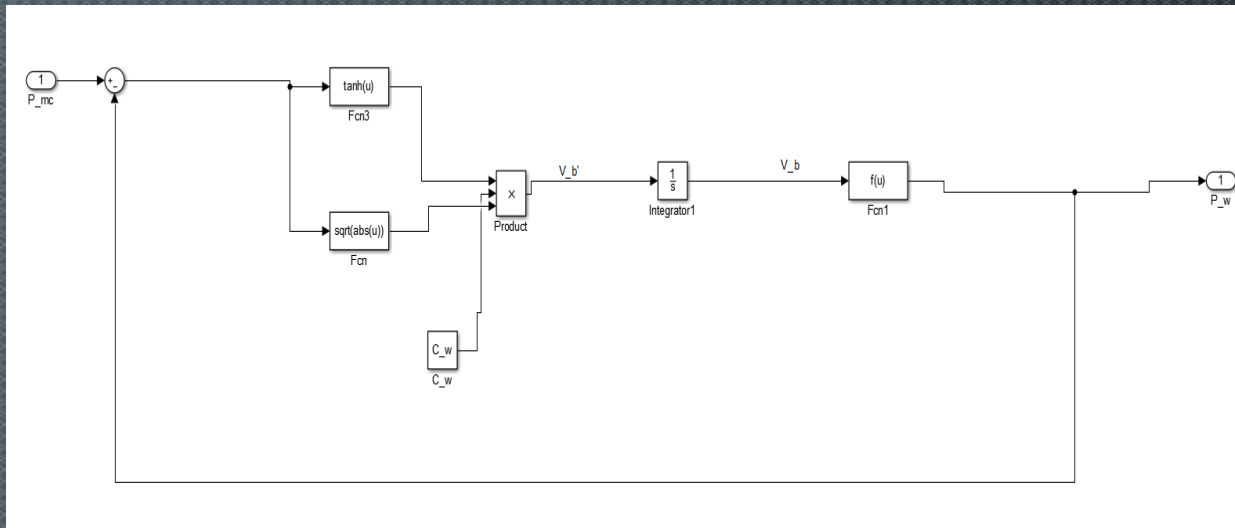
$$\frac{dV_b}{dt} = \tanh(P_{mc} - P_w) \times C_w \times \sqrt{P_{mc} - P_w}$$

$$P_w = C_{p2} V_b^2 + C_{p3} V_b^3$$

V'_b : 유량
 P_{mc} : 마스터 실린더 압력
 P_w : 캘리퍼 피스톤 압력
 C_w : 흐름 계수

3. Hydraulic Brake System Modeling & Analysis

Hydraulic Line

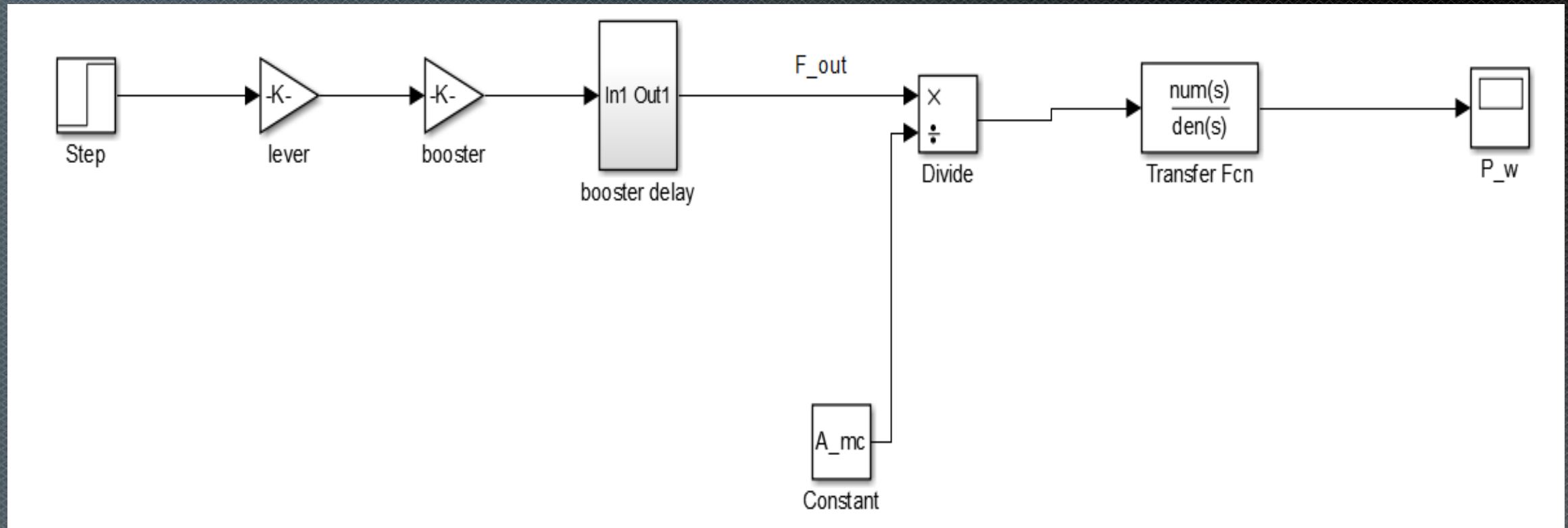


$$V_b' = \tanh(P_{mc} - P_w) \times C_w \times \sqrt{P_{mc} - P_w}$$

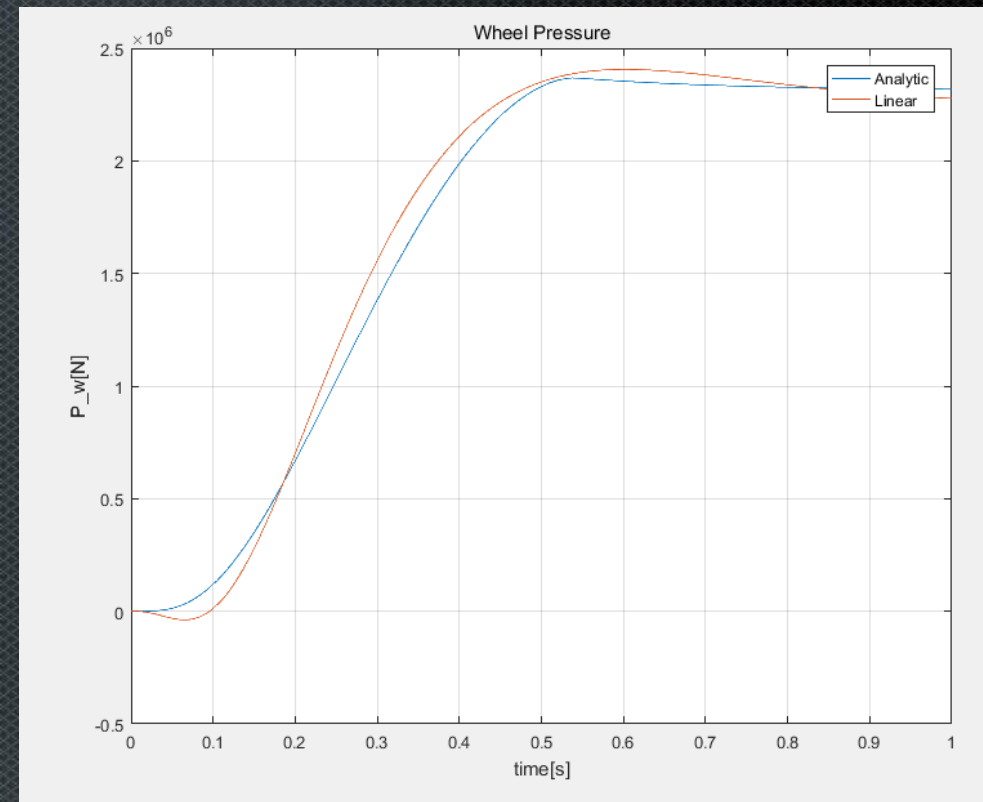
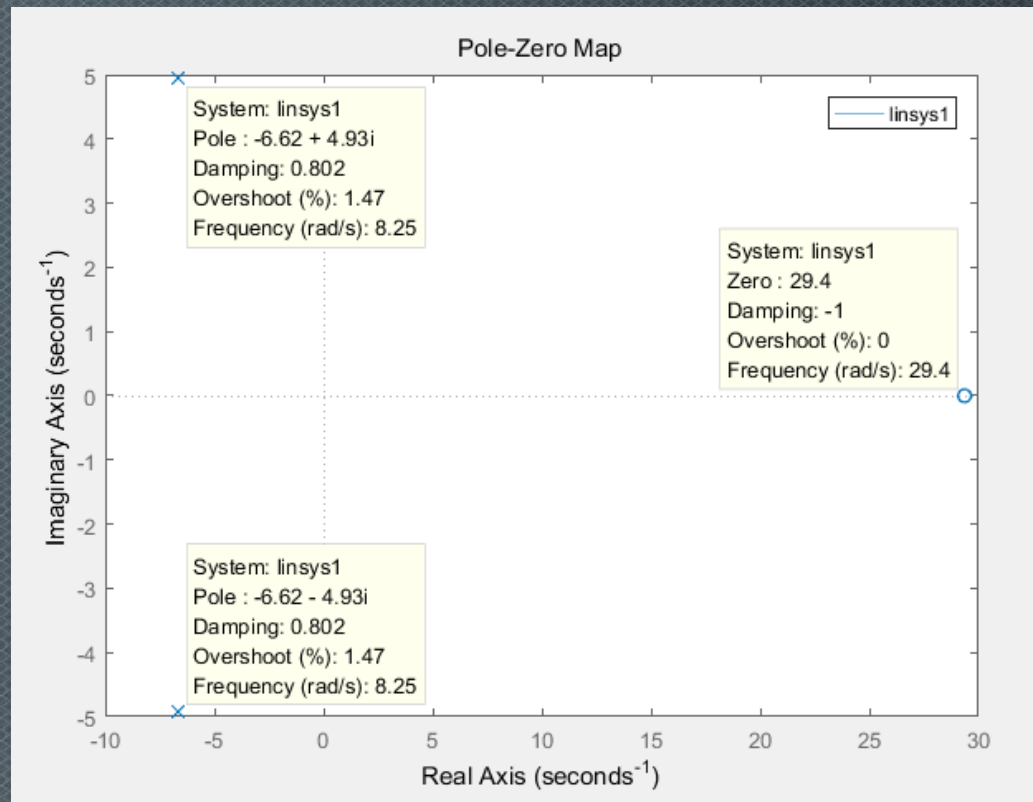
$$P_w = C_{p2} V_b^2 + C_{p3} V_b^3$$

3. Hydraulic Brake System Modeling & Analysis

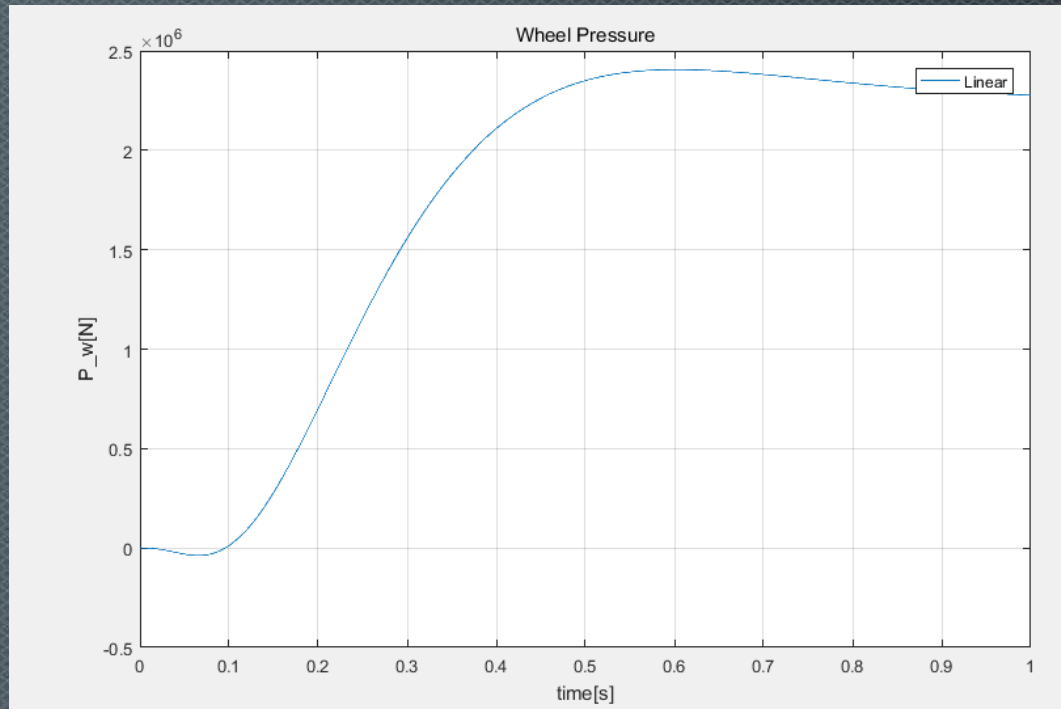
Transfer function



3. Hydraulic Brake System Modeling & Analysis



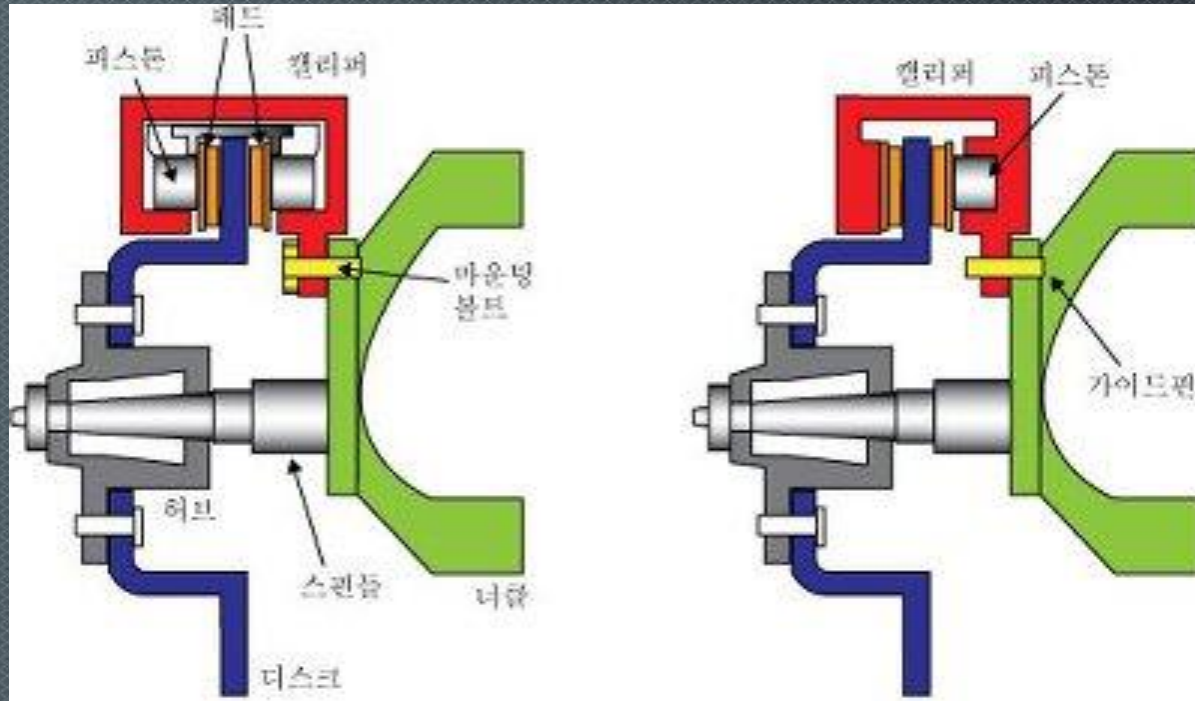
3. Hydraulic Brake System Modeling & Analysis



Input : $F_{in} = 150N$

Output : $P_w \cong 2.4 \text{ MPa}$

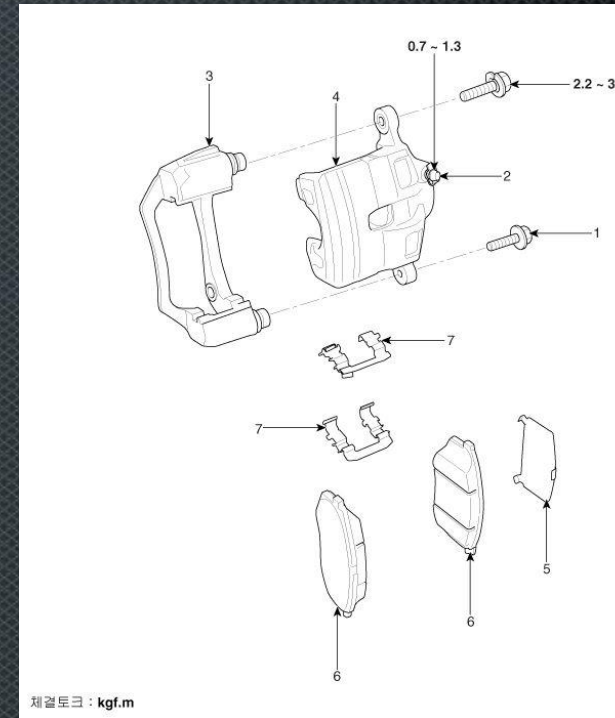
4. Brake Caliper Modeling & Analysis



Fixed Caliper Type

Floating Caliper Type

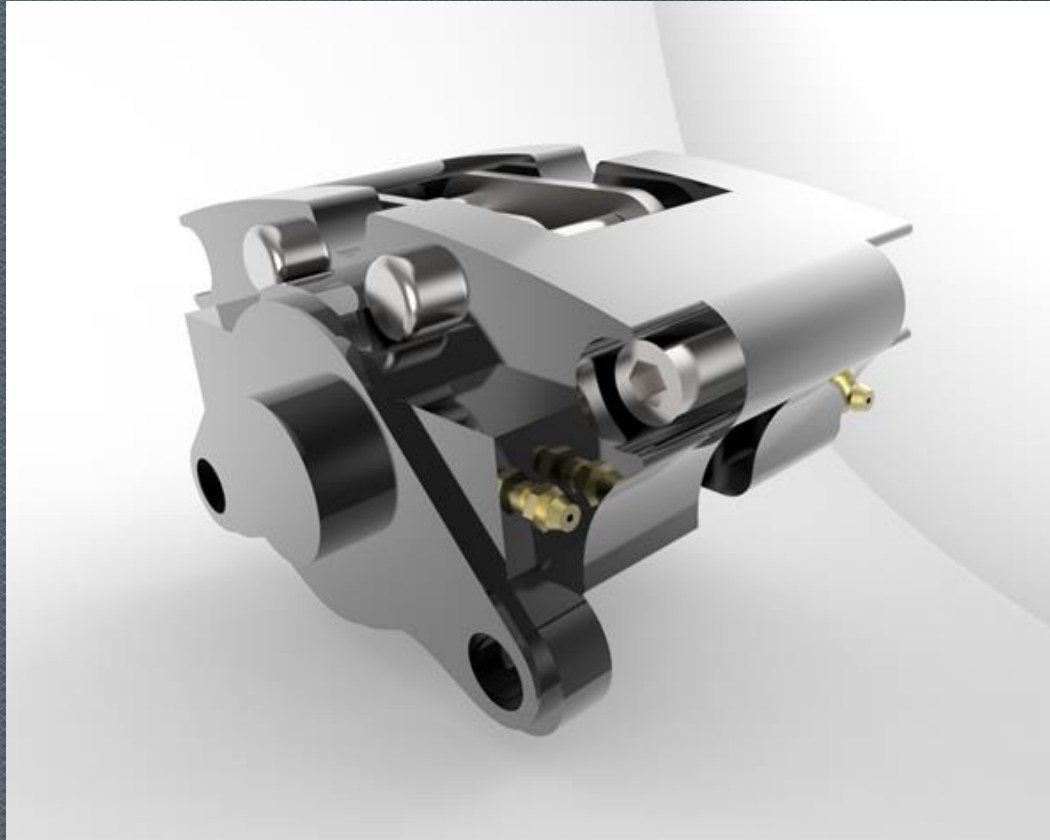
4. Brake Caliper Modeling & Analysis



Reference Model
Hyundai Avante AD 2016

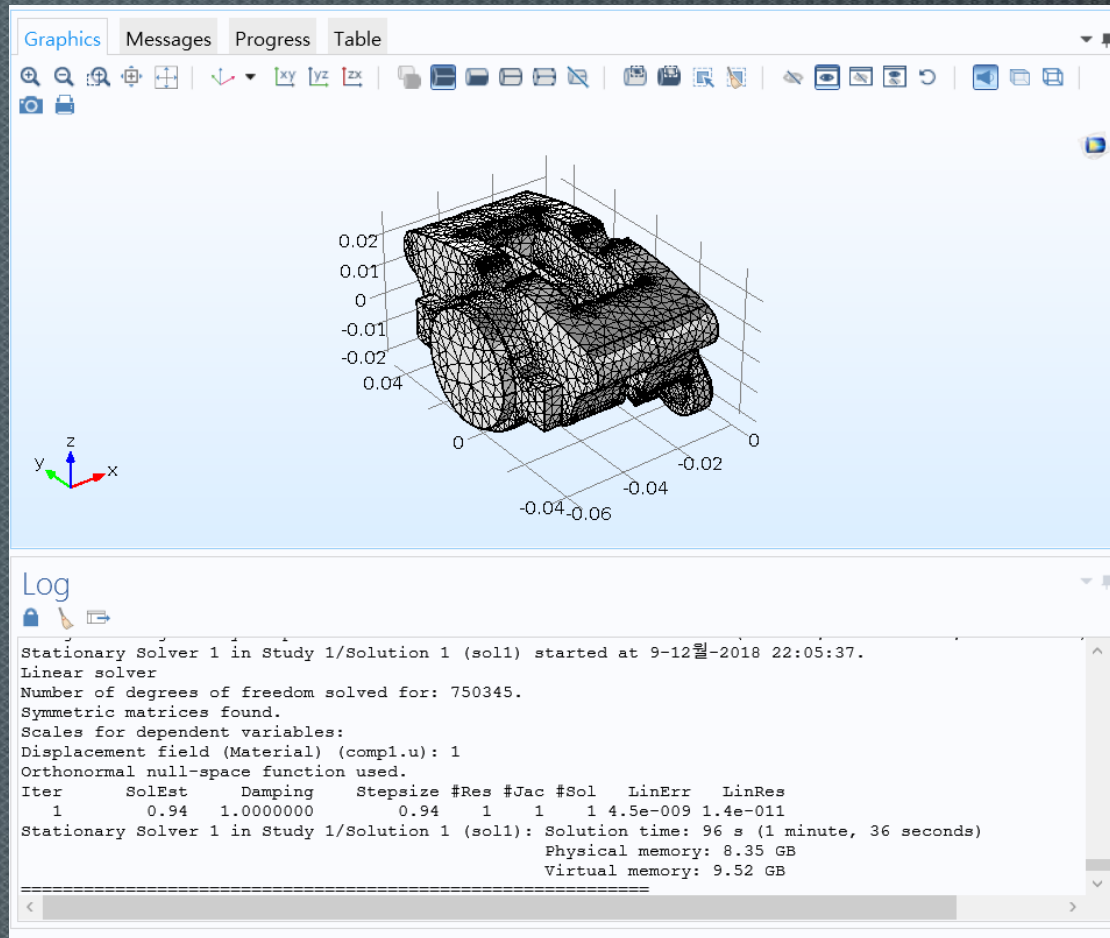
Floating Caliper Type

4. Brake Caliper Modeling & Analysis



Caliper Model
from GrabCad

4. Brake Caliper Modeling & Analysis

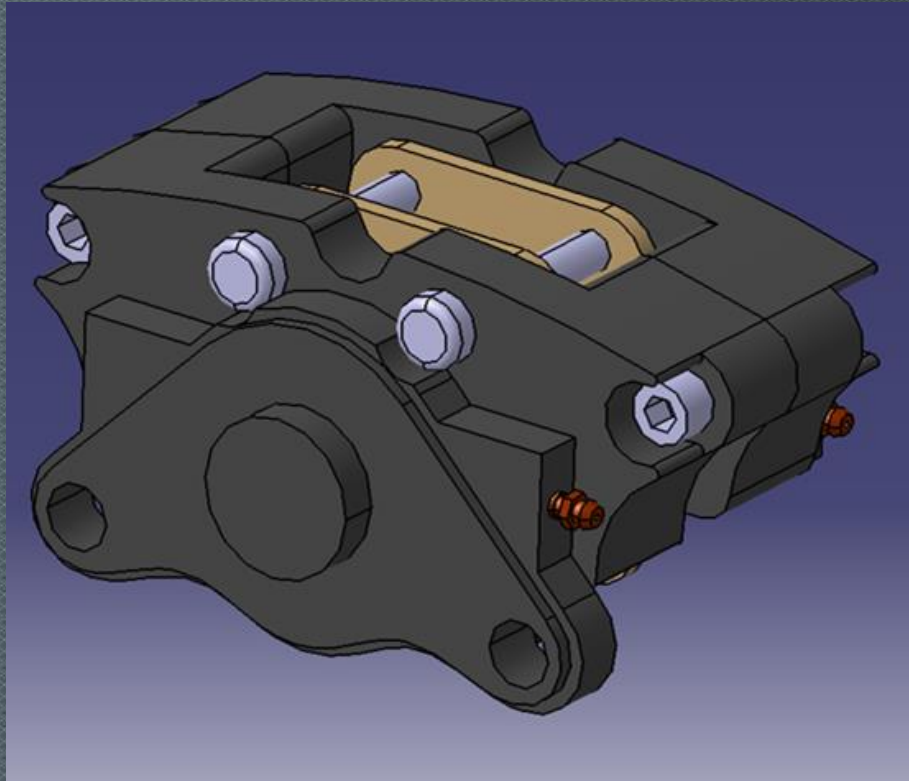


Detailed Model
Auto Mesh Build
Size: Fine

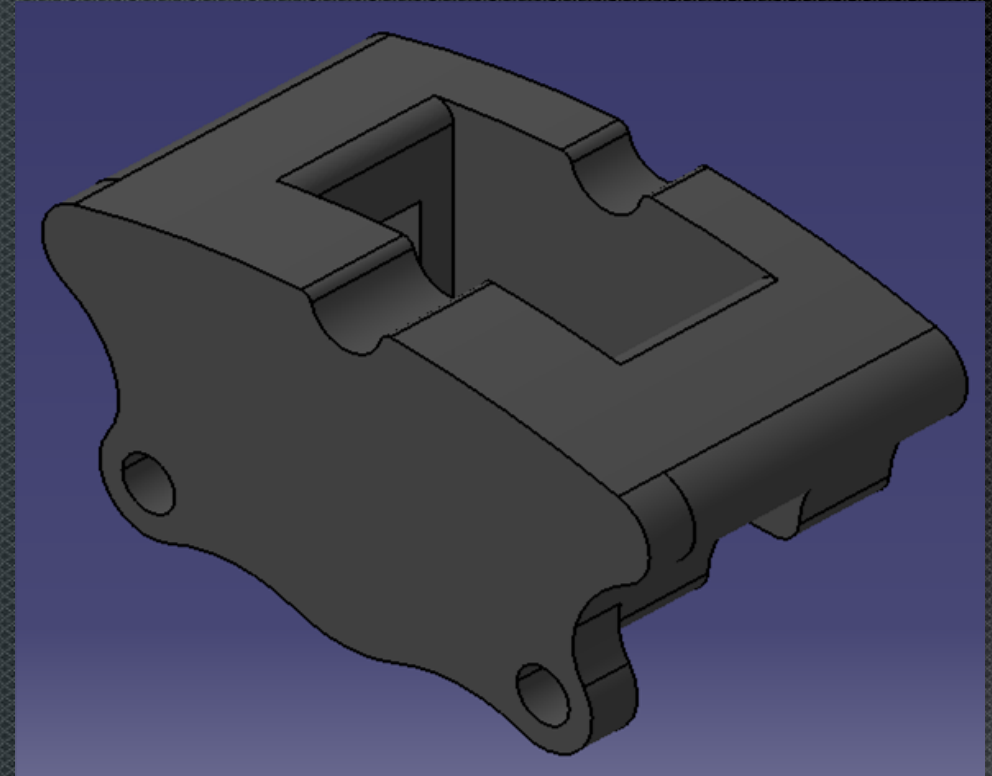
$DOF \cong 750000$

Solution time = 1 min 36s

4. Brake Caliper Modeling & Analysis

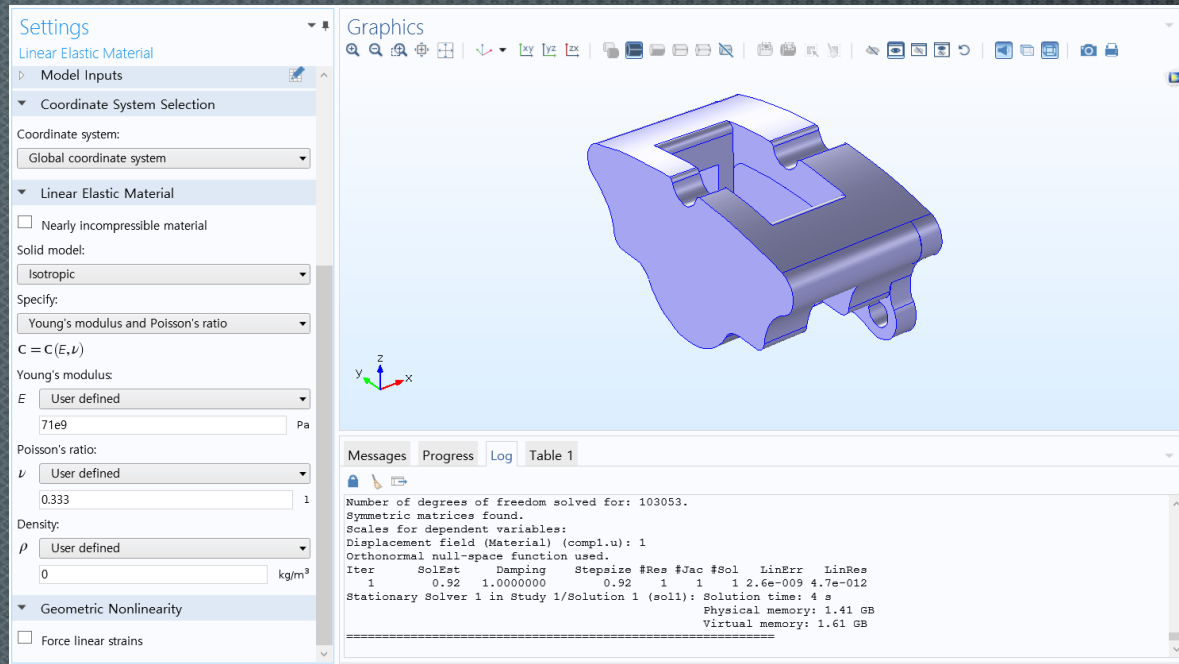


Detailed Caliper Model



Simplified Caliper Model

4. Brake Caliper Modeling & Analysis



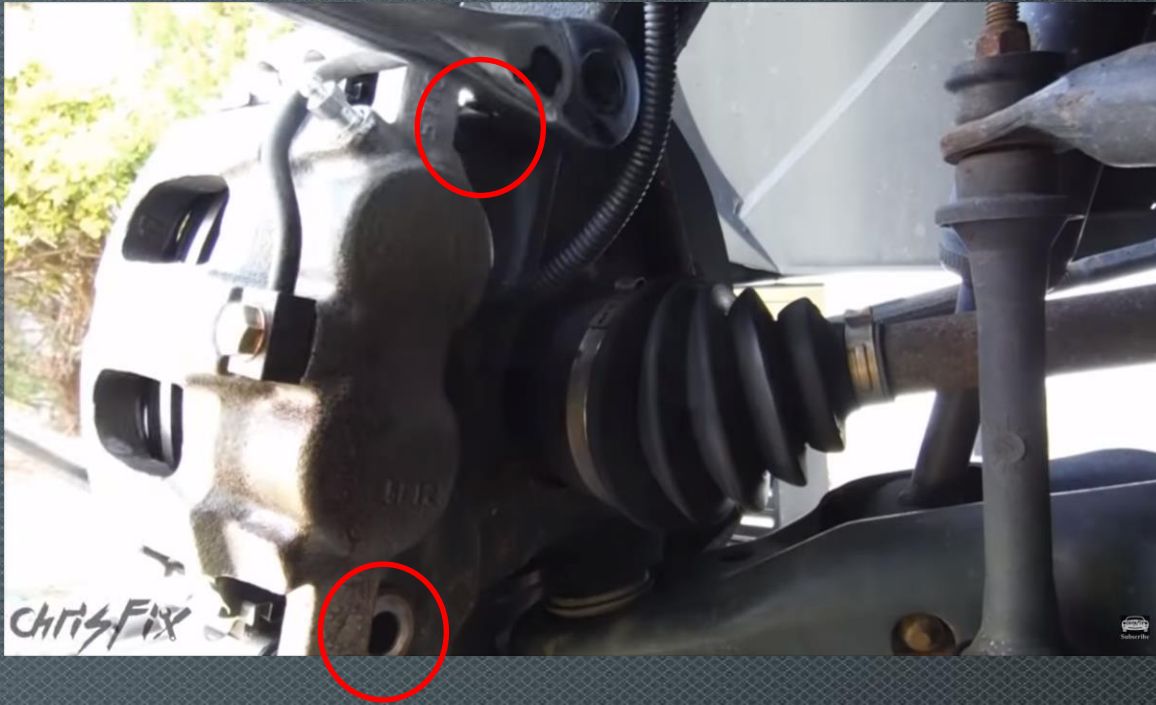
Linear Elastic Material

Gray Cast Iron

Young's Modulus = 118GPa

Poisson's Ratio = 0.294

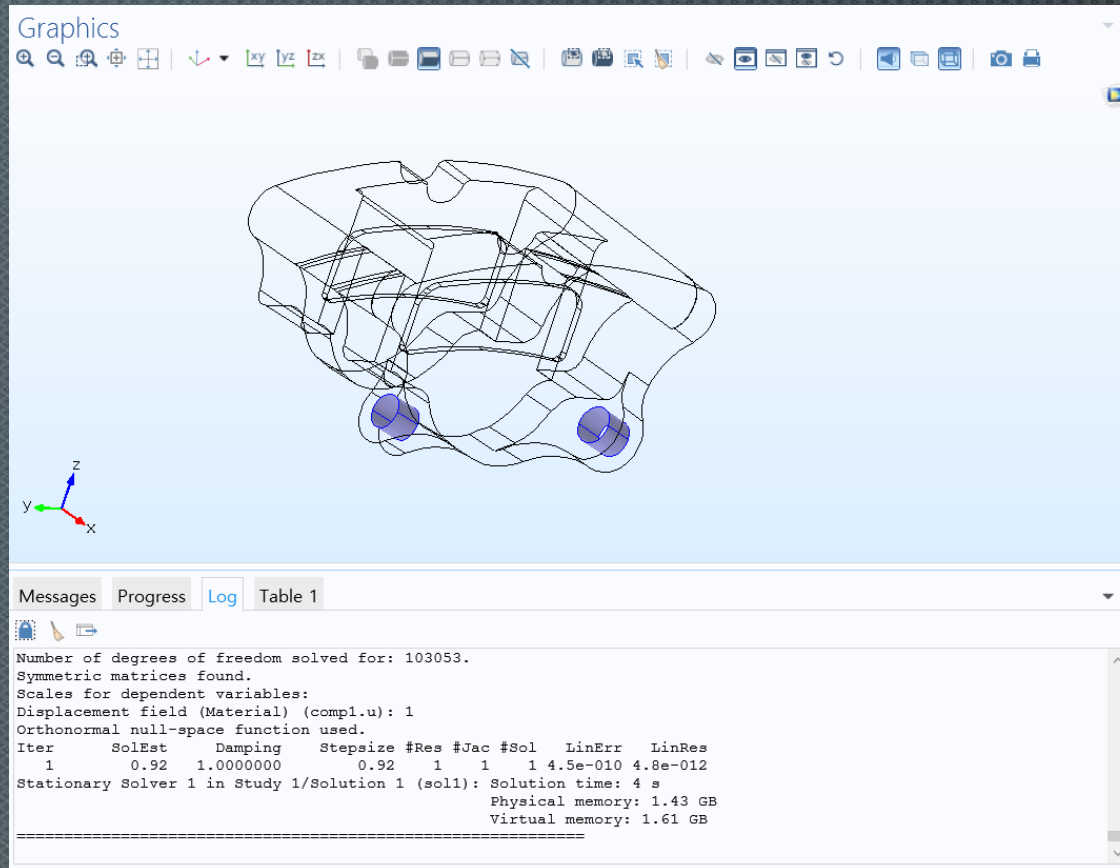
4. Brake Caliper Modeling & Analysis



Fixed Boundary Condition

-Bolted Part

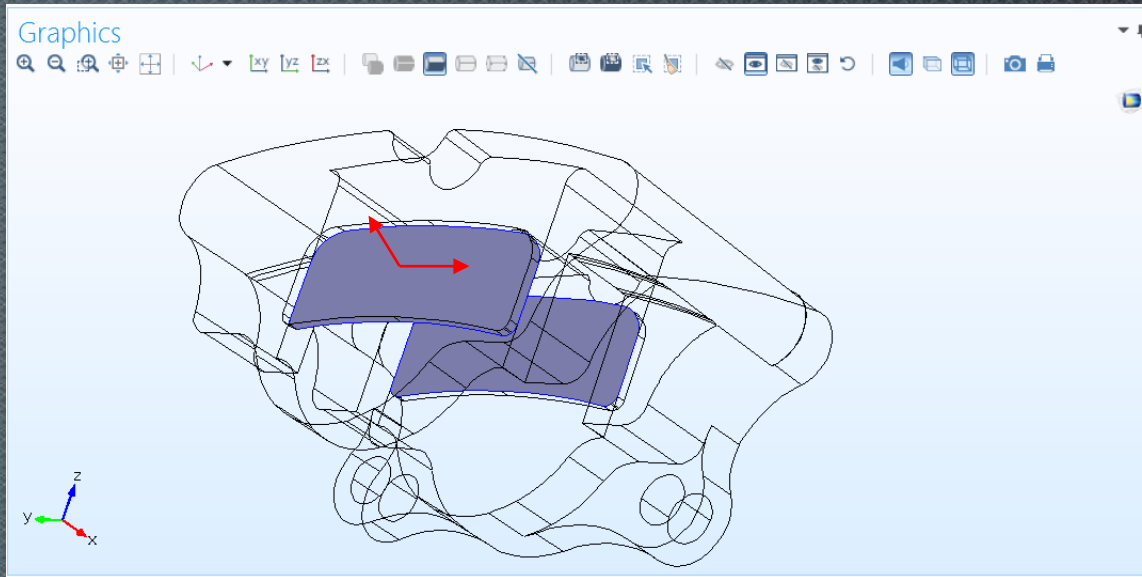
4. Brake Caliper Modeling & Analysis



Fixed Boundary Condition

-Bolted Part

4. Brake Caliper Modeling & Analysis



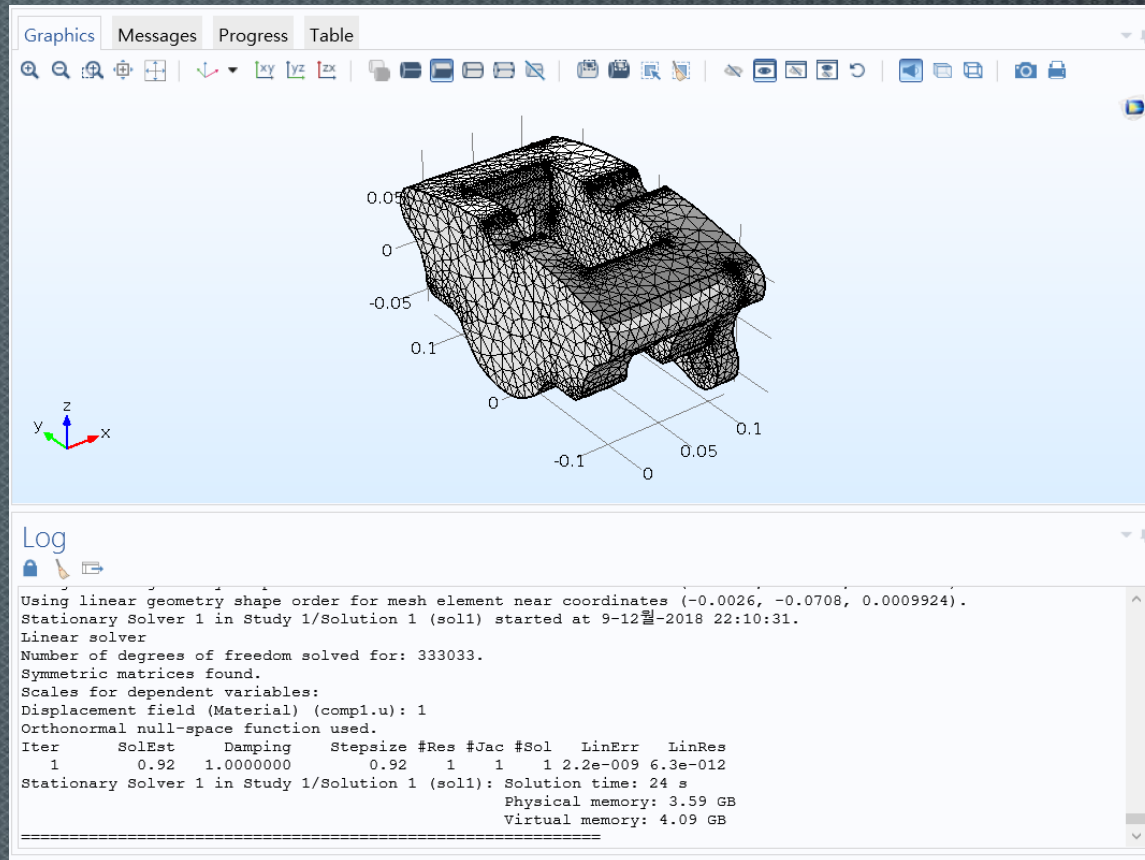
Boundary Load

$$F_{ax} = 2.4Mpa$$

$$\mu = 0.4 \text{ (Brake Pad)}$$

$$F_{ay} = 0.96Mpa$$

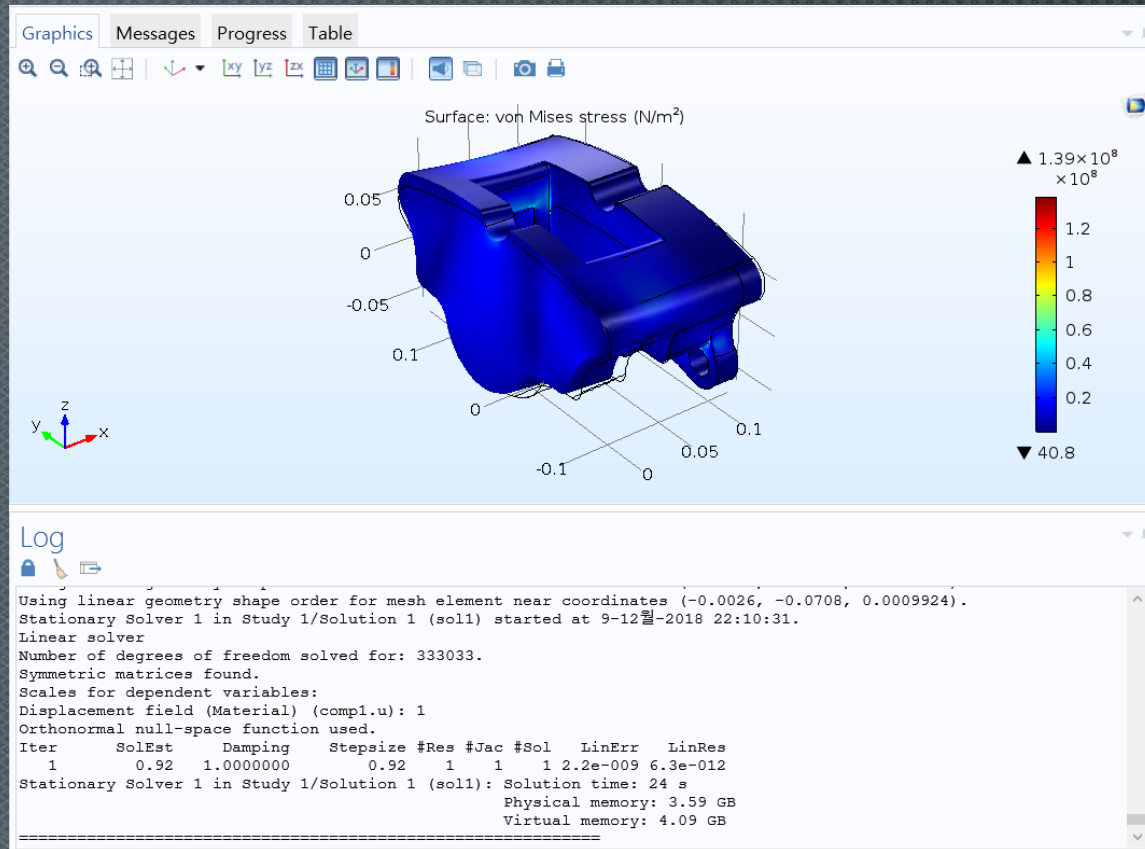
4. Brake Caliper Modeling & Analysis



Simplified Model
Auto Mesh Build
Size: Fine

$DOF \cong 330000$

4. Brake Caliper Modeling & Analysis



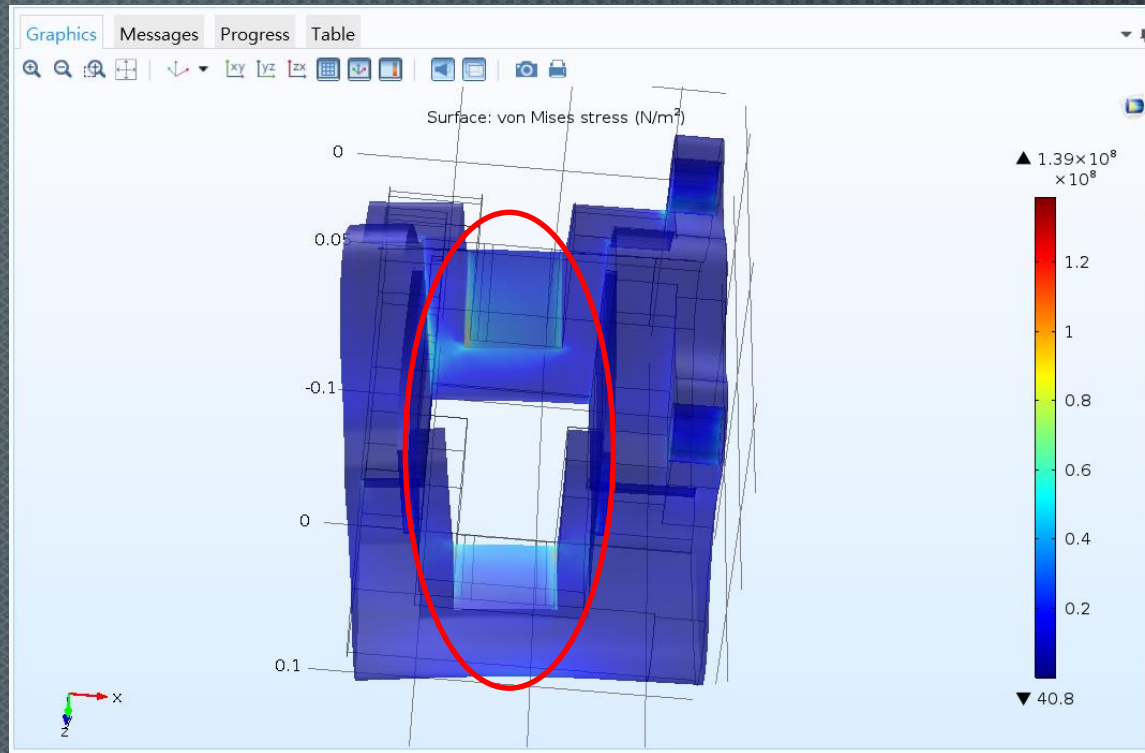
Simplified Model
Auto Mesh Build

$DOF \cong 330000$

Solution time = 24s

Maximum von Mises Stress
 $\cong 139\text{Mpa}$

4. Brake Caliper Modeling & Analysis

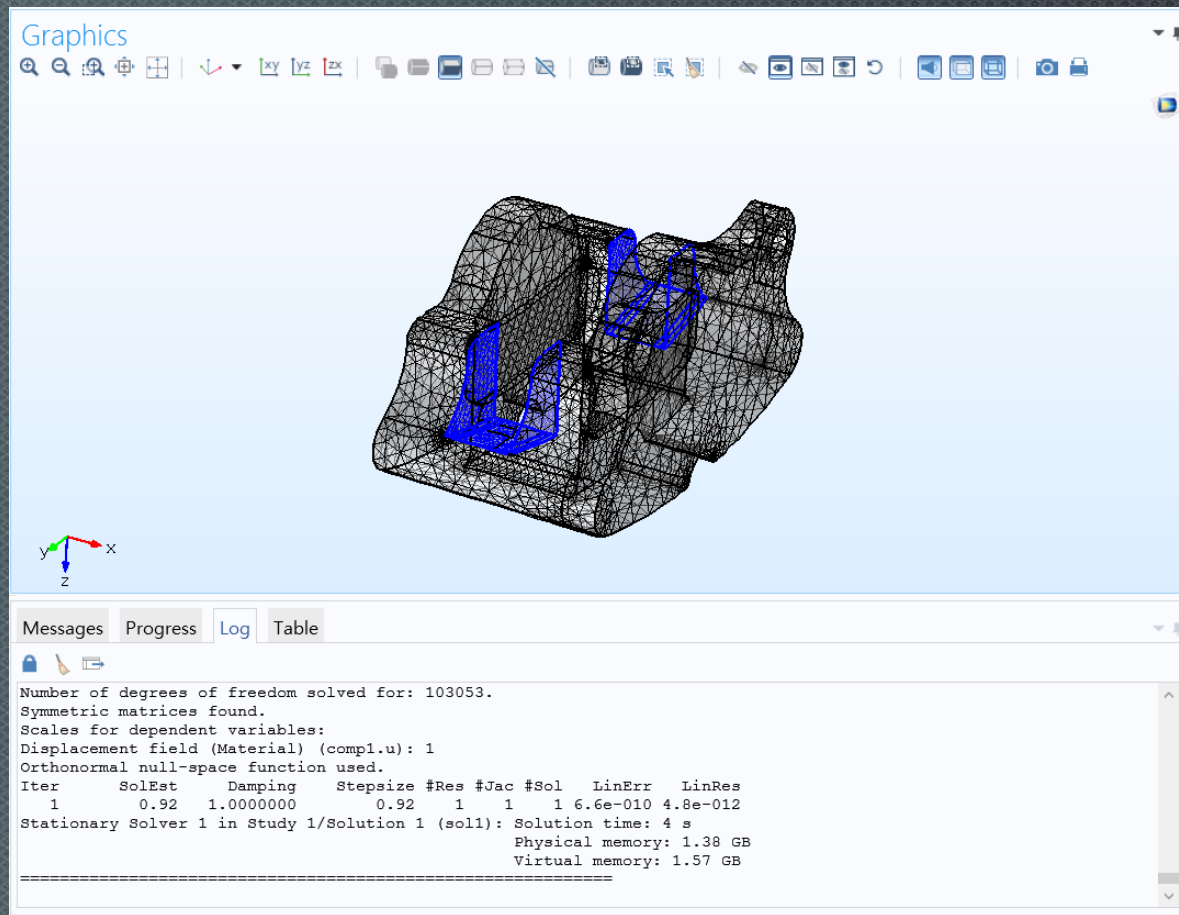


Simplified Model
Auto Mesh Build

$DOF \cong 330000$

Maximum von Mises Stress
 $\cong 139 \text{ Mpa}$

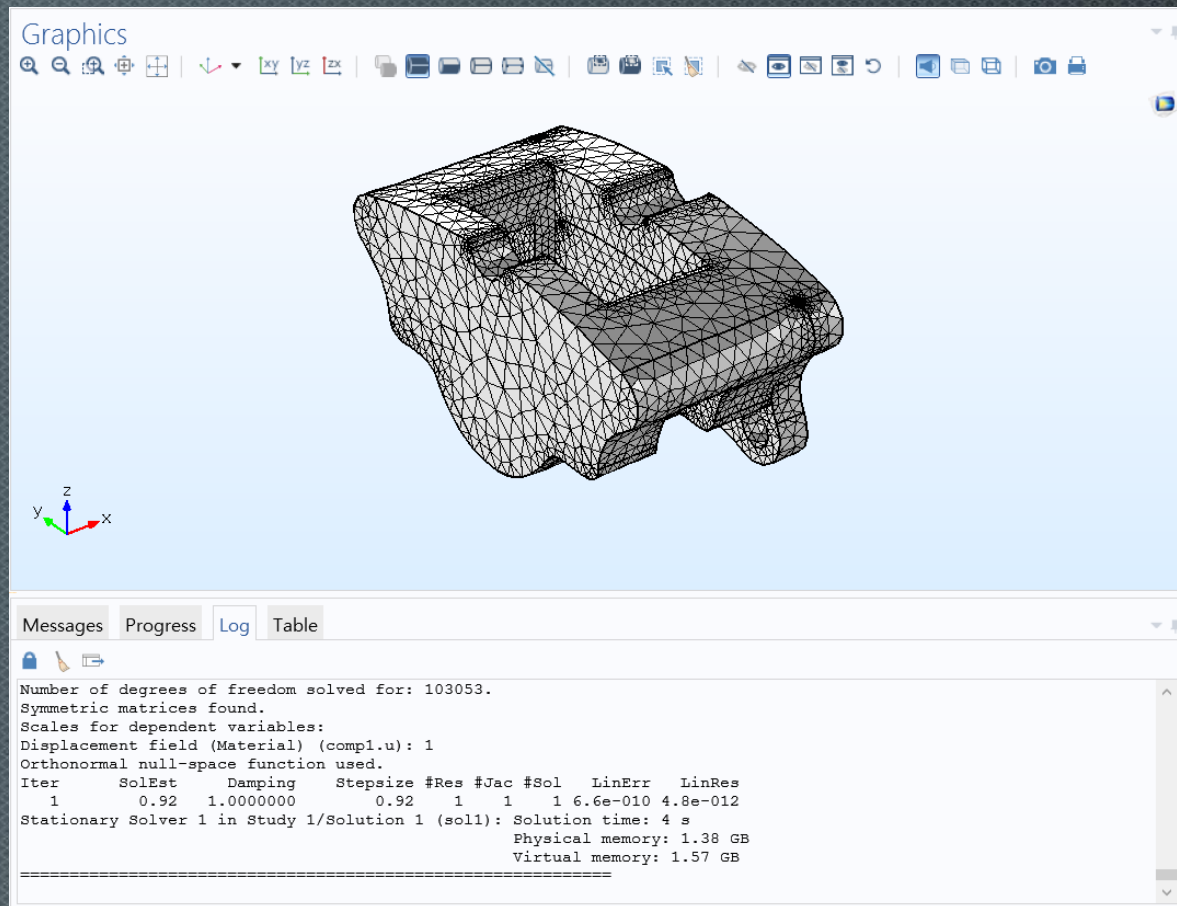
4. Brake Caliper Modeling & Analysis



Simplified Model
Manual Mesh Build
Mesh Size Adjustment by Domain

$DOF \cong 103000$

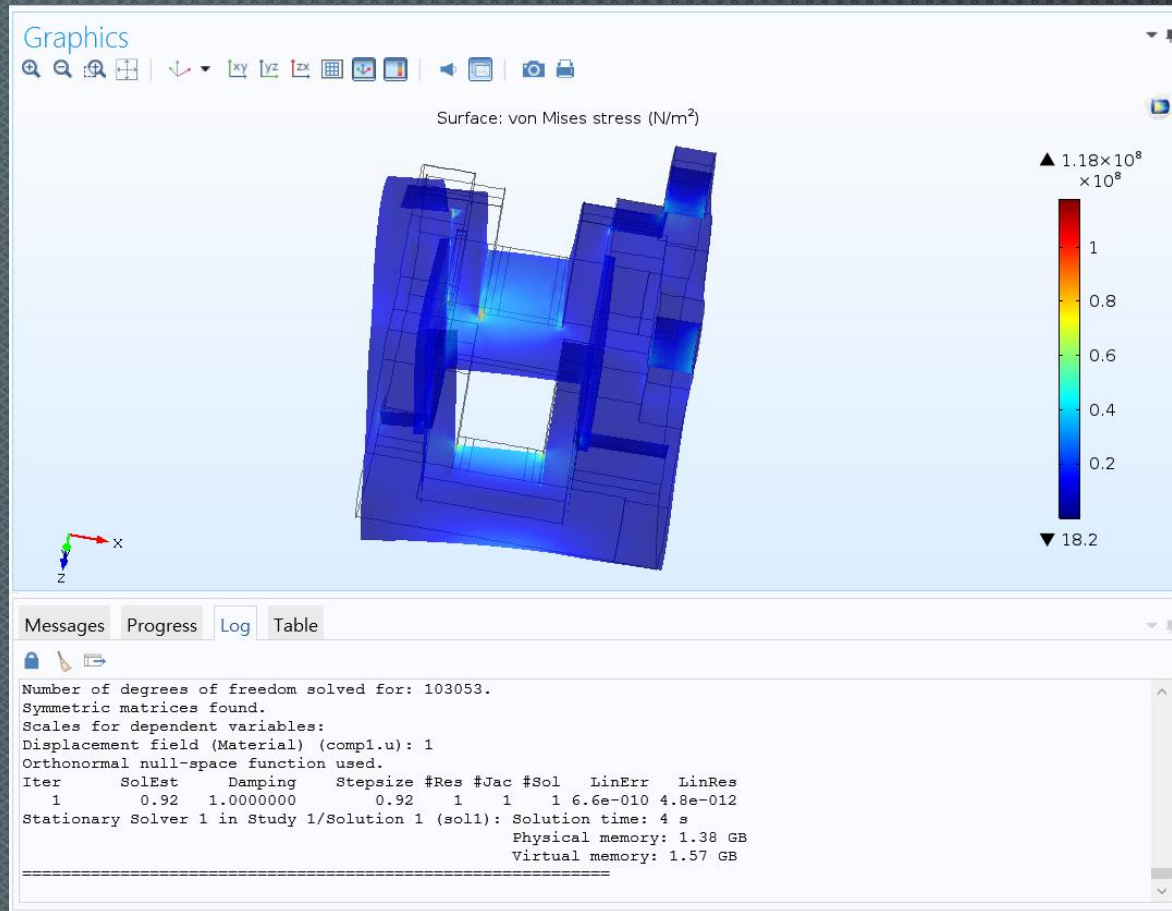
4. Brake Caliper Modeling & Analysis



Simplified Model
Manual Mesh Build
Mesh Size Adjustment by Domain

$DOF \cong 103000$

4. Brake Caliper Modeling & Analysis



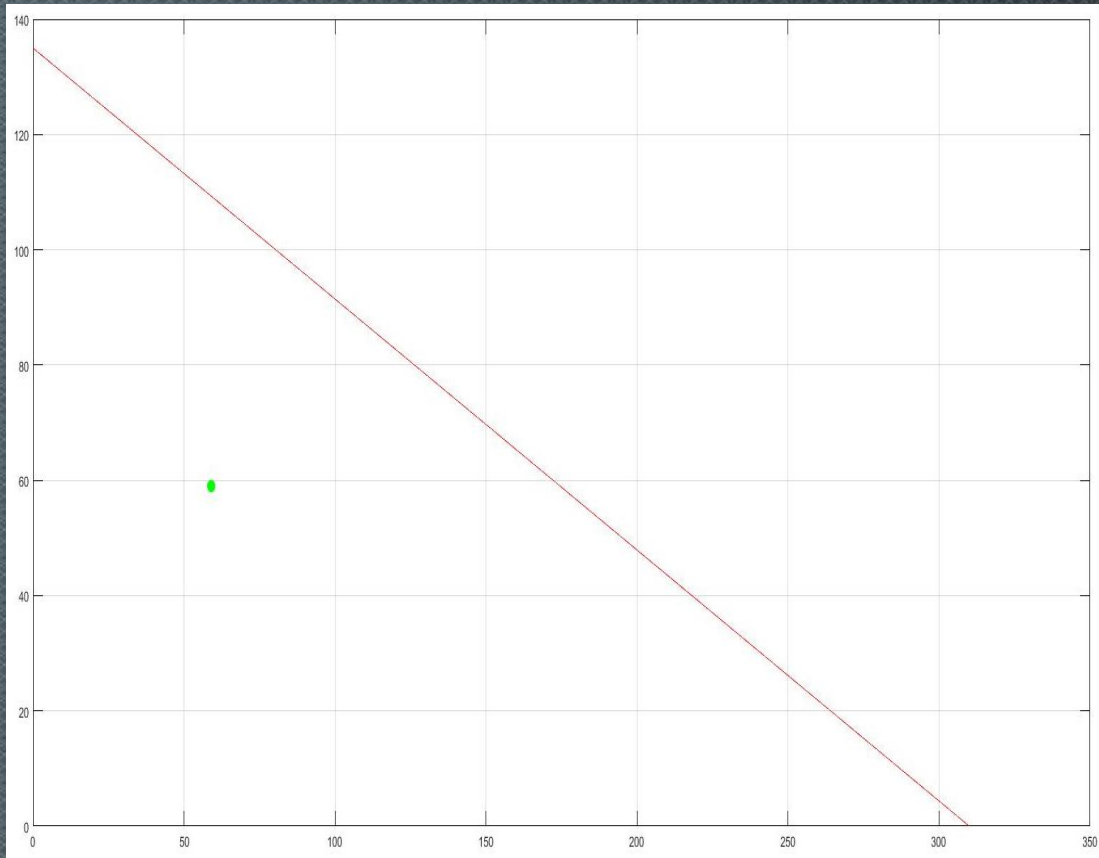
Simplified Model
Manual Mesh Build
Mesh Size Adjustment by Domain

$DOF \cong 103000$

Solution time = 4s

Maximum von Mises Stress
 $\cong 118\text{Mpa}$

5. Conclusion with Q&A



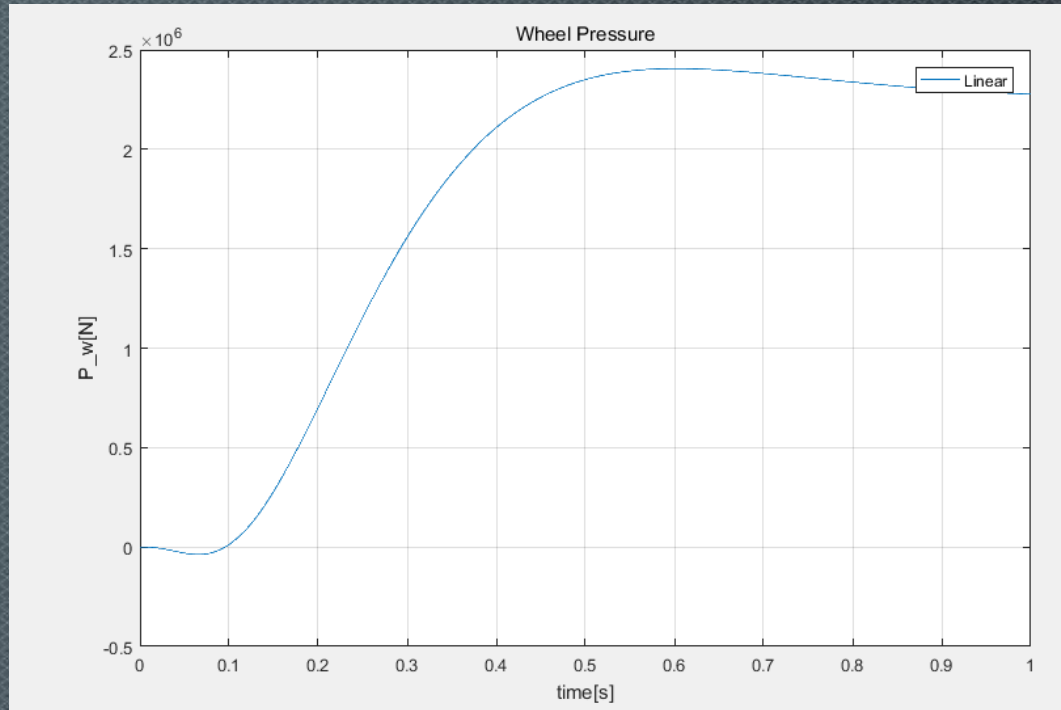
*Maximum von Mises Stress
 $\cong 118\text{Mpa}$*

Verifying with Goodman Line

$S_e \cong 135\text{Mpa}$ $S_{ut} \cong 310\text{Mpa}$

Permanent Caliper Life !

5. Conclusion with Q&A



Rise Time $\cong 0.4s$

Vehicle Initial Velocity 100km/h

-> Free Running Distance = 11m

Reference

Adrian Neys: In-Vehicle Brake System Temperature Model

Nikhil Pratap Wagh: DESIGN AND ANALYSIS OF MODULAR CALIPER ASSEMBLY

J. Christian Gerdes 외: Brake System Modeling for Simulation and Control

이경수: Modeling of Hydraulic Brake System and Examination using equipped test vehicle

한국정밀공학회: 구조해석을 이용한 브레이크 캘리퍼의 수명 평가

Brake Caliper 3D Model : www.grabcad.com

브레이크 제원: 현대자동차그룹 GSW <http://gsw.hyundai.com>