

Retarder BRAKE의 제동성능 분석



브레이크 TEAM

김현수 홍승욱



Contents

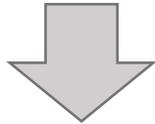
Part 1

팀명 선정 배경

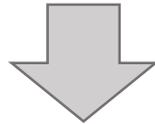
주제 선정 배경

Part 2

Retarder brake의 원리



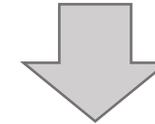
3D -> 2D 모델링



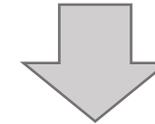
Retarder brake의 토크 해석

Part 3

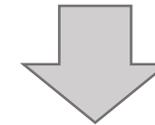
Full vehicle 모델링



Braking 토크 해석



제동거리 해석



결론 및 고찰



팀명 선정 배경

- Brake : 제동 장치, 속도를 줄이다
- Break : 깨다, 부수다
- 두 단어의 한국식 발음 : 브레이크



주제 선정 배경

- 대형트럭을 제동하는 경우 service brake만으로는 제동력이 부족하여 retarder brake를 추가로 사용하는 것을 알게 되었다.
- Retarder brake를 분석하는 데에 있어 CAE시간에 배운 Tool들을 적용하는 것이 적절하다고 판단되었다.



Part 1

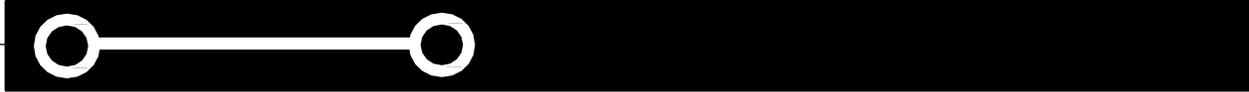
Part 2



RETARDER brake의 원리

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Part 1

Part 2



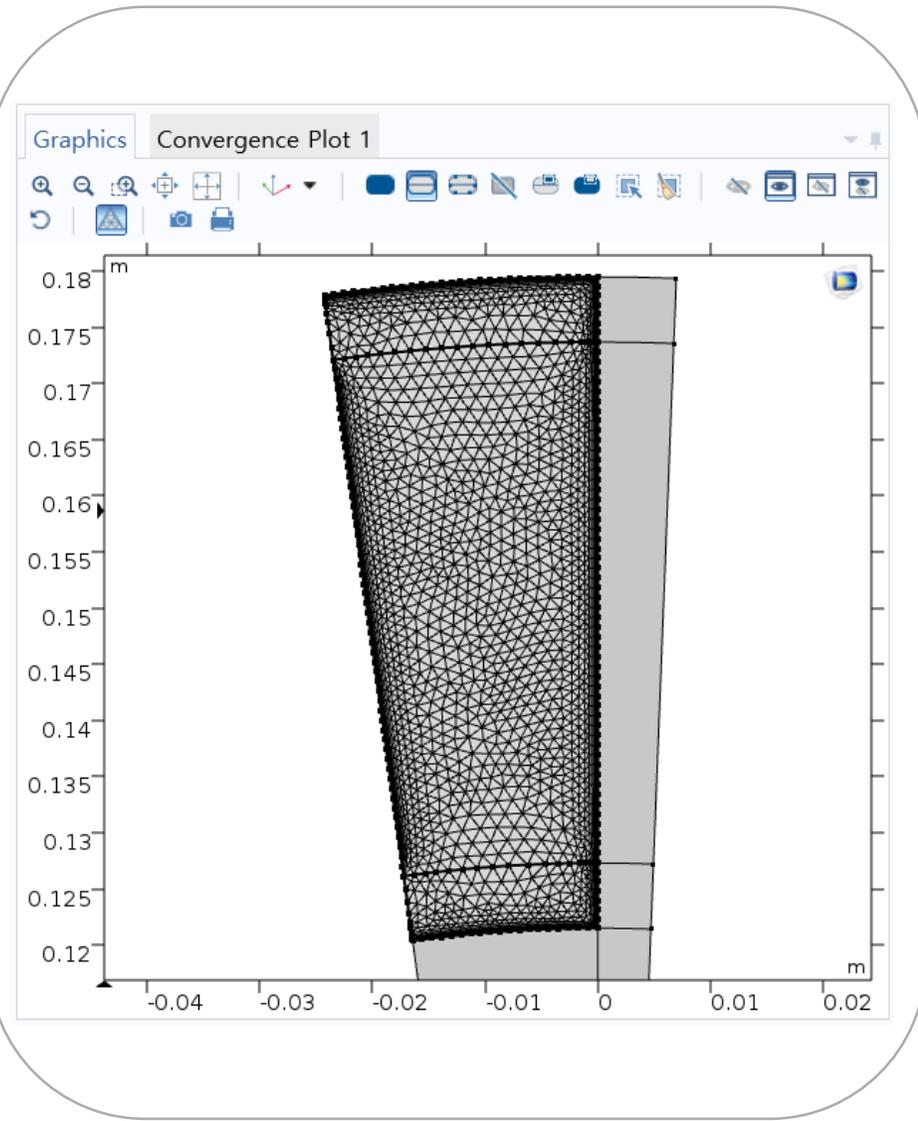
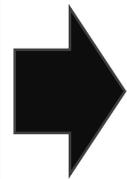
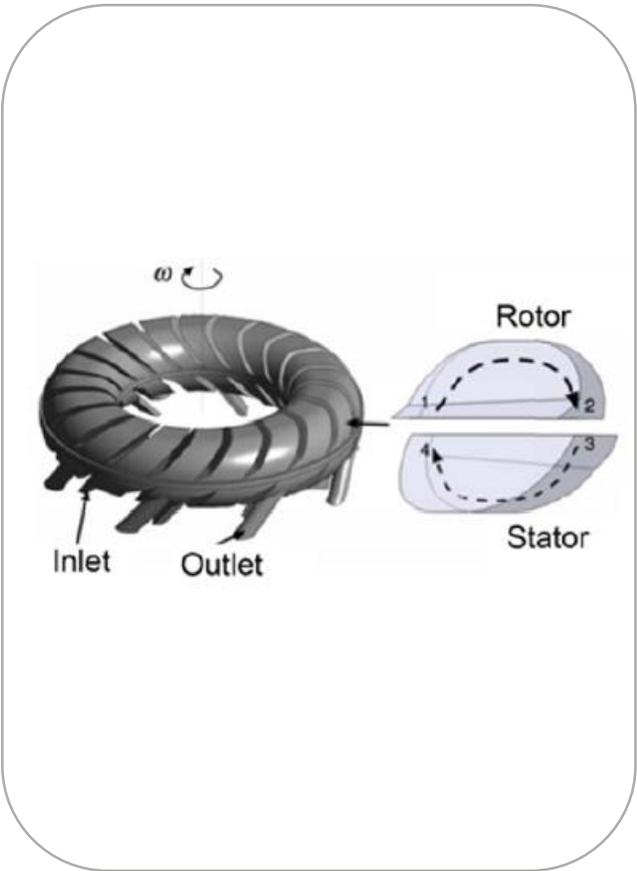
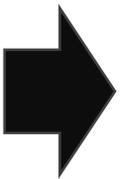
3D -> 2D 모델링



(a) Rotor of hydraulic retarder



(b) Stator of hydraulic retarder



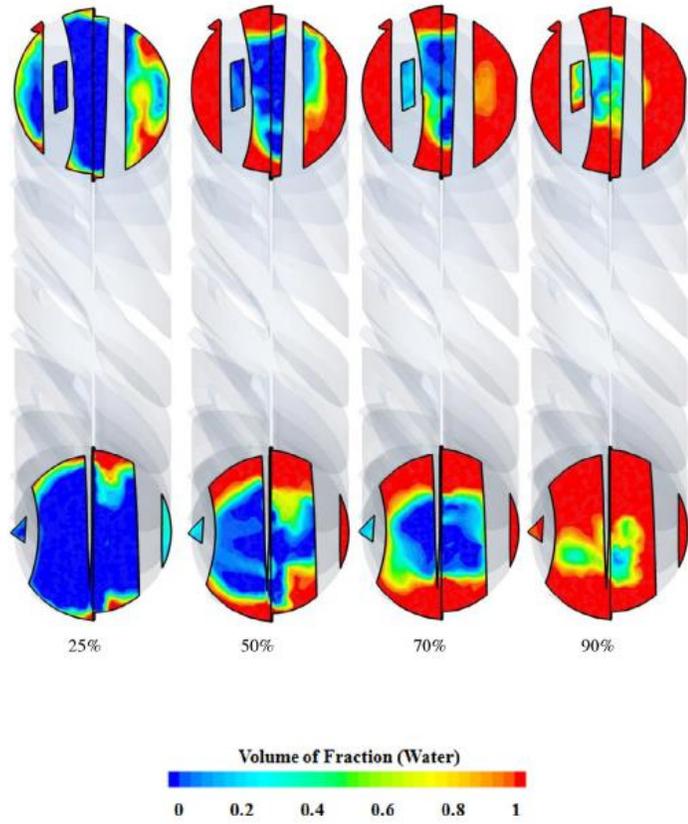
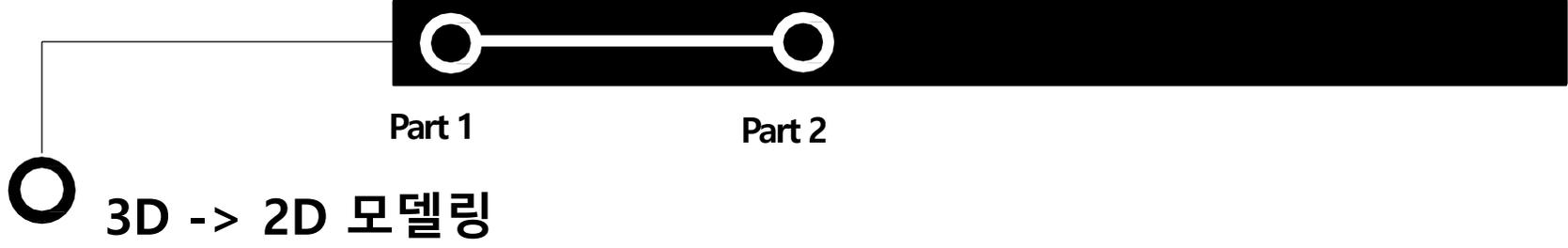


Fig.8. Phase distribution inside the water retarder for different charged-water conditions.

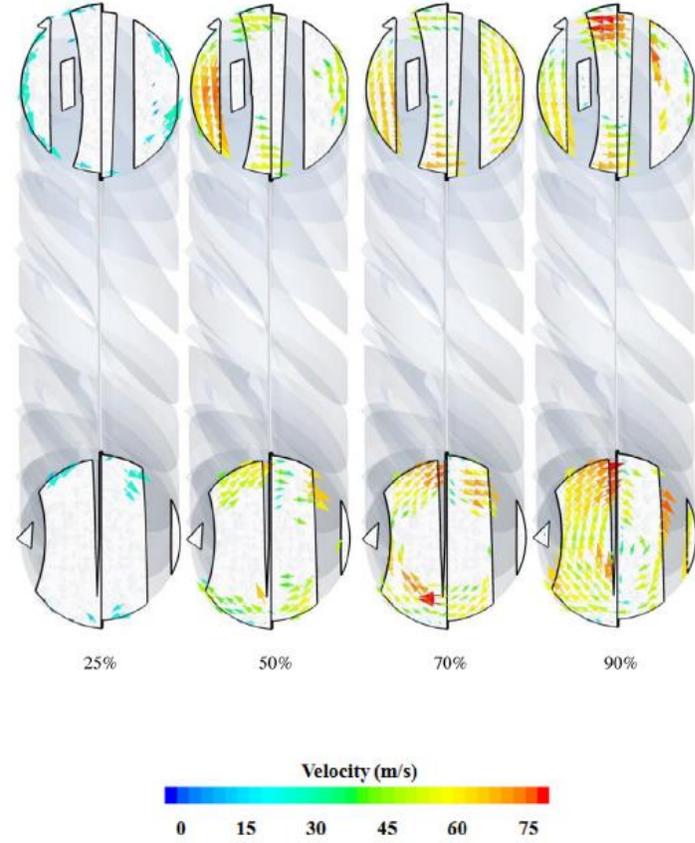
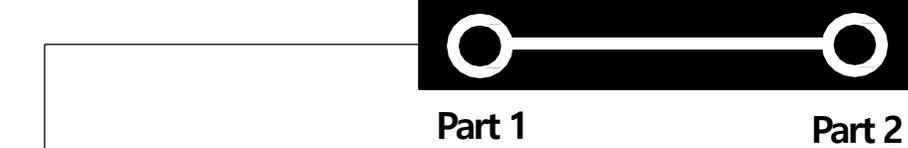


Fig. 9. Velocity vector plots inside the water retarder for different charged-water conditions.



3D -> 2D 모델링

➔ Inlet의 속도 = blade의 선 속도

➔ Inlet의 크기 = rotor안의 물의 양과 비례

➔ 물이 진행되는 폭 = rotor blade 사이의 간격

➔ **Rotor spec**

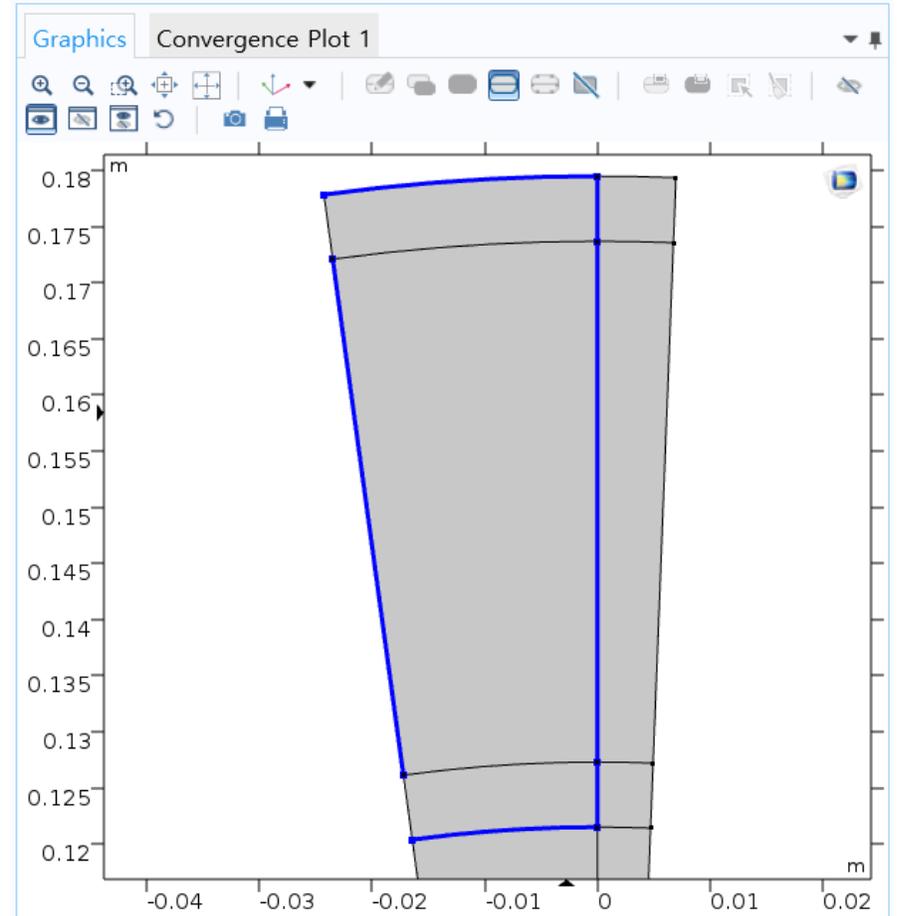
Rotor inner diameter = 243mm

Rotor outer diameter = 359mm

Blade thickness = 7mm

Number of blades = 36

Fluid = water

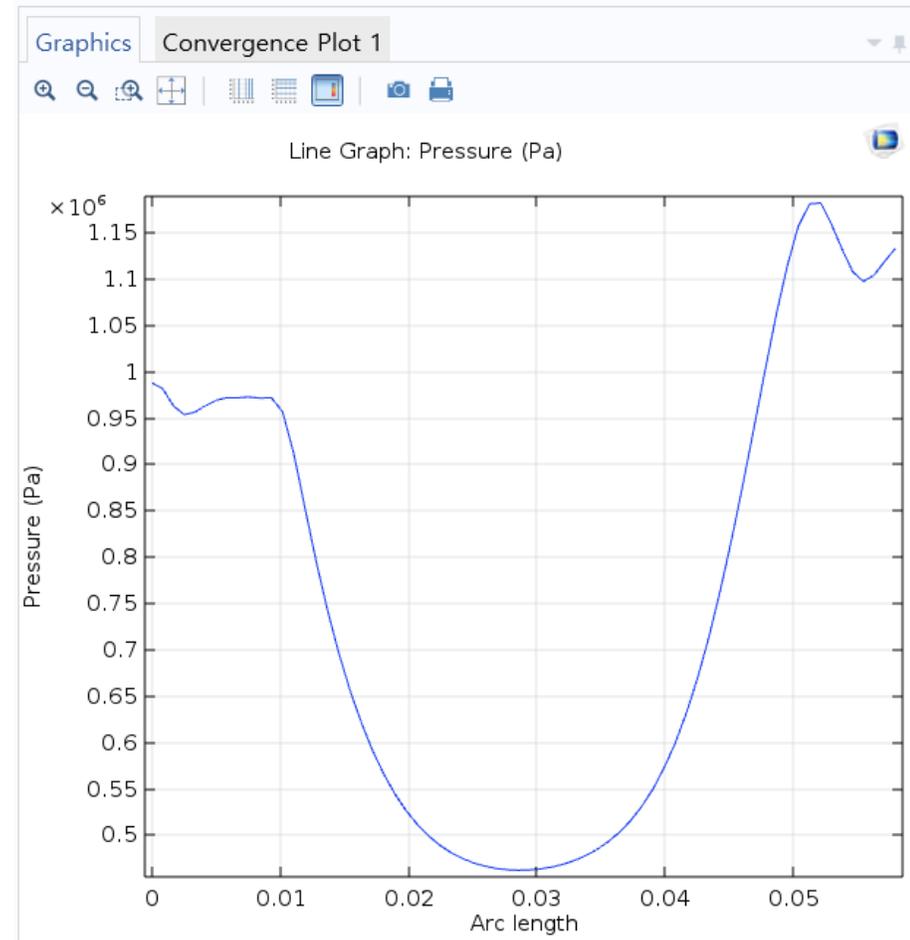
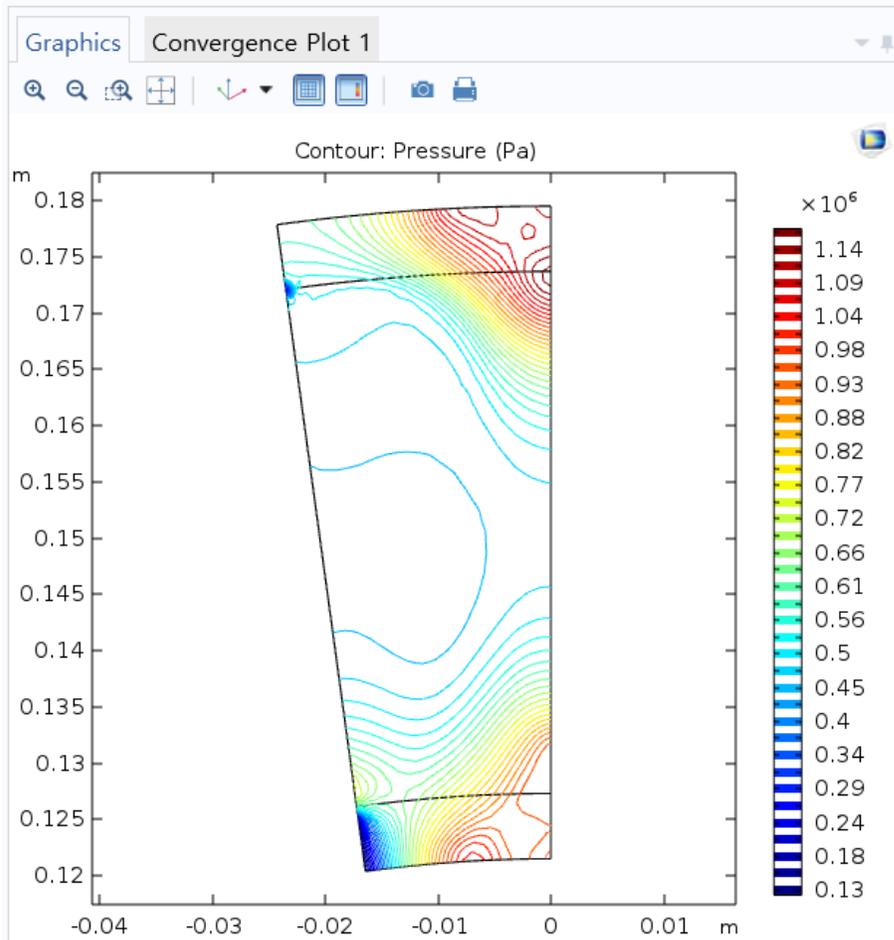


Part 1

Part 2



Retarder brake의 토크 해석



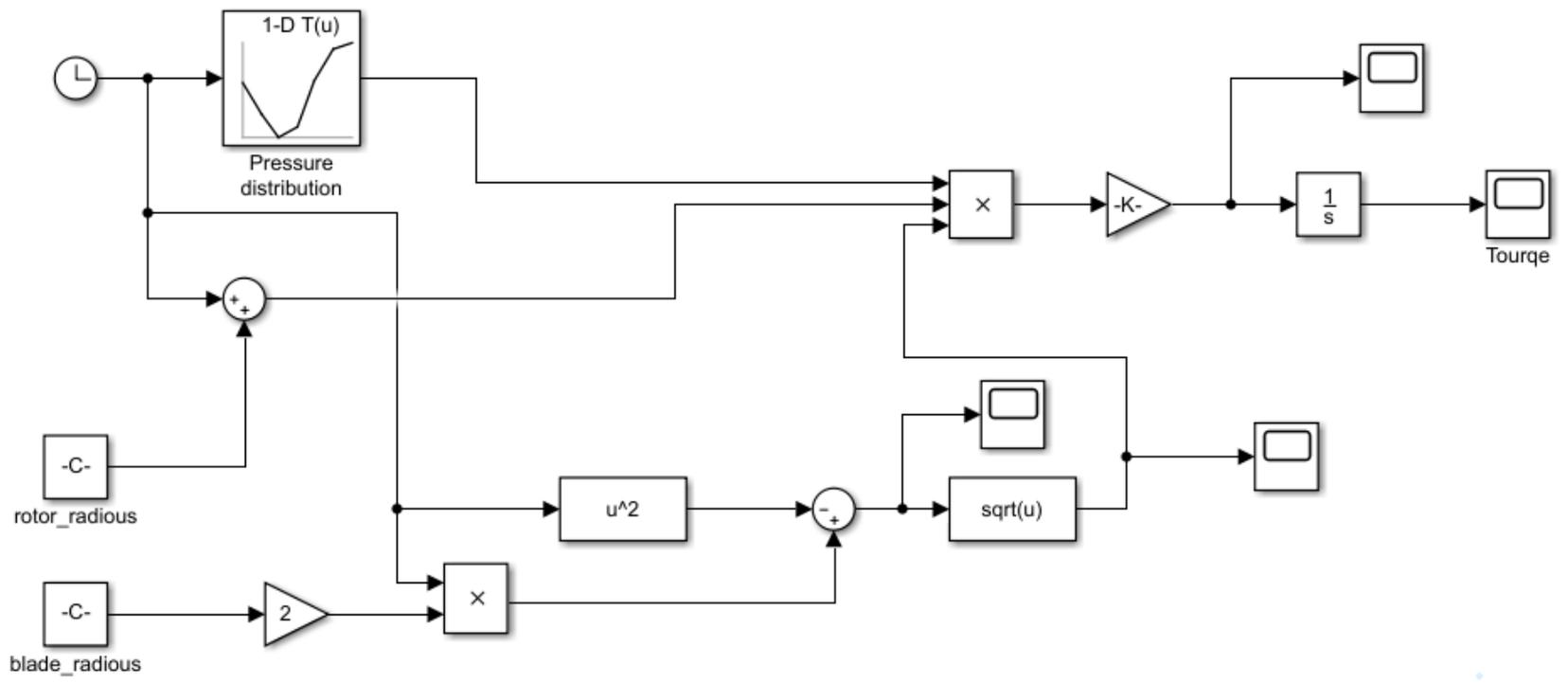


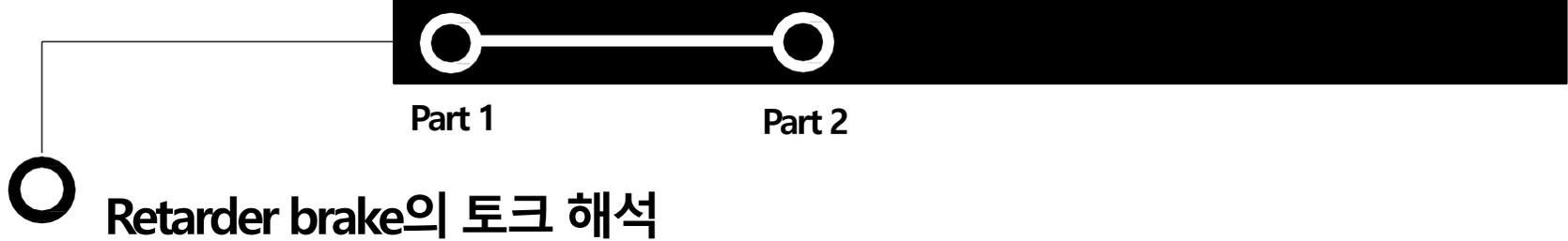
Part 1

Part 2



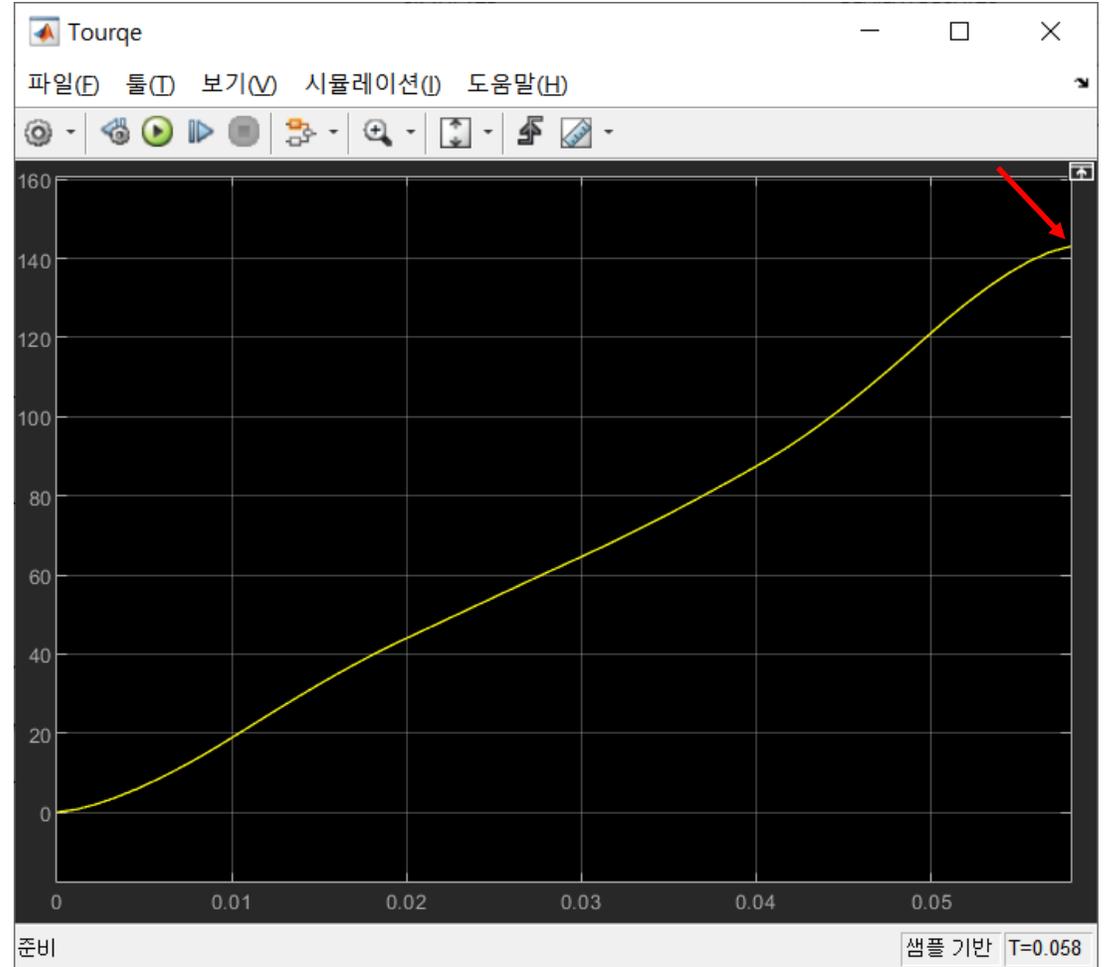
Retarder brake의 토크 해석





→ 그래프의 x축 끝단의 값을 읽어 토크를 알 수 있다.

→ 이 과정을 RPM과 물의양을 변화시키며 반복하였다.





Part 1

Part 2



Retarder brake의 토크 해석

Retarder brake torque

Rpm 물 부피(%)	800	1000	1200	1400	1600	1800	2000
20	35	47	60	79	97	118	142
40	41	52	66	82	105	124	148
60	50	68	90	112	140	178	217
80	80	114	152	200	255	317	387
95	118	170	237	315	407	500	620



Part 1

Part 2

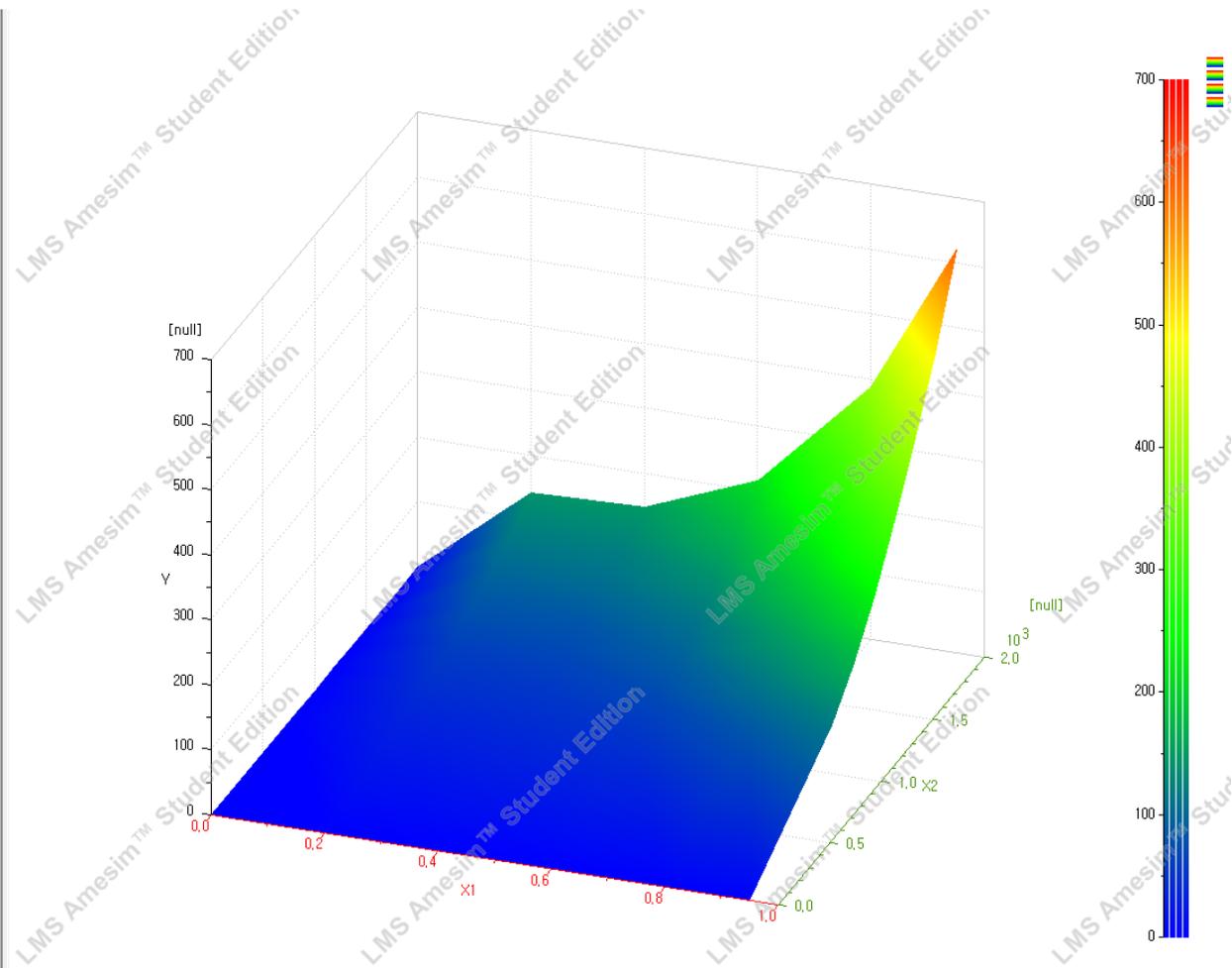


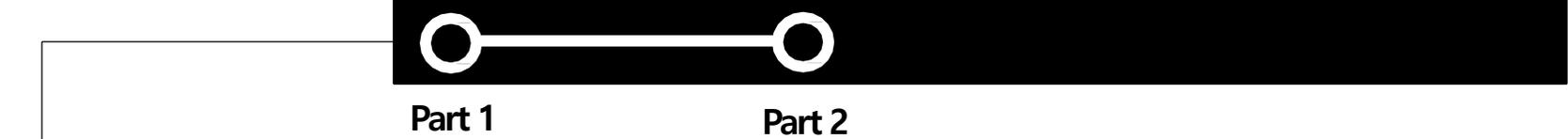
Retarder brake의 토크 해석

Retarder brake torque map

Format: 2D Table

	1	2	3	4	5	6
x_1	0	0.2	0.4	0.6	0.8	0.95
x_2	0	0	0	0	0	0
1	0	0	0	0	0	0
2	800	0	35	41	50	80
3	1000	0	47	52	68	114
4	1200	0	60	66	90	152
5	1400	0	79	82	112	200
6	1600	0	97	105	140	255
7	1800	0	118	124	178	317
8	2000	0	142	148	217	387





Retarder brake의 토크 해석

Retarder brake torque analysis

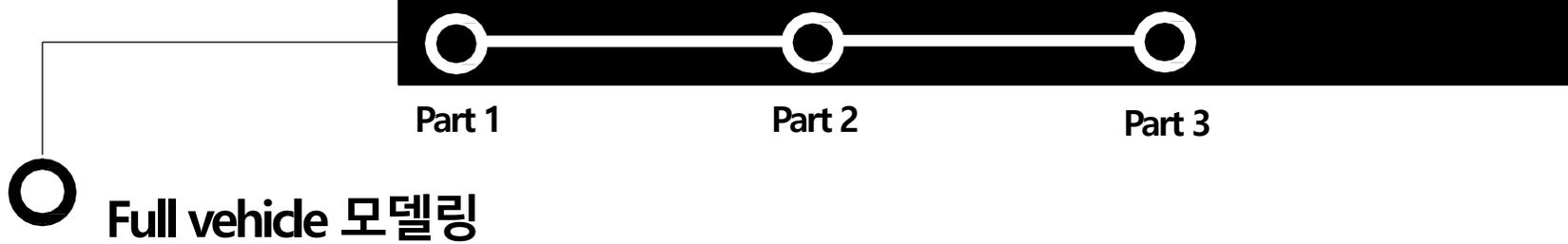
Rpm	800	1000	1200	1400	1600	1800	2000
물부피(%)							
20	35	47	60	79	97	118	142
40	41	52	66	82	105	124	148
60	50	68	90	112	140	178	217
80	80	114	152	200	255	317	387
95	118	170	237	315	407	500	620

simulation

Table 2. The Simulation Result of the Torque

speed liquid filled ratio	800 r/min	1000 r/min	1200 r/min	1400 r/min	1600 r/min	1800 r/min	2000 r/min	2200 r/min
10%	14.2	22.3	35.3	56.3	82.0	123.7	158.0	173.0
20%	27.4	45.3	75.6	107.8	163.3	259.5	273.4	346.6
30%	42.3	71.3	109.5	163.5	247.8	361.5	405.0	543.1
40%	56.9	88.0	132.5	217.5	330.5	489.6	550.3	694.2
50%	67.1	110.8	170.8	271.1	402.5	592.6	721.8	879.1
60%	80.5	131.8	196.5	321.5	485.9	721.3	867.9	1058
70%	94.0	156.4	228.8	380.4	574.9	836.6	971.0	1195
80%	109.9	178.6	263.5	479.5	649.7	945.8	1087	1412
90%	123.8	197.8	299.7	506.1	739.0	1068	1204	1531
95%	126.8	211.1	313.1	570.4	776.8	1127	1318	1678

Thesis



현대 메가트럭(5톤)

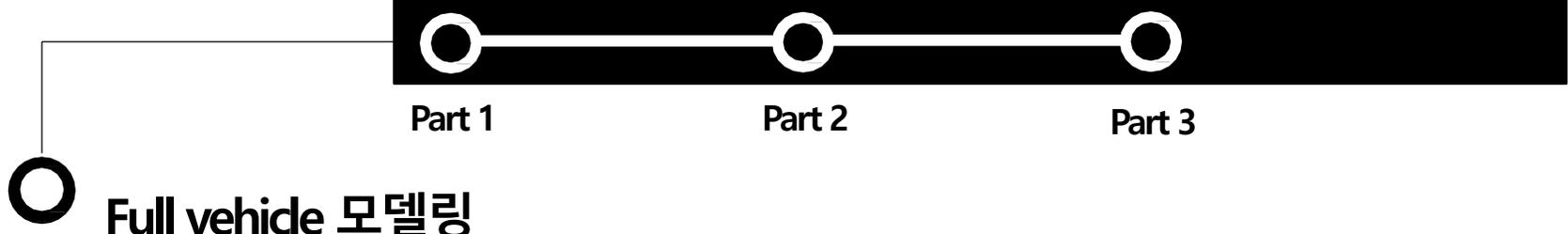
- Vehicle mass = 5000kg (수하물 적당히 실었다 가정)
- Tire radius = 25cm
- Vehicle inertia = $312.5\text{kg}\cdot\text{m}^2$

가정

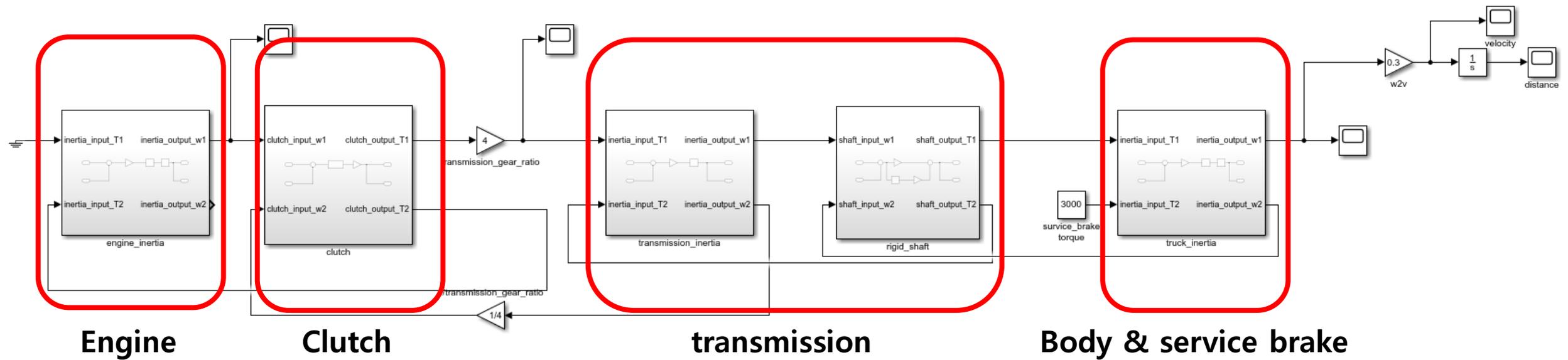
- Engine inertia = $1\text{kg}\cdot\text{m}^2$
- Retarder brake inertia = $1\text{kg}\cdot\text{m}^2$
- Transmission inertia = $1\text{kg}\cdot\text{m}^2$
- Transmission gear ratio : 4
- Retarder brake gear ratio : 4
- Service braking torque = 3000Nm
- Vehicle velocity = 50km/h

메가트럭

구분	메가트럭 (4.5톤/5톤)			메가트럭 와이드캡 (4.5톤/5톤)			
	초장축	초장축 플러스	초장축 플러스 7.4	와이드캡 8.3	와이드캡 8.9		
일반	전장 (mm)	8,660	9,410	9,820	10,825	11,425	
	전폭 (mm)	2,420	2,420	2,495	2,495	2,495	
	전고 (mm)	2,660	2,660	2,660	3,105	3,105	
	적재함	장 (mm)	6,250	7,000	7,400	8,300	-
		폭 (mm)	광폭 : 2,280 평폭 : 2,120	2,280	2,350	2,350	-
		고 (mm)	400	400	400	400	-
	최저지상고	180	180	180	220	220	
	상면지상고 (mm)	1,140	1,140	1,140	1,210	-	
	W.B (축간거리) (mm)	4,895	5,395	5,695	6,200	6,600	
	최대 적재량 (톤)	4.5/5	4.5/5	4.5/5	4.5/5	4.5/5	
엔진	엔진	G엔진	G엔진	G엔진	G엔진	G엔진	
	총배기량(ℓ)	6.3	6.3	6.3	6.3	6.3	
	엔진성능 (PS/kgm)	280/95	280/95	280/95	300/110	300/110	
	연료탱크용량 (ℓ)	250	250	250	400 (200+200)	400 (200+200)	
타이어	전 (싱글)	245/70R19.5-14PR	245/70R19.5-18PR	245/70R19.5-18PR	12R22.5-16PR	12R22.5-16PR	
	후 (더블)	245/70R19.5-14PR	245/70R19.5-18PR	245/70R19.5-18PR	245/70R19.5-14PR	245/70R19.5-14PR	
어플리케이션	전축	6,000	6,000	6,000	7,100	7,100	
	후축	9,500	9,500	9,500	9,500	9,500	



Service brake only





Full vehicle 모델링

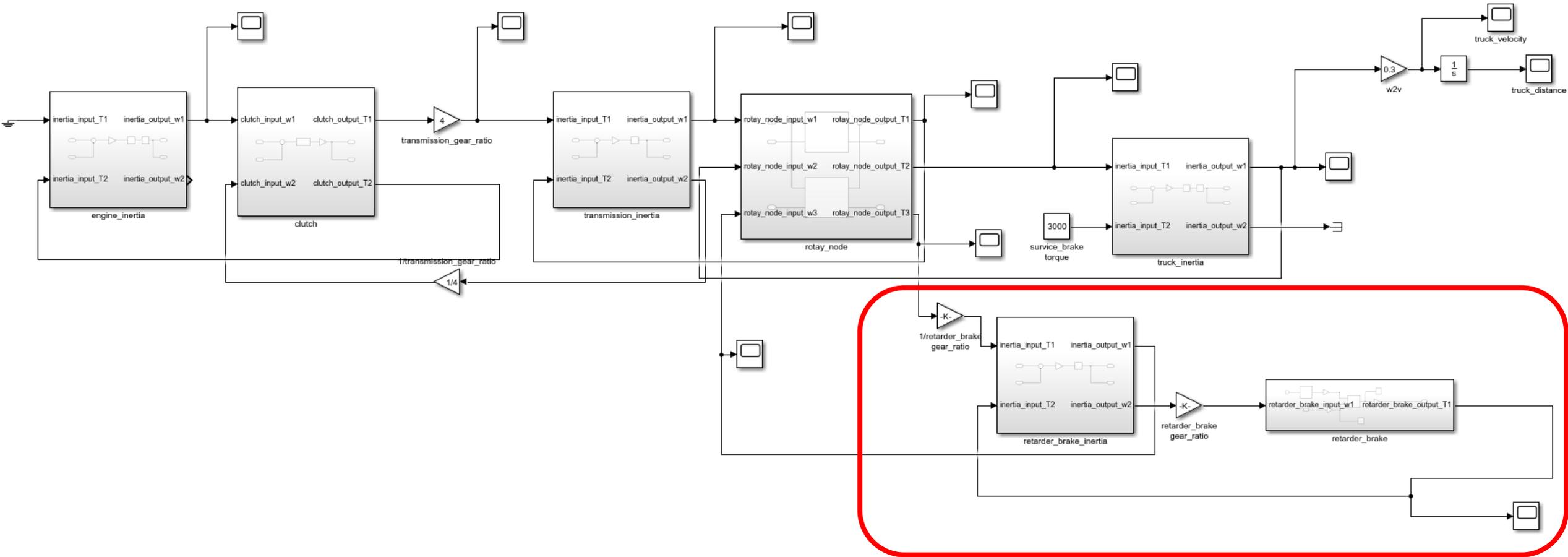


Part 1

Part 2

Part 3

Service + Retarder brake

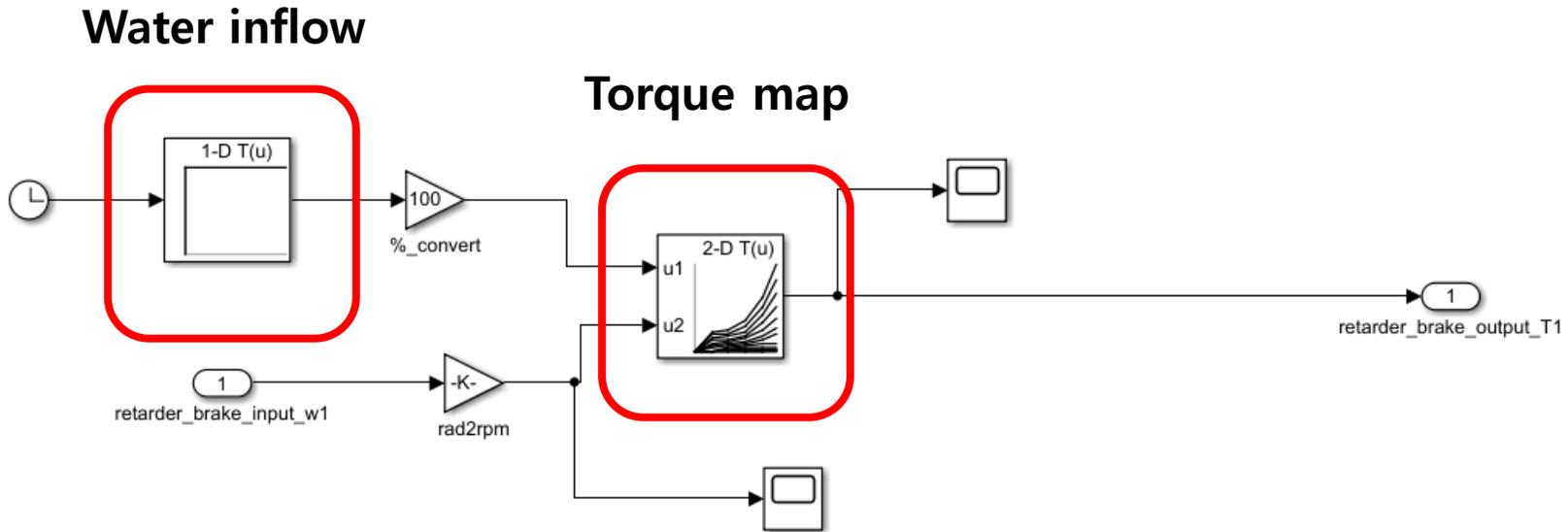


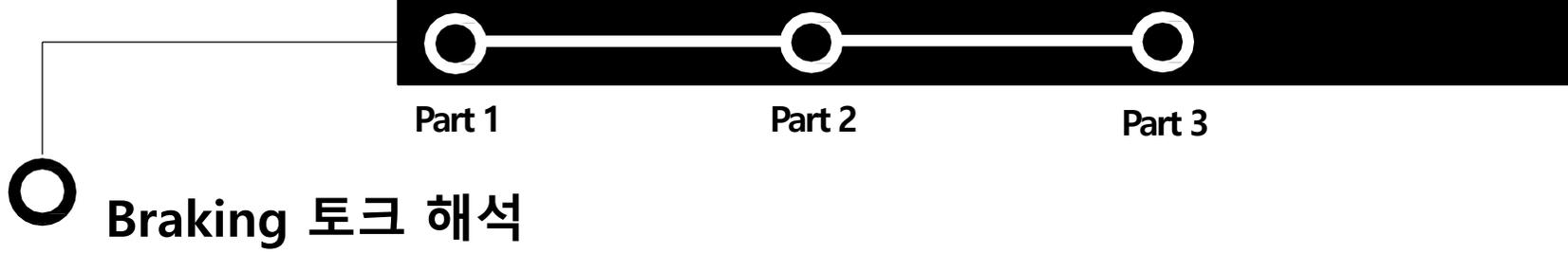
Retarder brake



Full vehicle 모델링

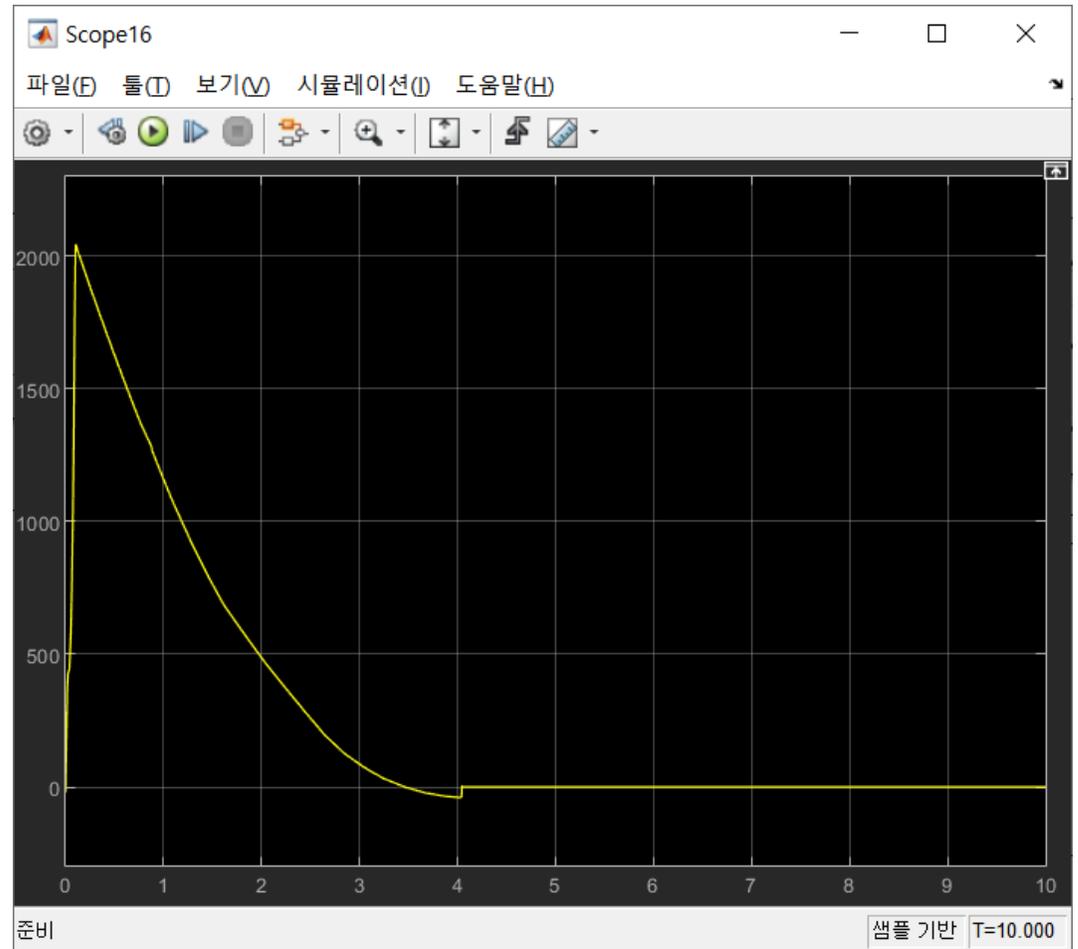
Retarder brake 모델링

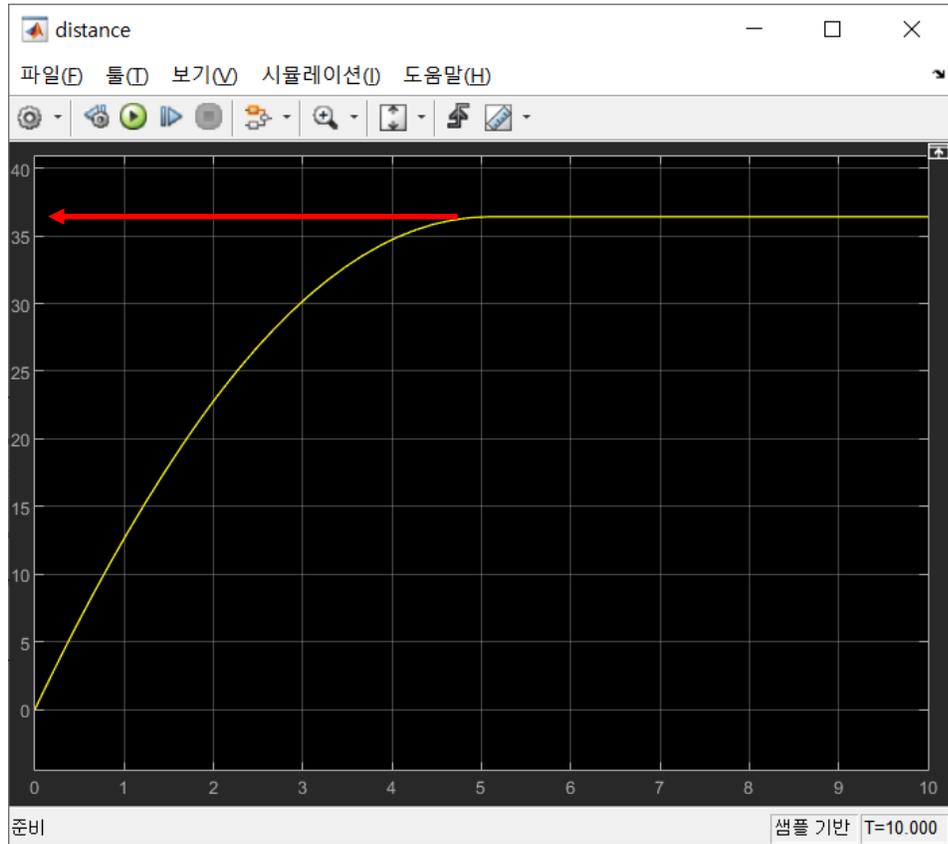
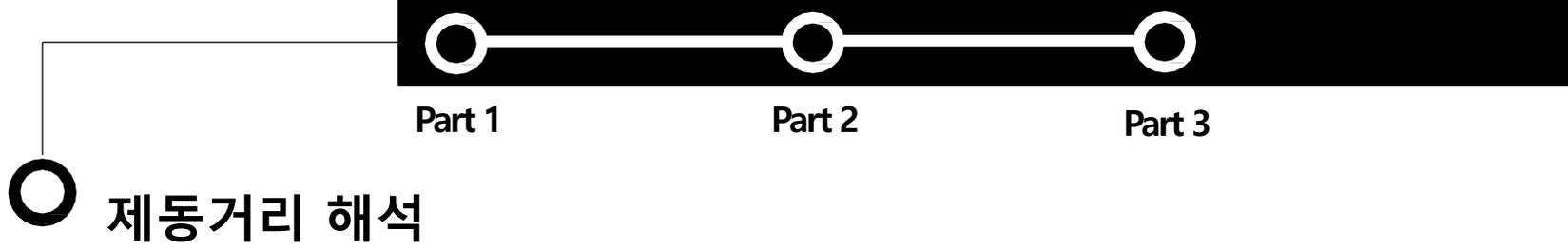




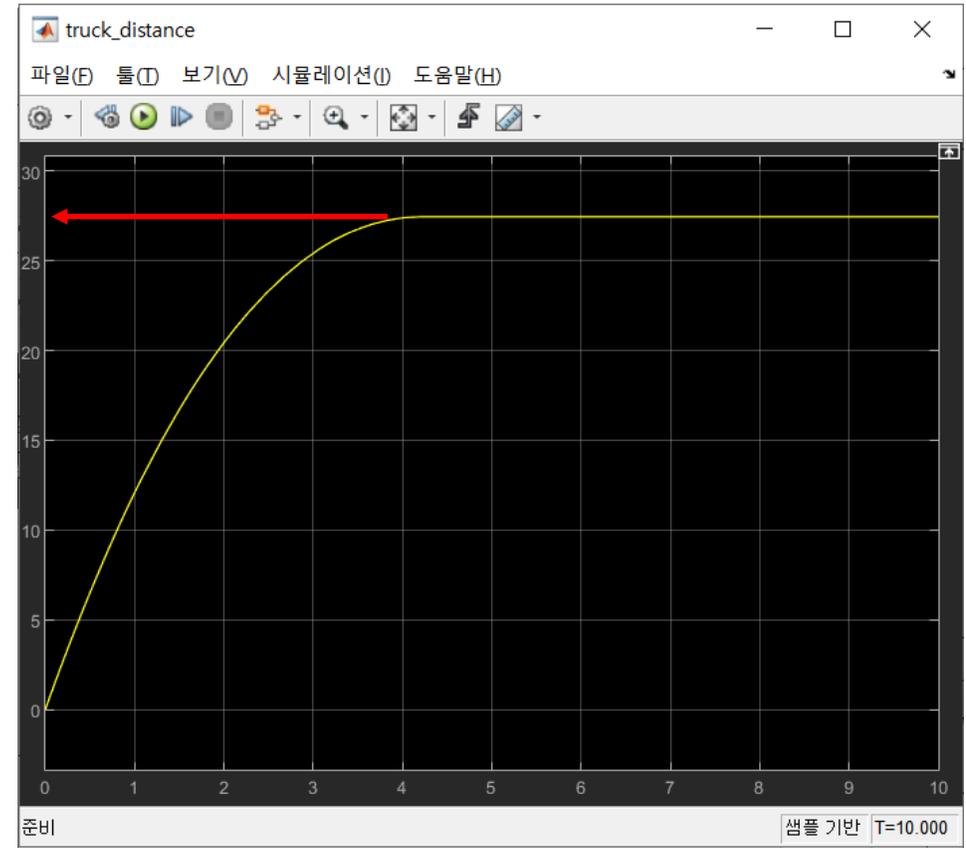
➔ Braking 토크 값 확인

➔ 속도에 따른 토크 경향성 확인

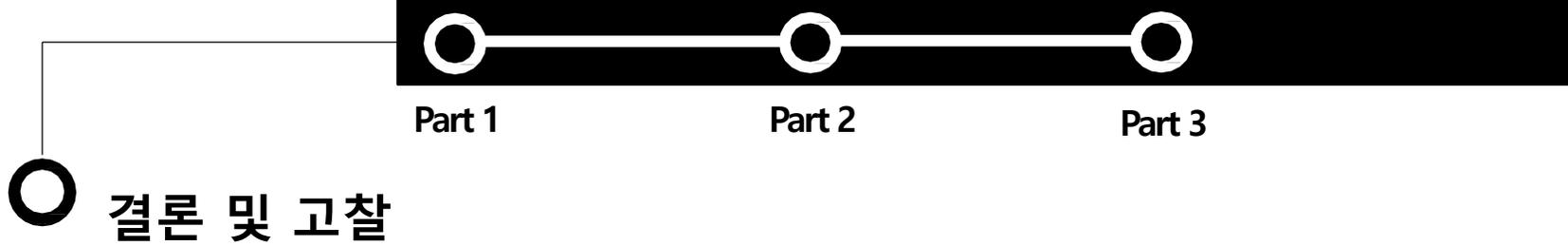




Service brake only



Service + retarder brake



-Retarder brake 사용시 service brake만 사용할 때보다 제동거리와 제동시간이 유의미하게 줄어들 수 있었다.

-제동거리를 측정하기 위해 제동거리 정의에 따라 50km/h로 주행 중 brake torque를 구해 service brake의 torque 비중이 더 컸지만, 더 높은 속도에서는 retarder brake의 torque비중이 더 클 것이라 예상할 수 있다.

-3D -> 2D 모델링과정에서 실제와 많은 차이가 발생하였을 것이다.

-실제 5톤 트럭의 정확한 제원을 알았다면 더 정확한 Simulation을 할 수 있었을 것이다.



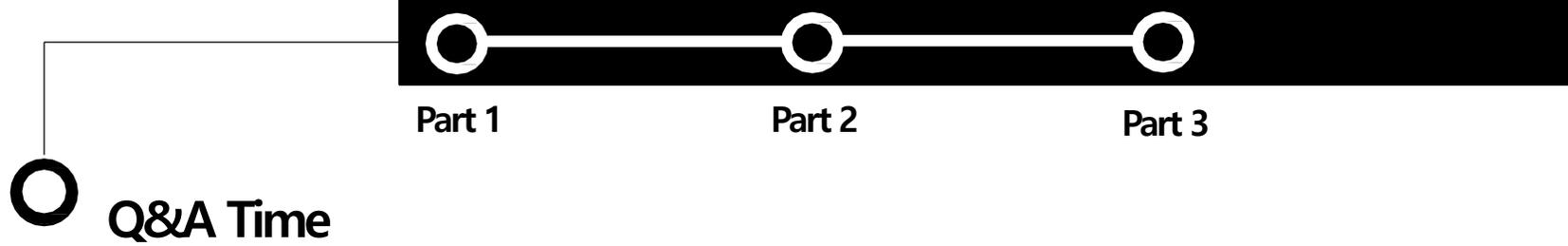
Reference



HYDRAULIC RETARDERS FOR HEAVY VEHICLES: ANALYSIS OF FLUID MECHANICS AND COMPUTATIONAL FLUID DYNAMICS ON BRAKING TORQUE AND TEMPERATURE RISE
Hongpeng Zheng, Yulong Lei* and Pengxiang Song State Key Laboratory of Automobile and Control, College of Automotive Engineering, Jilin University, Changchun 130025, China
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Simulation Study of the Vehicle Hydraulic Retarder Li Ronghao^{1,a}, Yang Jue^{1,b} and Zhang Wenming^{1,c}
¹ School of Mechanical Engineering, University of Science and Technology Beijing, Beijing 100083, China a.lironghao1213@163.com, b.yangjue@ustb.edu.cn, c.Wenmingzhang@ustb.edu.cn

Flow and performance analyses of a partially-charged water retarder
Nahmkeon Hur Mohammad Moshfeghi Wonju Lee Department of Mechanical Engineering, Sogang University, Seoul, Korea Multi-Phenomena CFD Engineering Research Center , Seoul , Korea



Thank you for listening