

기계시스템공학실험1

전자 저울의 원리 및 RLDA

교수: 오충석 [x7323, T443]

조교: 정상진/이명석

KIT

I. (주) 카스 (CAS)

■ 역사

- 1983 설립 (부국정밀기계)
- 1987 첫 전자저울 수출 (포르투갈)
- 1989 무역의 날 100만불 수출탑
- 1997 에밀레종 무게 잴 (18.9 tonf)
- 2000 전자저울 누적생산 100만대
- 2002 수출 1억불
- 2013 World Class 300 기업 선정
- 2019 A380 최초 계량

■ 시장 점유율

- 국내 70%, 미국 20%, 세계 20%



- 홈페이지
 - <http://www.cas.co.kr/>
- 홍보 영상 [07:51]
 - “We weigh the world.”



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II. 전자저울의 원리

- 역공학 (Reverse Engineering)
 - 모델: CAS SW-02 (2009년)
 - 사양
 - 최대 중량 2 kgf
 - 가독성 1 gf
 - 분해능 1/2000
 - 외형 크기 260 (W) × 287 (D) × 137 (H) [mm]
 - 제품 무게 2.8 kgf
 - 디스플레이 LCD (5 자리)



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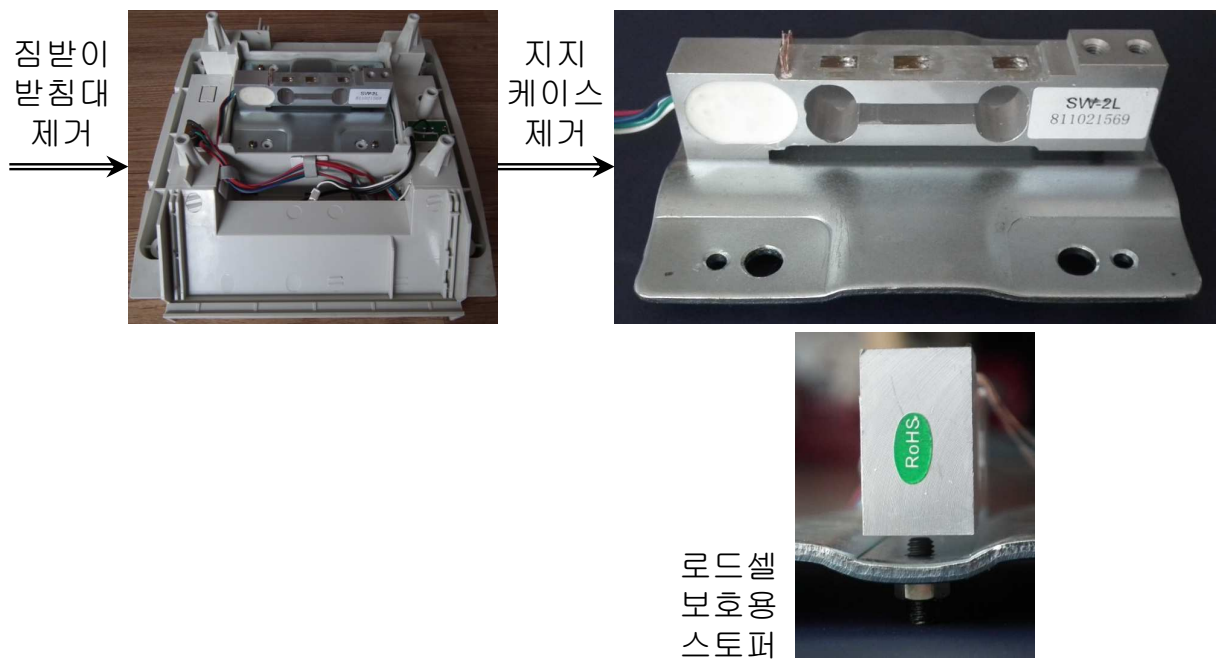
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■ 분해 (Tear Down)



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로드 셀
보호용
스토퍼

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로드셀
분리

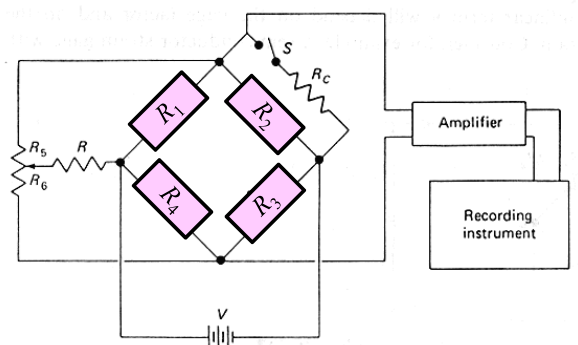
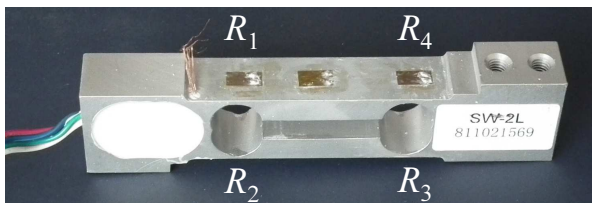


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■ 저항 값

- Full Bridge: 곁힘 로드셀
- $R_1 \sim R_4 = R \approx 1,000 \Omega$, $S_g = 2.0$ (가정)



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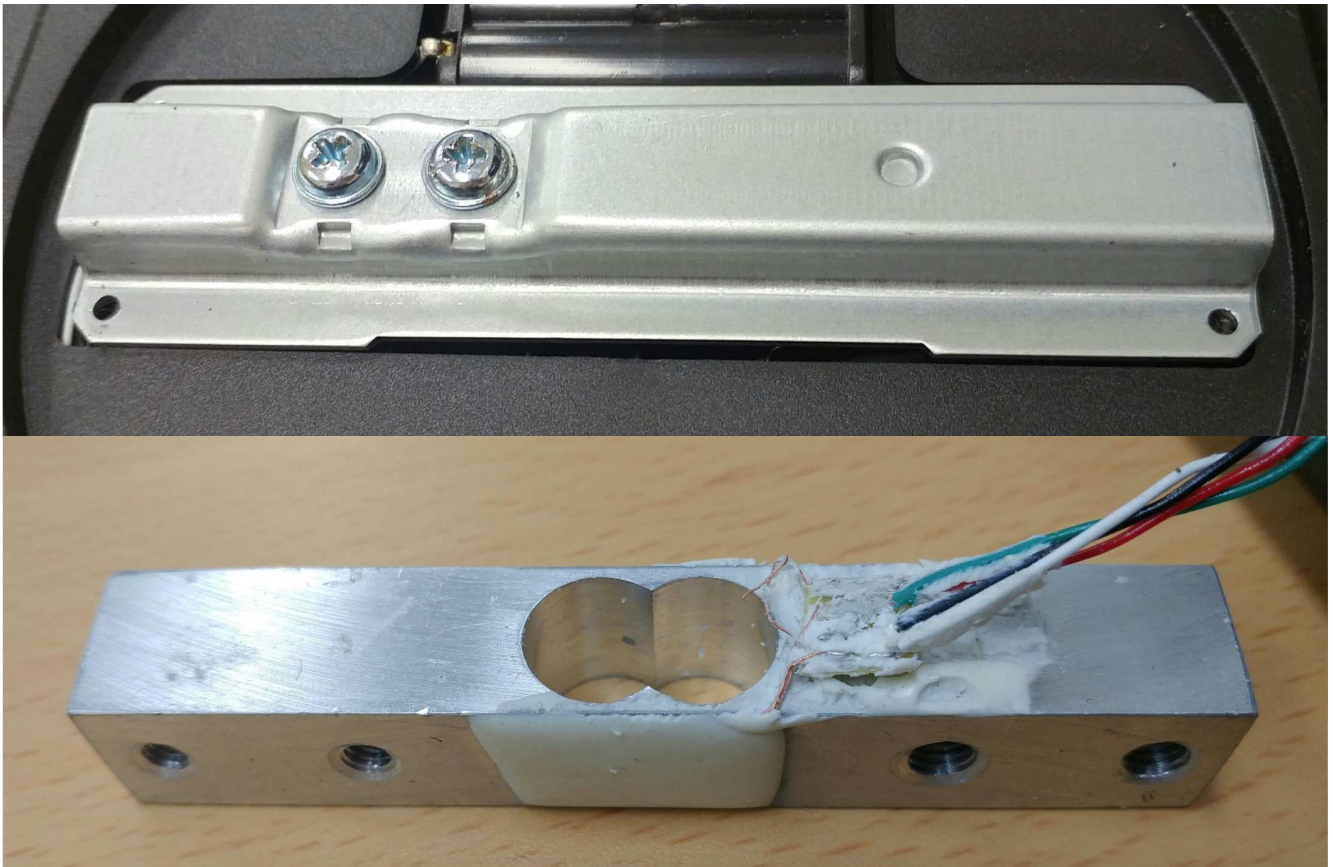
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III. 전자 저울

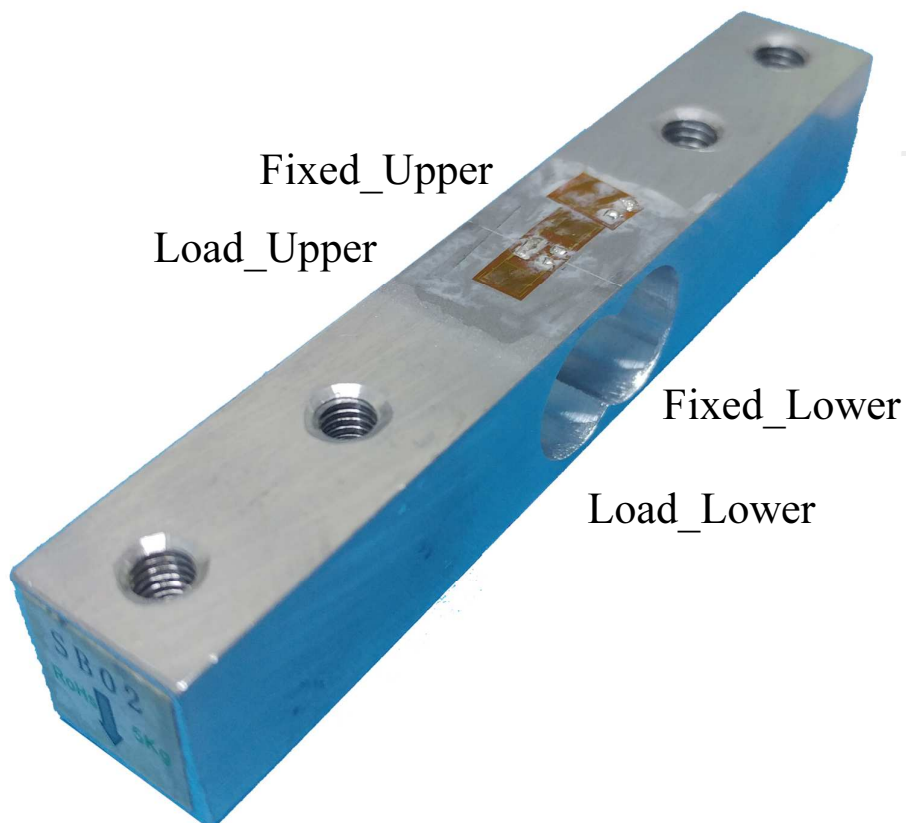
OXO Good Grips (11 lb)
\$40~\$60





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The **R**estriction **o**f the use of certain **H**azardous **S**ubstances
in electrical and electronic equipment

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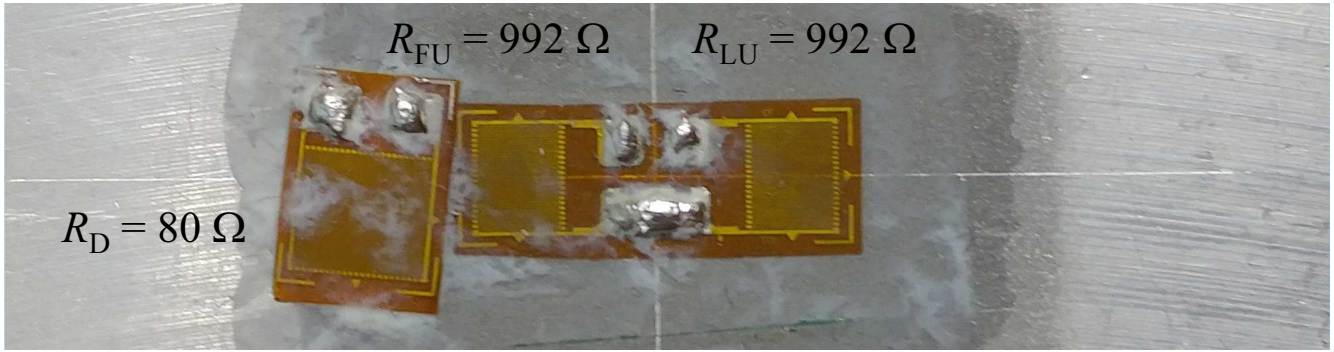
Fixed_Upper

Load_Upper

$$R_{FU} = 992 \, \Omega$$

$$R_{LU} = 992 \, \Omega$$

$$R_D = 80 \, \Omega$$

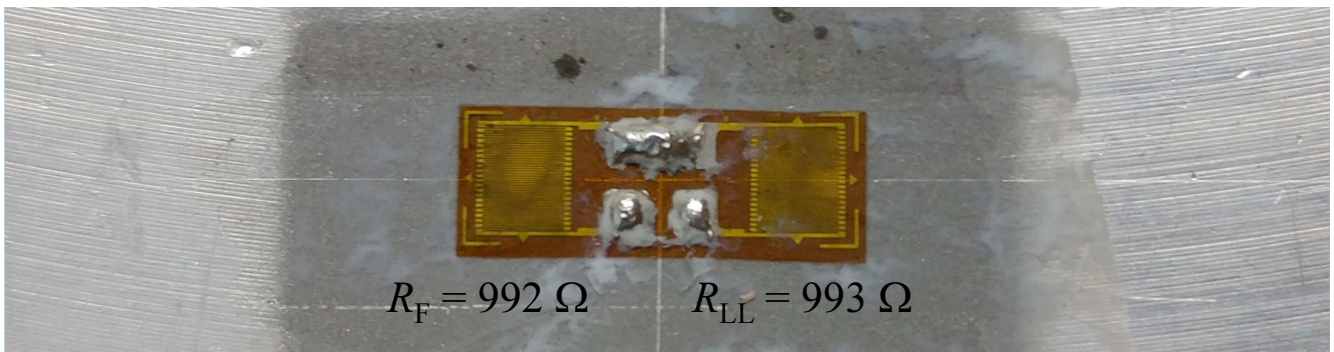


Fixed_Lower

Load_Lower

$$R_F = 992 \, \Omega$$

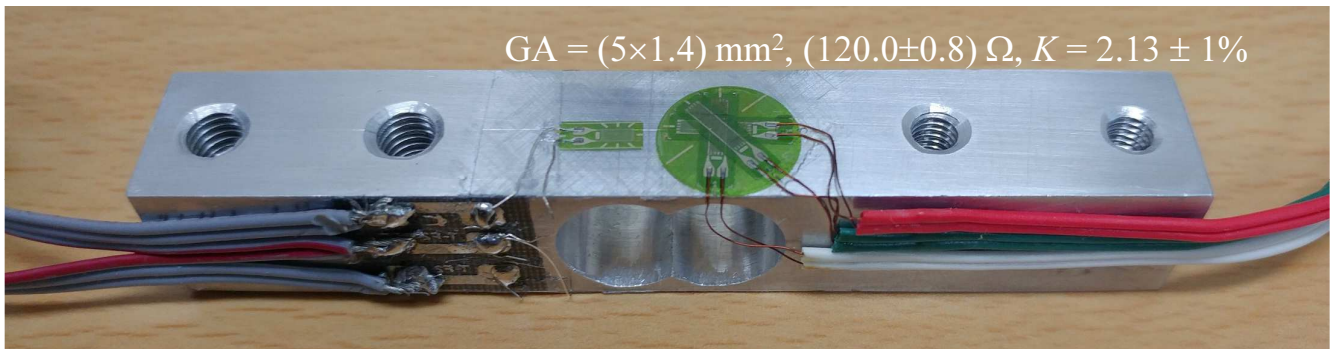
$$R_{LL} = 993 \, \Omega$$



Fixed_Upper

Load_Upper

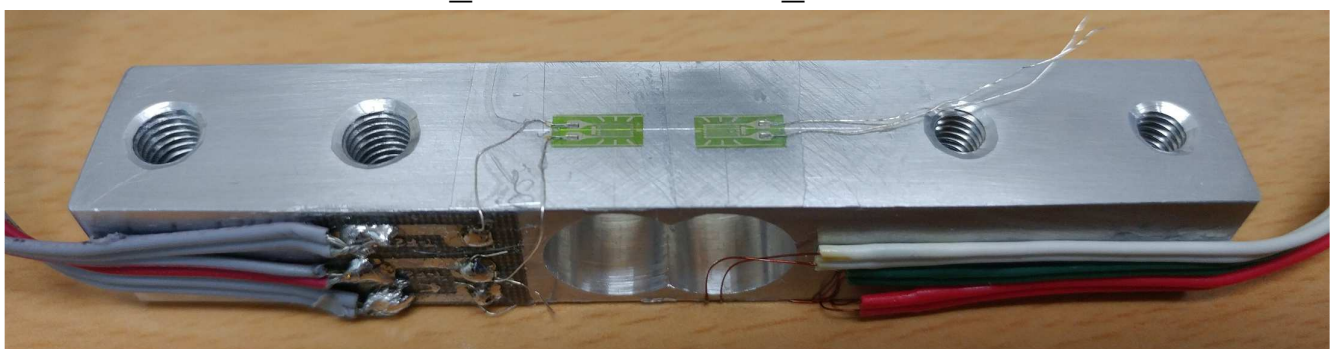
$$GA = (5 \times 1.4) \, \text{mm}^2, (120.0 \pm 0.8) \, \Omega, K = 2.13 \pm 1\%$$



$$GA = (2 \times 1.2) \, \text{mm}^2, (120.2 \pm 0.2) \, \Omega, K = 2.12 \pm 1\%$$

Fixed_Lower

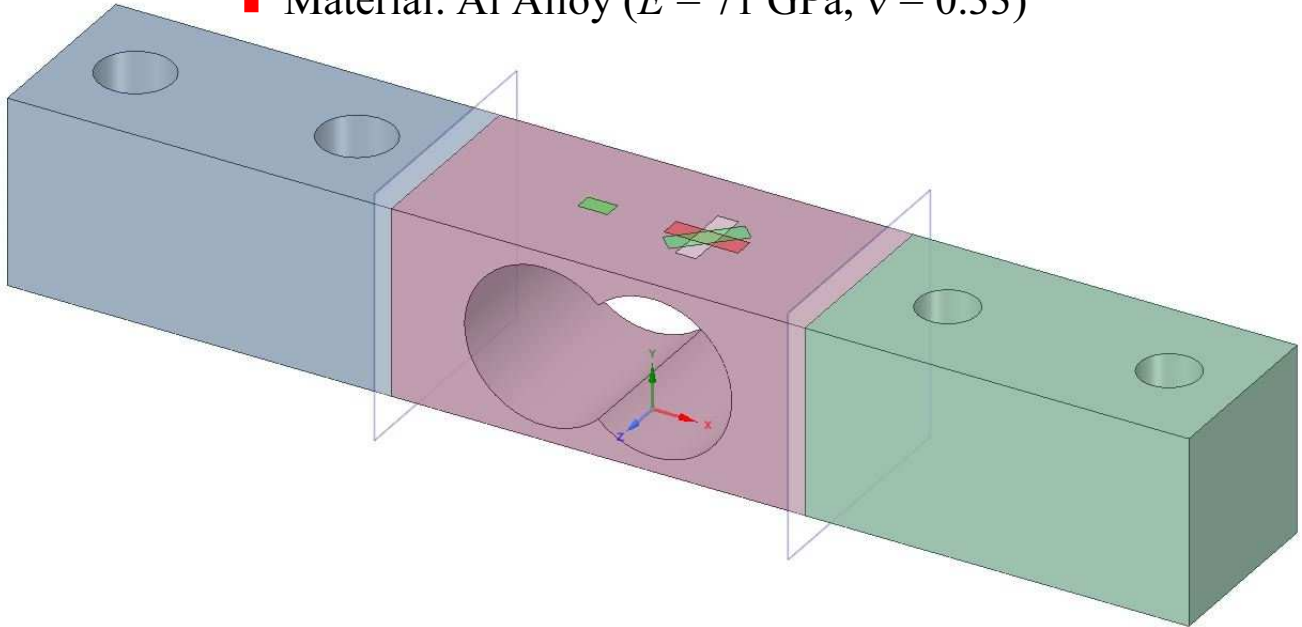
Load_Lower



- Computation

- Geometry

- Material: Al Alloy ($E = 71 \text{ GPa}$, $\nu = 0.33$)



A: Static Structural

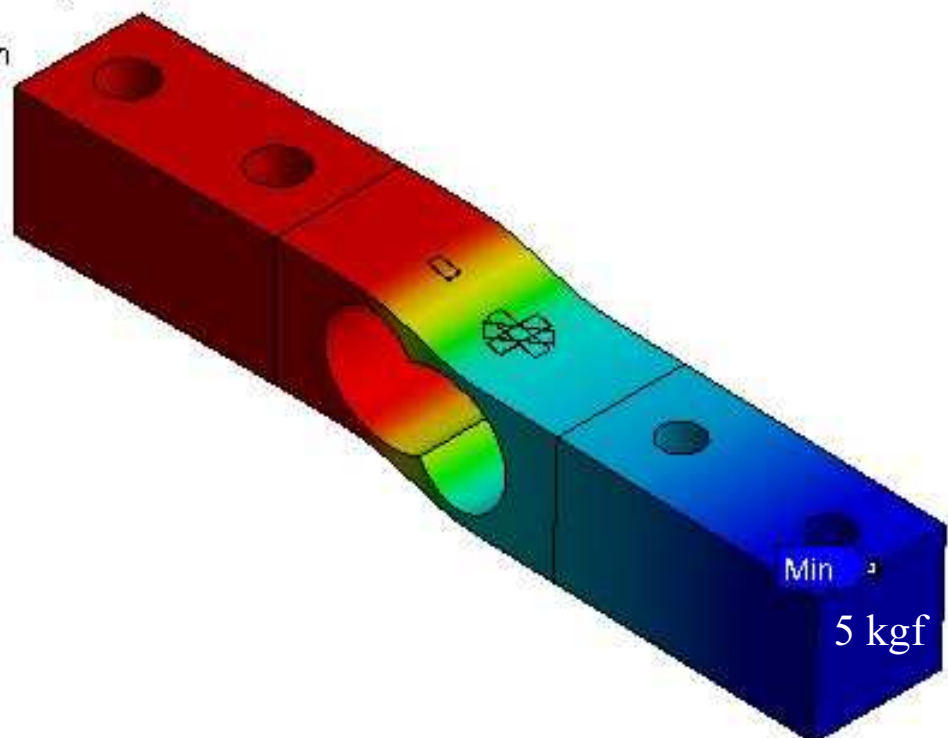
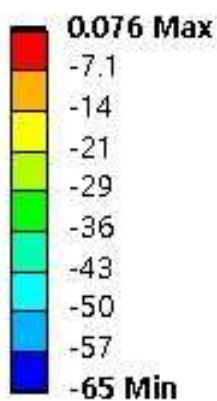
Y Axis - Directional Deformation - 1. s

Type: Directional Deformation(Y Axis)

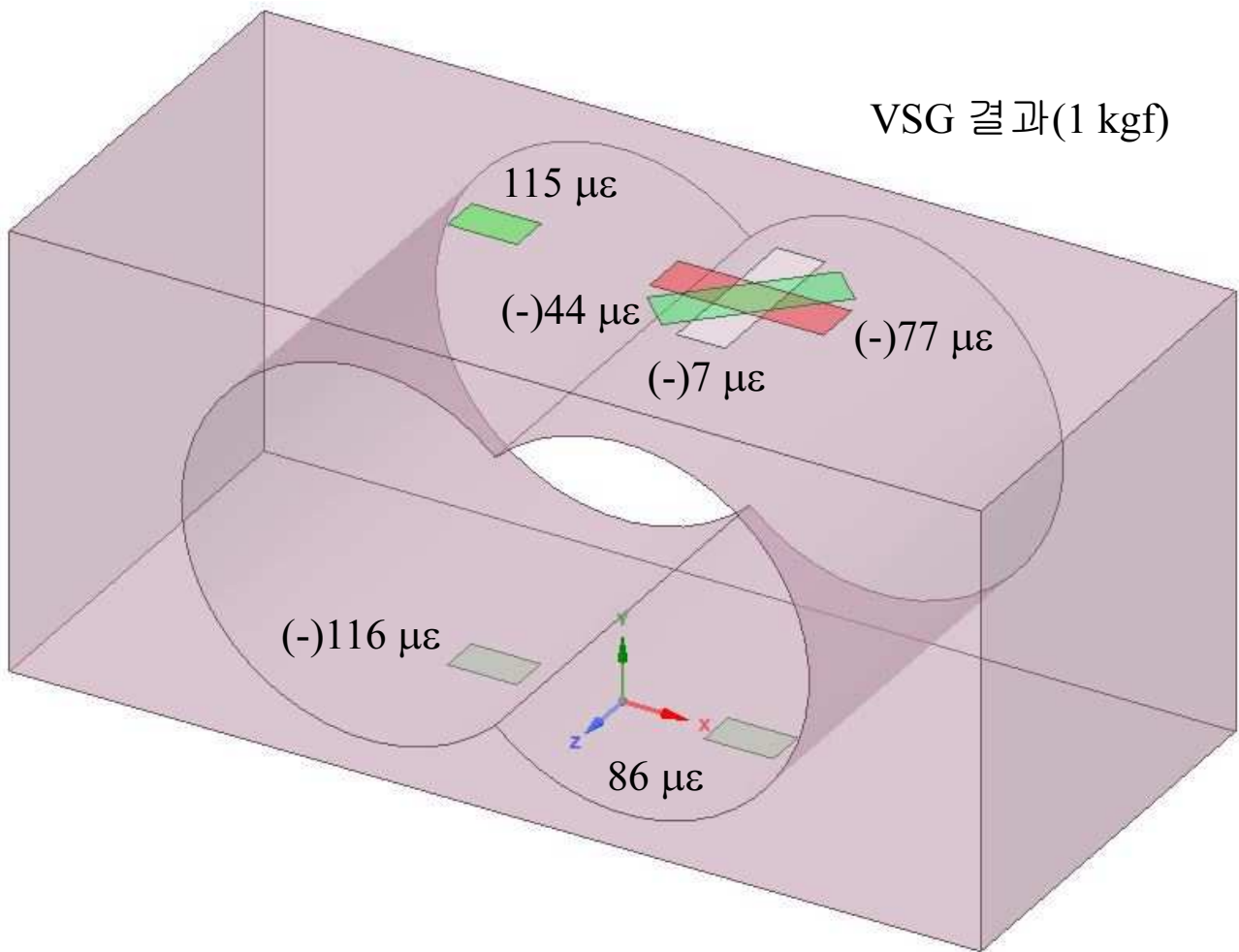
Unit: μm

Global Coordinate System

Time: 1



VSG 결과(1 kgf)



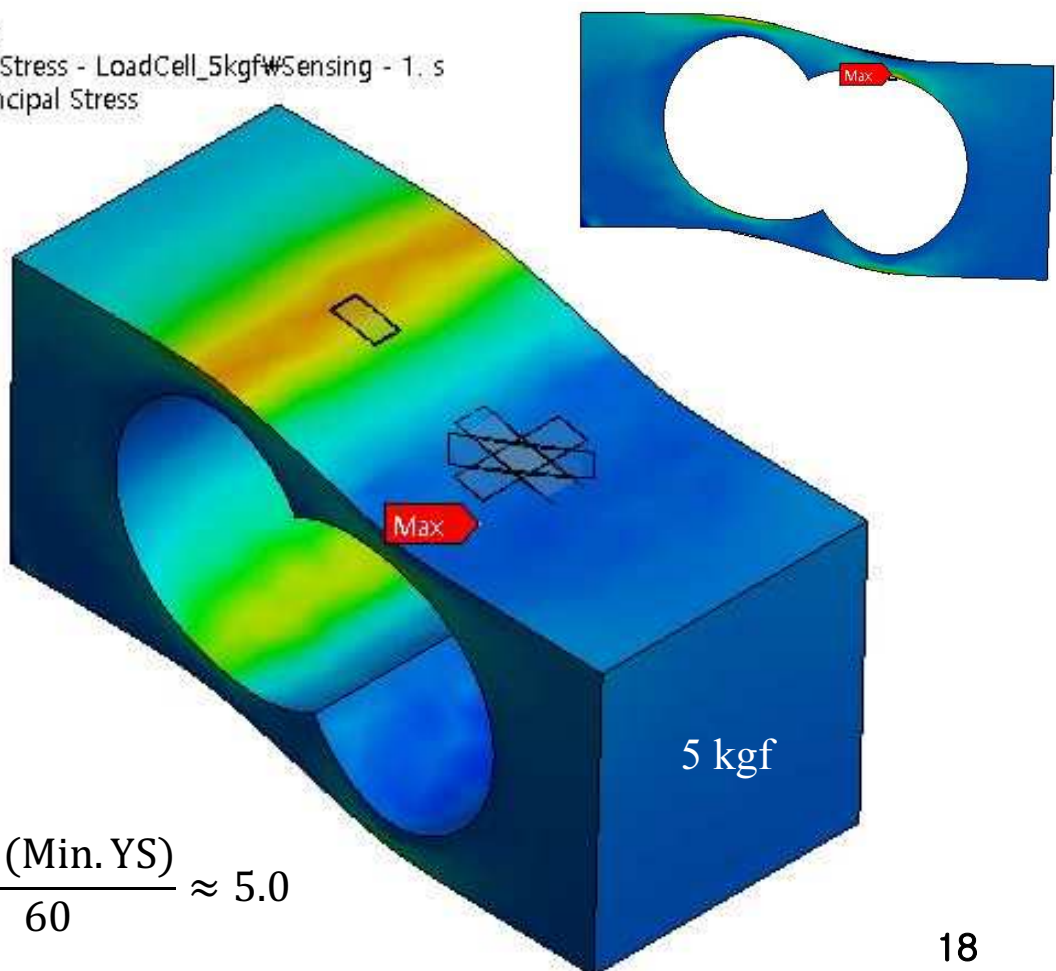
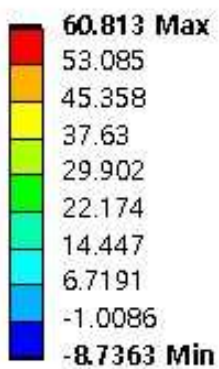
A: Static Structural

Maximum Principal Stress - LoadCell_5kgfWSensing - 1. s

Type: Maximum Principal Stress

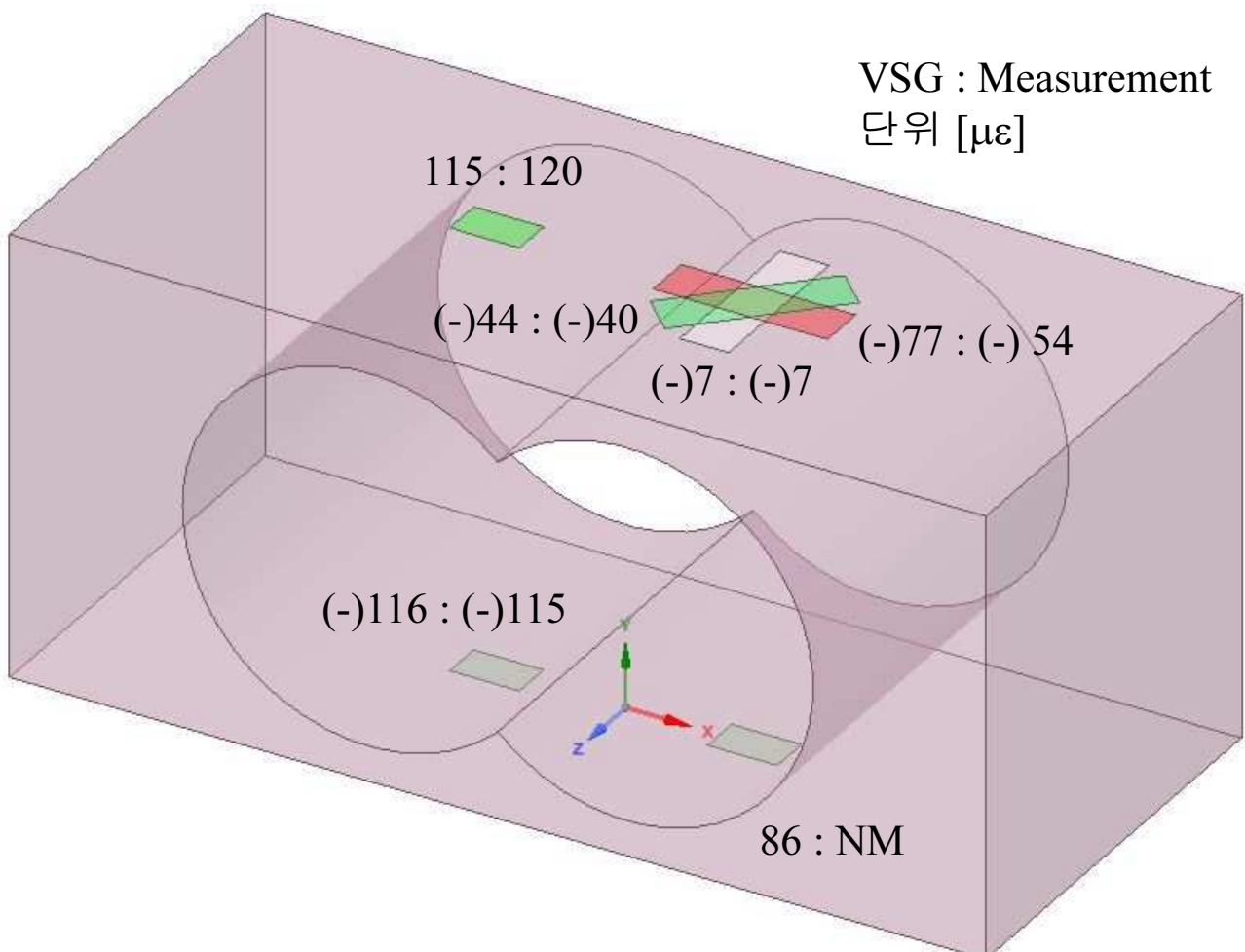
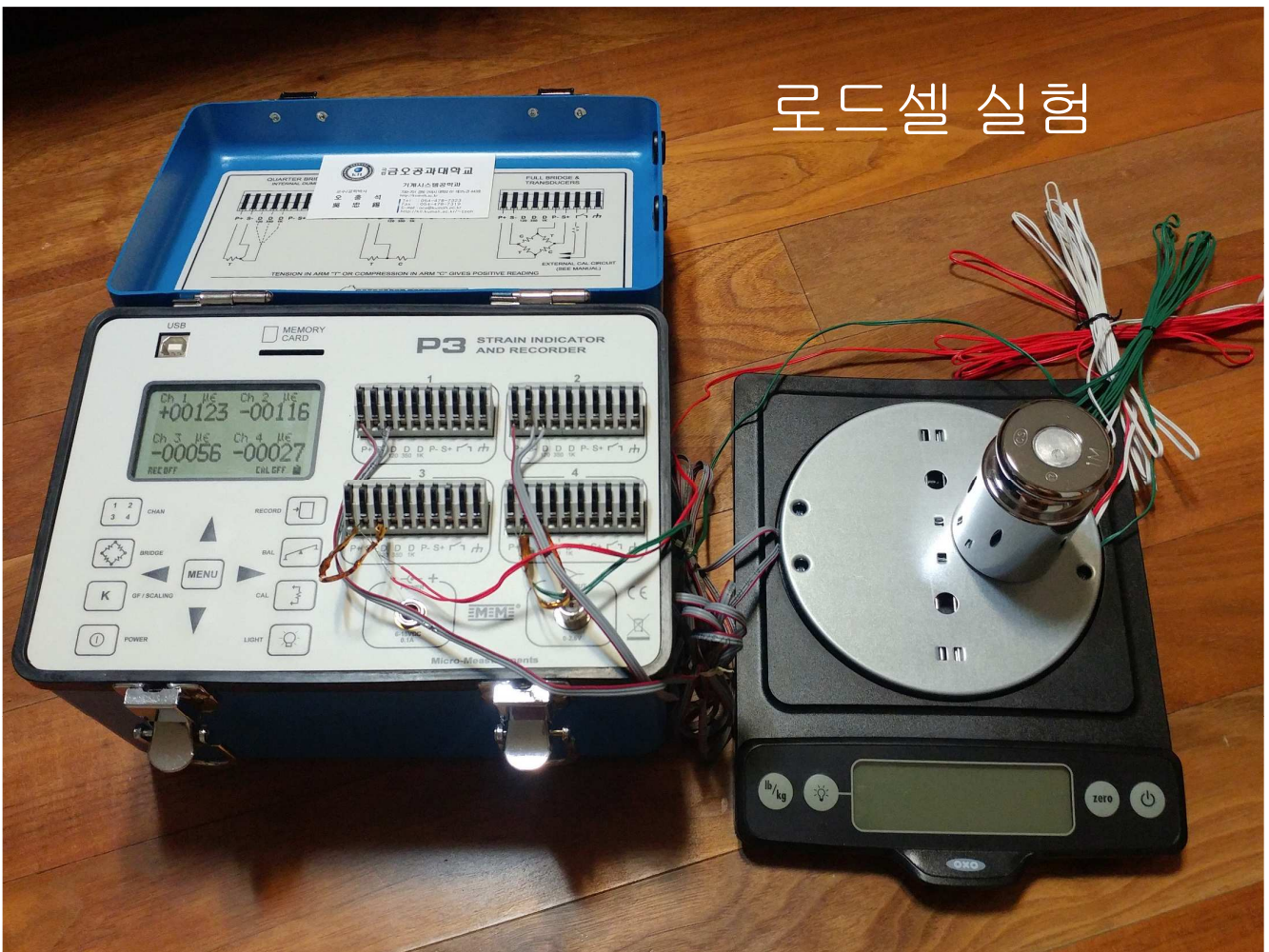
Unit: MPa

Time: 1



$$SF = \frac{300 \text{ (Min. YS)}}{60} \approx 5.0$$

로드셀 실험



IV. RLDA

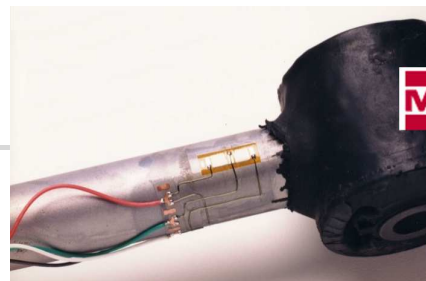
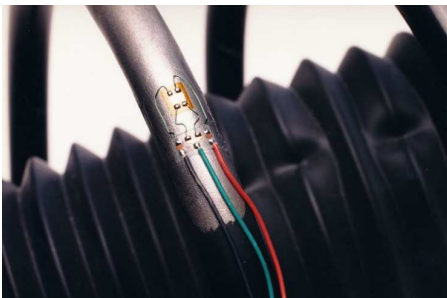
- Road Load Data Acquisition (RLDA)
 - 도로 부하(하중) 데이터 획득
 - 수송 기계 설계 시 기초 데이터
- 필요한 장비
 - 각종 변환기(transducers) 및 증폭기(amplifiers)
 - 데이터 저장 장치(data logger)
- Proving Ground
 - 각종 수송 기계 가속 내구 시험 (실외)
 - Milbrook PG [04:20]



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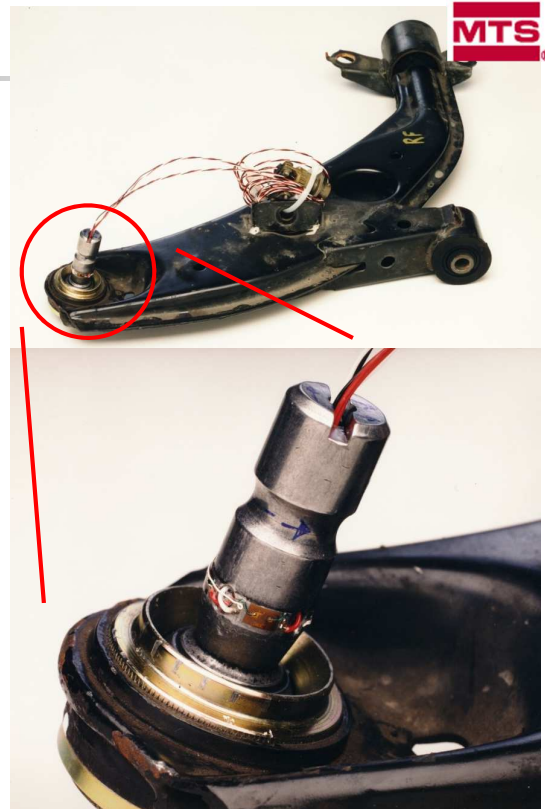
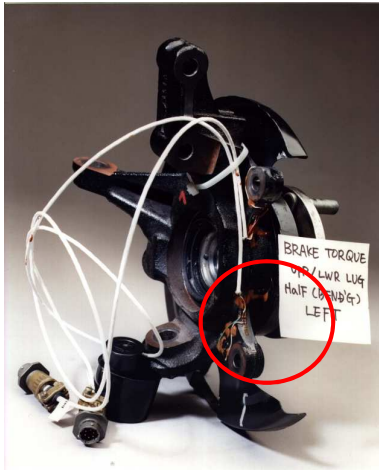
- 자동차용 Field Test
 - Trailing Link, Rear Lateral Link, Strut & Spring



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- Ball Joint
- Disk Brake



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■ Road Simulation

■ 목적

- 가속 내구 시험(실내)

■ 과정

- 1) 각종 변환기 장착
- 2) RLDA
- 3) 데이터 편집: 무효 데이터 제거
- 4) Road Simulator에 장착
- 5) 입력: 편집된 Road 데이터
- 6) 출력: RLDA 시 변환기를 통해 측정된 데이터
- 7) 반복 시험 및 검증



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V. 변환기 보정 방법

■ 보정 (Calibration)

- 각종 변환기 (transducers) 성능 평가
- 변환기를 통한 실제 물리량 측정

■ 보정 절차

- 알고 있는 값 (x)과 변환기 출력 값 (y) 비교
 - $y = f(x) = ax + b$ (가능한 한 직선 식)

변환기	x	y
로드셀	W	변형률, 앰프 출력
가속도계	a	변형률, 앰프 출력

- 변환기 출력 값 (y)을 통한 실제 물리량 (x) 측정
 - $x = g(y) = cy + d$ (가능한 한 직선 식)

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