

MET-211 Lab 4 Group 7

Fatigue Test

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Polytechnic Institute



Lab 4: Goals of the Lab

Properties and Stress Concentrations

1. Use the fatigue tester to determine the failure of test specimen.
2. Present the **results** of your investigation in the laboratory to the class so the data can be combined with others and compared.

Specimen in Fatigue Tester

1. Variation: Elastic Modulus

Determine how much variation exists in the Elastic Modulus of a selection of steel samples due to alloy and geometry.

Elastic Modulus (Young's Modulus) (*Stiffness of a material*)

The modulus of elasticity, E , is a measure of the stiffness of a material determined by the slope of the straight-line portion of the stress-strain curve. It is the ratio of the change of stress to the corresponding change in strain. [textbook, p. 59]

$$E = \frac{\text{stress}}{\text{strain}} = \frac{\sigma}{\epsilon}$$

1. Variation: Typical Stress-Strain Curve

Determine how much variation exists in the Elastic Modulus of a selection of steel samples due to alloy and geometry.

Typical Stress-Strain Curve: Low Carbon Steel

A. Proportional Limit:

Straight line indicates stress is proportional to strain.

B. Elastic Limit:

Material will return to original size and shape if load is removed. At higher stresses material is permanently deformed.

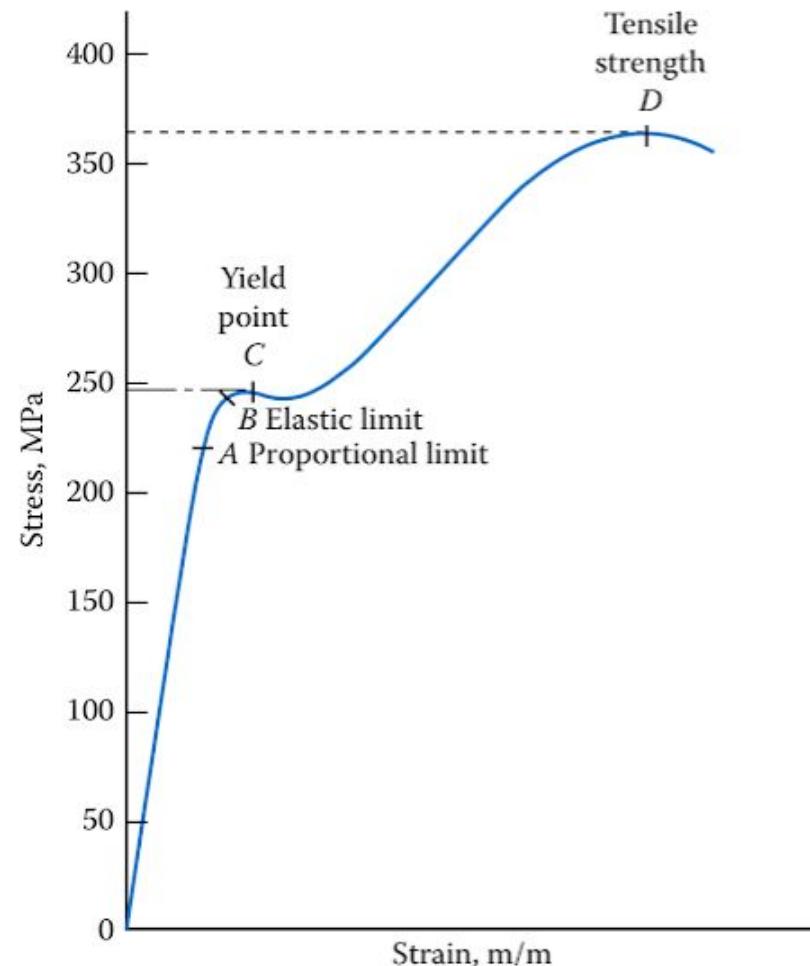
C. Yield Point: 248 MPa (36,000 psi)

Stress at which a noticeable elongation of the sample occurs with no apparent increase in load.

D. Tensile Strength: 365 MPa (54,000 psi)

Highest Value of apparent stress.

[textbook, pp. 56-57]



Source: Typical stress-strain curve for steel. [textbook, p. 57]

1. Variation: Specimen Material Properties

Determine how much variation exists in the Elastic Modulus of a selection of steel samples due to alloy and geometry.

AISI 12L14 Carbon Steel (UNS G12144) (Low Carbon Steel)

AISI (American Iron and Steel Institute)

	Metric	English
Density	7.87 g/cm ³	0.284 lb/in ³
Elastic modulus	190-210 GPa	27557-30458 ksi
Yield Point	415 MPa	60200 psi
Tensile strength	540 MPa	78300 psi
Elongation at break	10%	10%
Reduction of area	35%	35%
Poisson's ratio	0.27-0.30	0.27-0.30

Source: [aisi]

Material type verified with a Olympus X DELTA Professional Handheld XRF Analyzer

X-Ray Diffraction (XRD) is a laboratory-based technique commonly used for identification of crystalline materials and analysis of unit cell dimensions. [xrd]



Source: [delta]

1. Variation: Typical vs. AISI 12L14

Determine how much variation exists in the Elastic Modulus of a selection of steel samples due to alloy and geometry.

	Typical Carbon Steel		AISI 12L14 Carbon Steel	
	Metric	English	Metric	English
Elastic modulus	207 GPA	30,000 ksi	190-210 GPa	27,557-30,458 ksi
Yield Point	248 MPa	36,000 psi	415 MPa	60,200 psi
Tensile strength	365 MPa	54,000 psi	540 MPa	78,300 psi
Elongation at break	9-36%	9-36%	10%	10%
Poisson's ratio	0.29	0.29	0.27-0.30	0.27-0.30

2. Testing Procedure



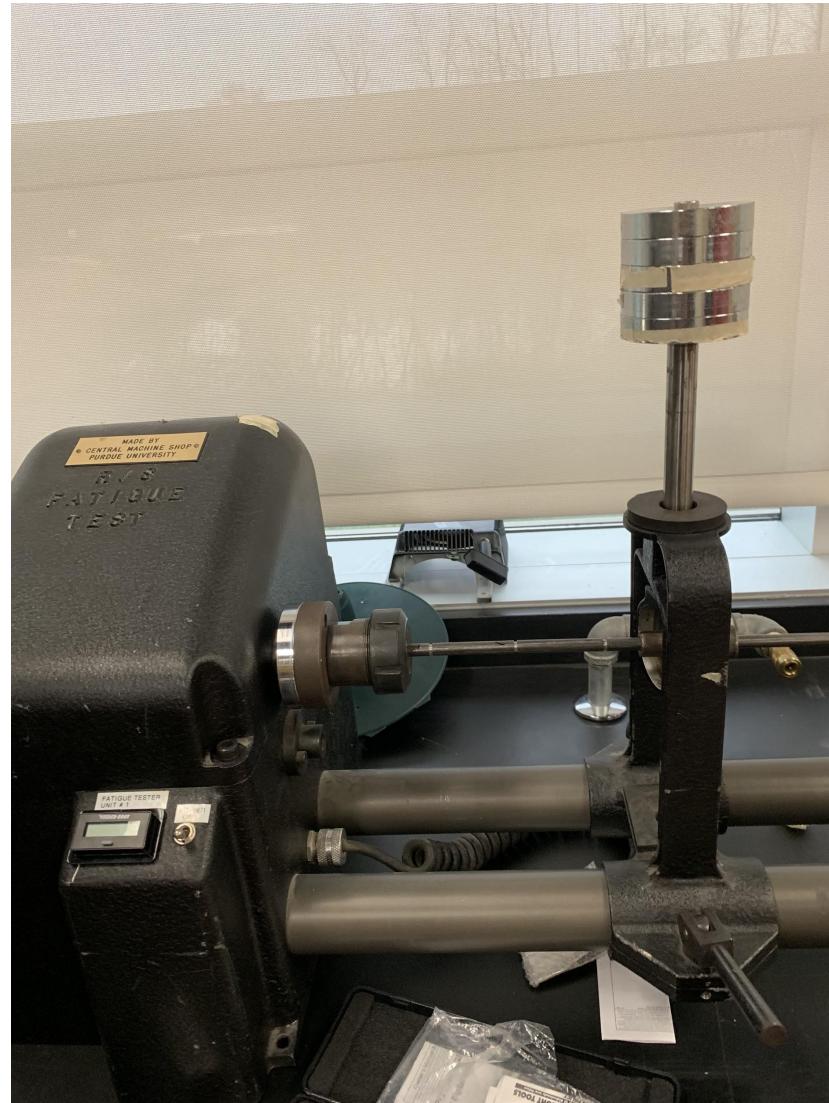
2. Testing Procedure



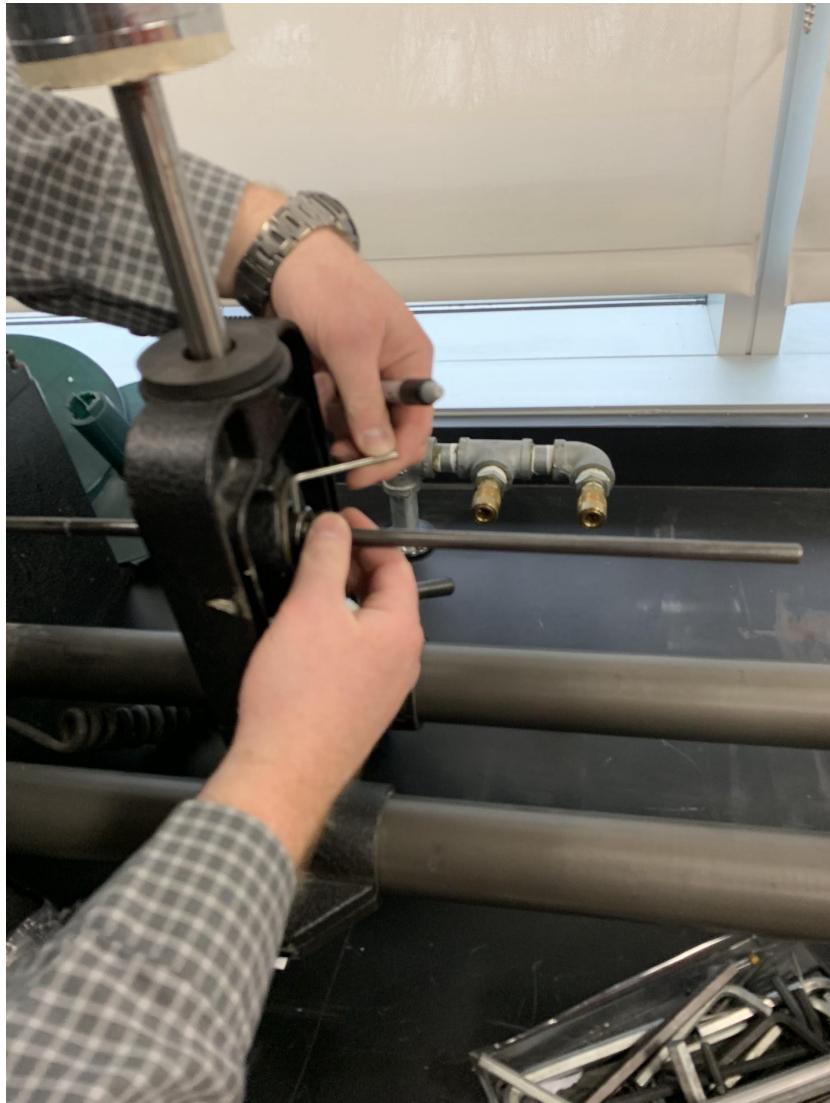
2. Testing Procedure



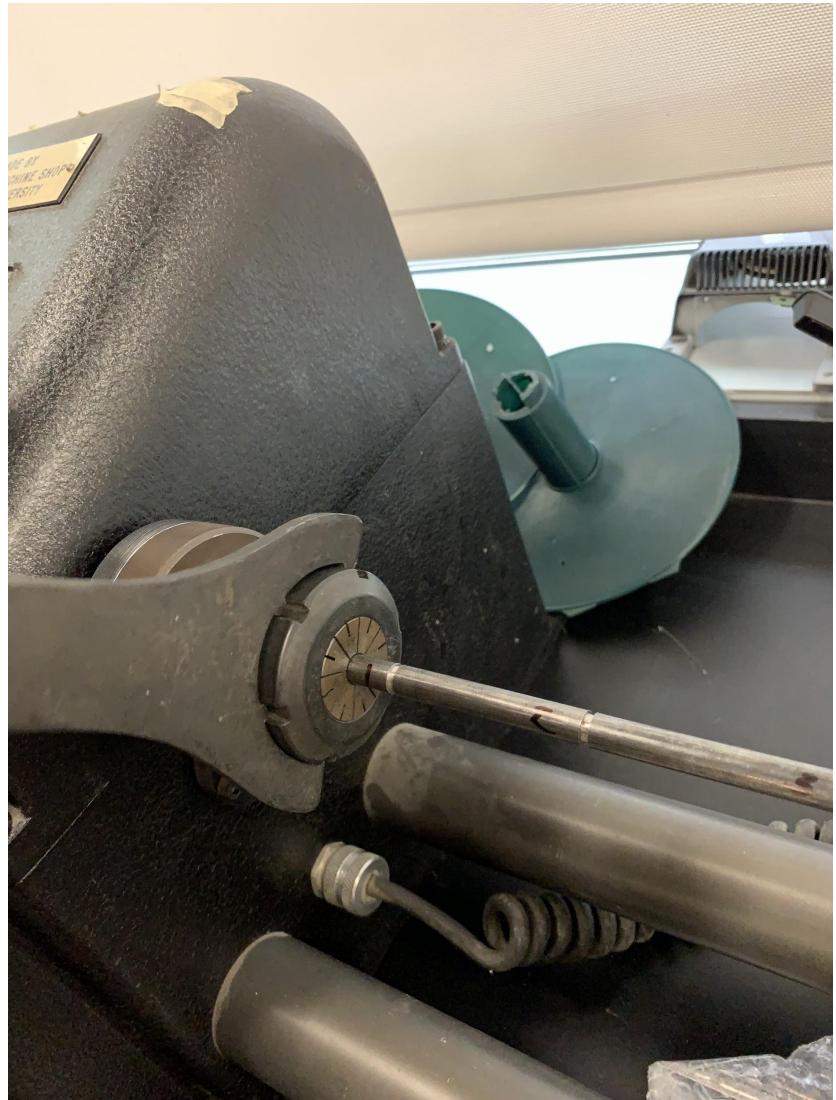
2. Testing Procedure



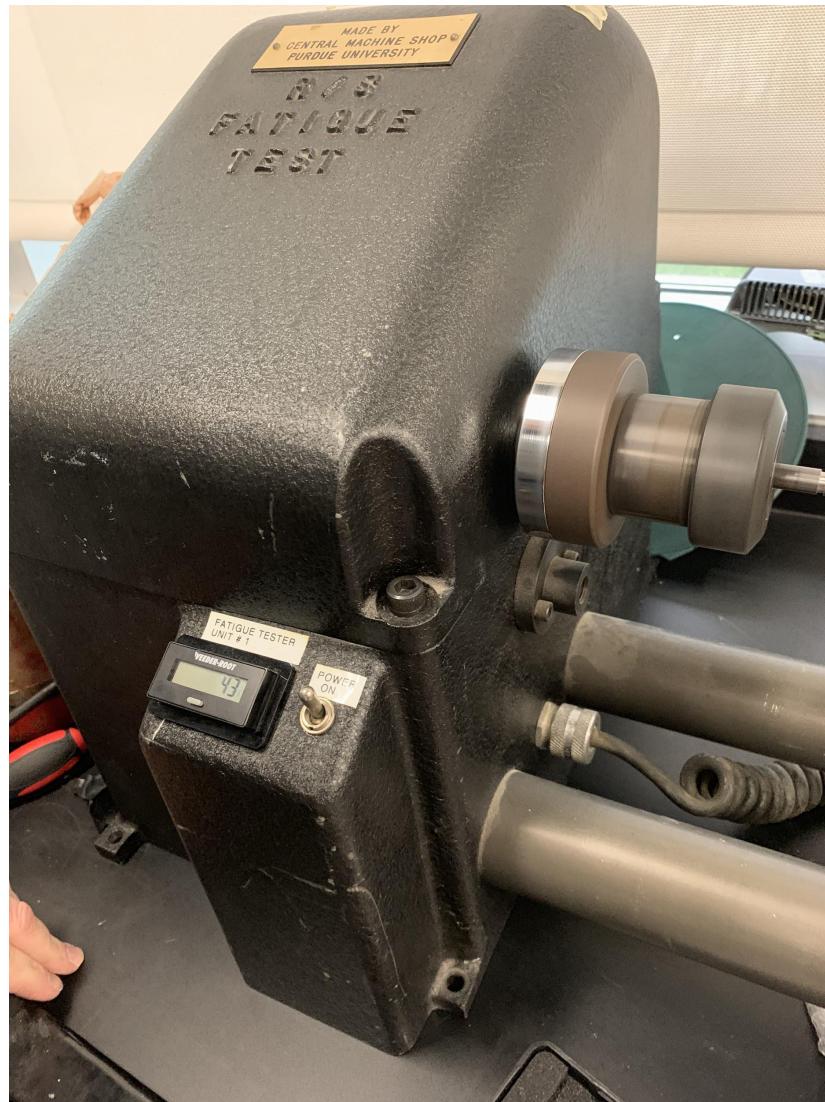
2. Testing Procedure



2. Testing Procedure



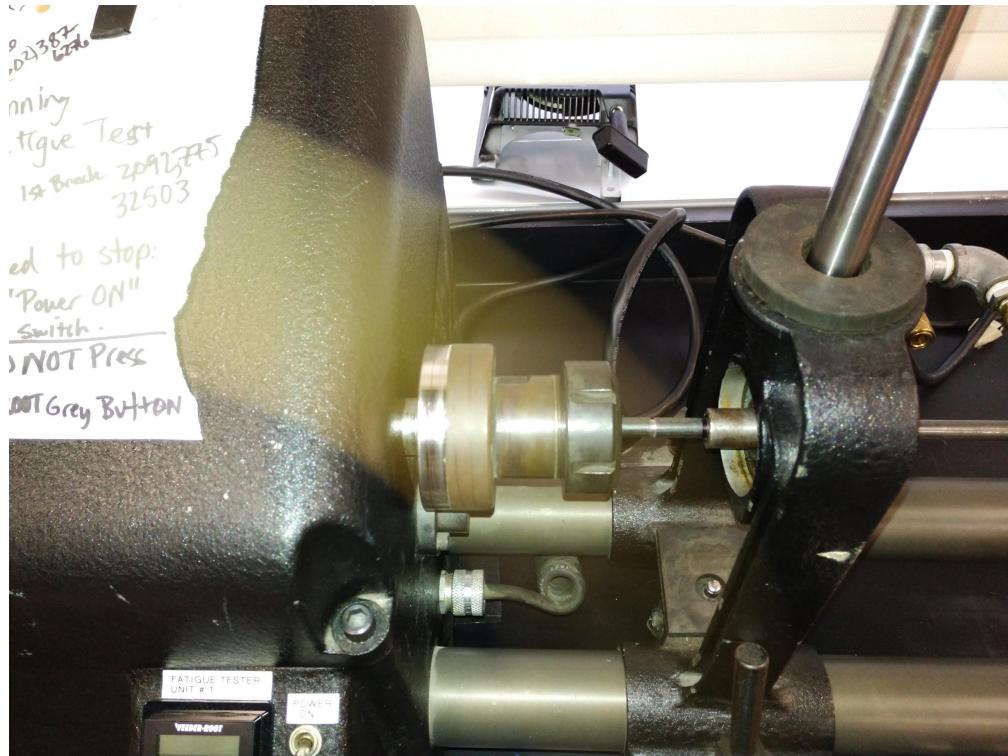
2. Testing Procedure



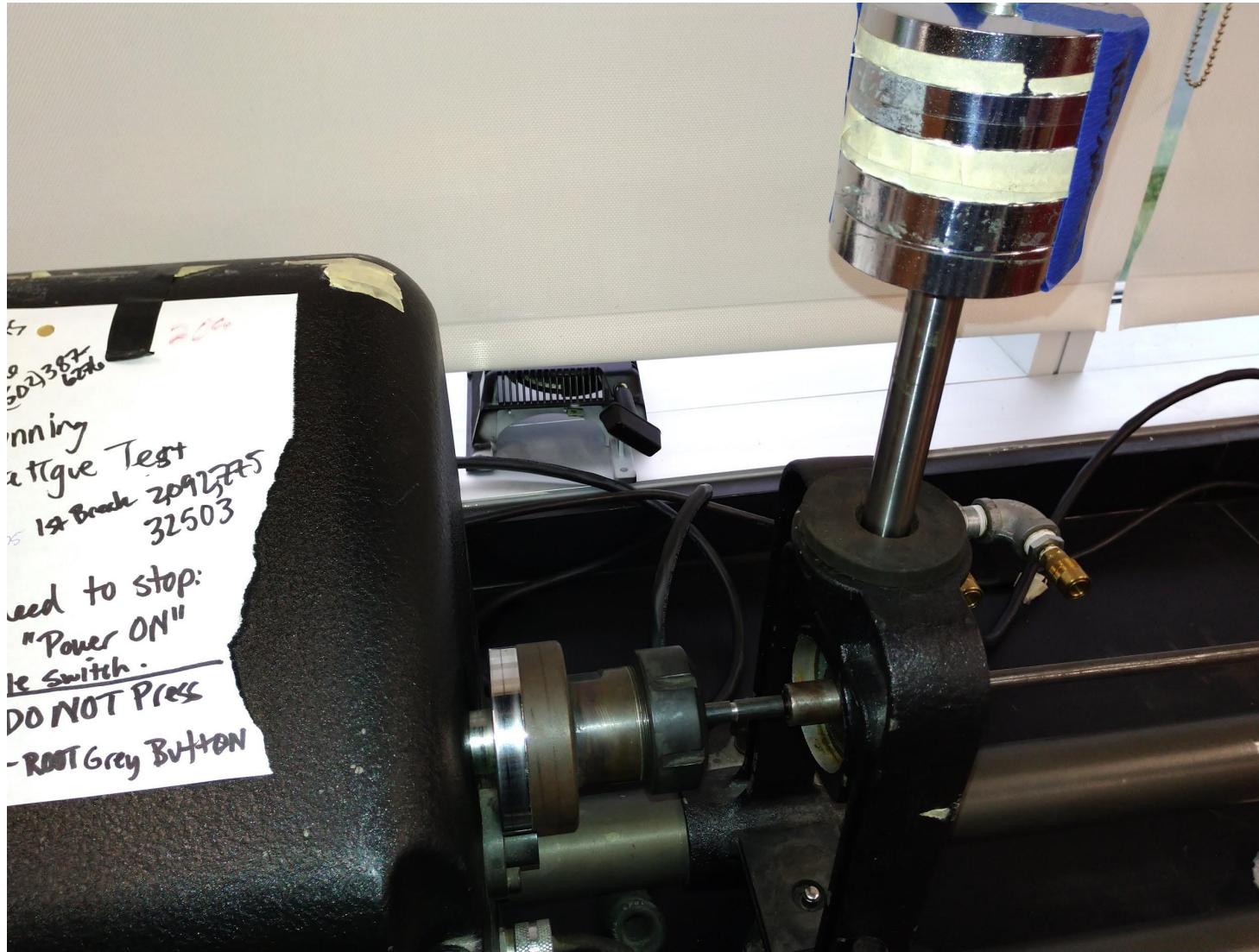
2. Testing Procedure



9-10-2018
Running
Fatigue Test
14 Break 20912775
32503
ed to stop:
"Power ON"
Switch -
> NOT Press
NOT Grey Button



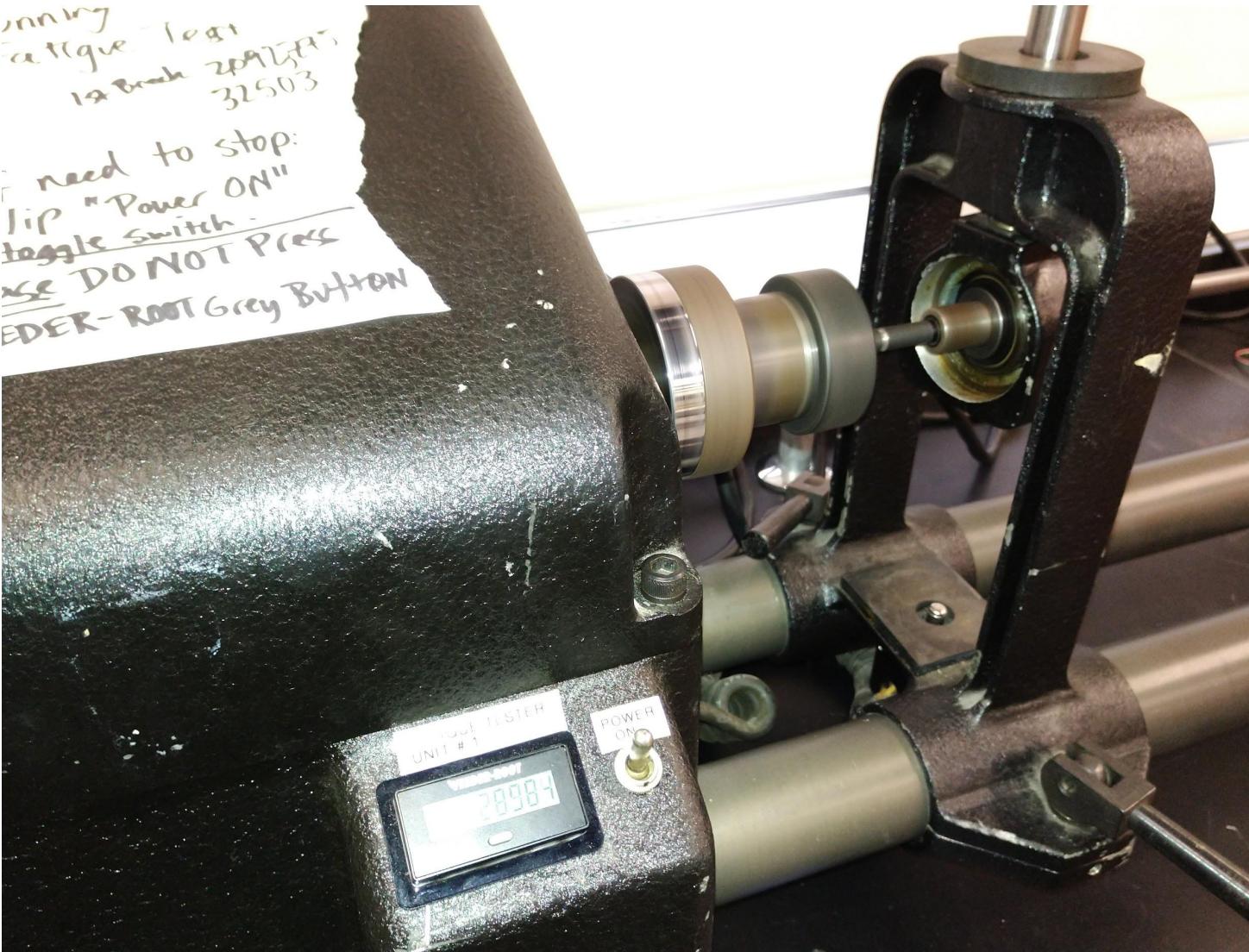
2. Testing Procedure



2. Testing Procedure

running
Fatigue Test
12 Dec 2017
31503

I need to stop:
flip "Power ON"
toggle switch
use DO NOT Press
EDER-ROST Grey Button



2. Testing Procedure



3. Results

	length							
	with groove (in)	groove (in)	without groove (in)	Outside Diameter (in) pg 732 D	Inside Diameter (the groove) (in) pg 732 d	I for OD	I for ID	pg 732 D/d
#1	2.516	0.99	1.526	0.372	0.301	0.00094002987 96	0.00040293582 4	1.235880399
#2	2.4815	0.0875	2.394	0.372	0.303	0.00094002987 96	0.00041375229 21	1.227722772
#3	2.543	0.0955	2.4475	0.372	0.3005	0.00094002987 96	0.00040026517 32	1.237936772
								1.233846648
							k=	1.62

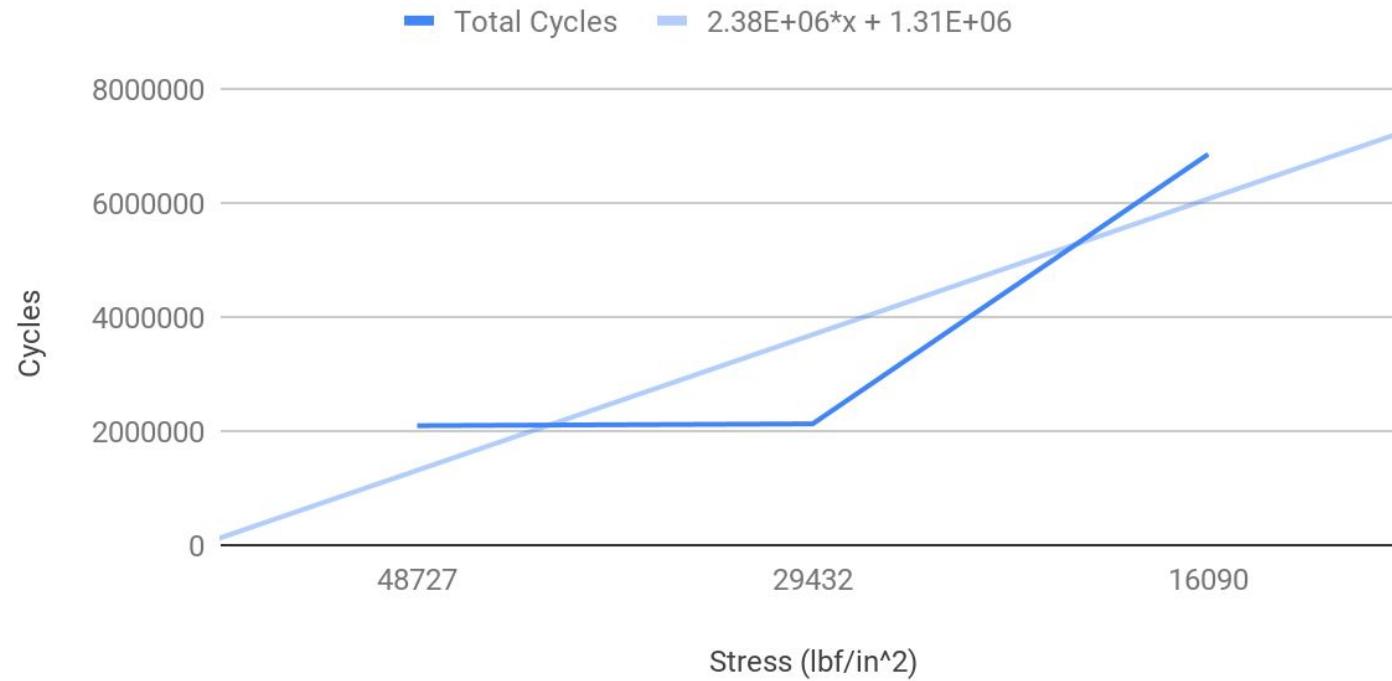
3. Results

Moment Arm Length	Force	Specimen	Moment = Moment Arm Length x Force	Stress sub(nom) = $M/(\pi \times \text{inner diameter})^3/32$	Stress sub(max) = $Kt \times$ Stress sub(nom) (lbf/in ²)	Reading	Cycles	Total
8.8155	9.135	1	80.5295925	30078.49625	48727.16393	2092775	2092775	
5.4315	9.135	2	49.6167525	18167.72534	29431.71506	32503	2125278	
2.8965	9.135	3	26.4595275	9932.275584	16090.28645	4722277	6847555	

3. Results

Low Carbon Steel Fatigue Test

Stress (lbf/in²) vs. Cycles



References

[textbook] Mott, Robert L. Applied strength of materials. Upper Saddle River, N.J: Pearson/Prentice Hall, 2008. Print.

[aisi] AISI 12L14 Carbon Steel (UNS G12144)
https://www_azom_com/article.aspx?ArticleID=6604

[wikipedia-tensile-testing] Tensile testing - Wikipedia
https://en.wikipedia.org/wiki/Tensile_testing

[delta] DELTA Professional Handheld XRF Analyzer
<https://www.olympus-ims.com/en/xrf-xrd/delta-handheld/delta-prof/>

[xrd] Definition: X-Ray Diffraction (XRD) | Open Energy Information
[https://openei.org/wiki/Definition:X-Ray_Diffraction_\(XRD\)](https://openei.org/wiki/Definition:X-Ray_Diffraction_(XRD))

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