

MATERIAL TESTING LAB

The ability to predict the loads that will cause a part to fail depends upon both material properties and the machine part geometry. This lab involves two testing procedures that are used to verify these characteristics. The first test is a materials test known as a tensile test which is used to determine/verify material properties. The second test is a failure test which is used to determine/verify the loading level that will cause a machine part to fail. The objectives of each test are somewhat different and are given in the following sections.

OBJECTIVE: Tensile Test

The objective of this experiment is to determine the following properties of two different steels (1040HR and 1040CD) from standard test specimen. The properties to be investigated include:

- *Yield stress (use 0.1% offset method if yield point is not well defined)*
- *Proportional limit*
- *Ultimate stress*
- *Modulus of elasticity*
- *Ductility*
- *Reduction in area*

PROCEDURE:

- *Identify the material for each specimen.*
- *Mark off a 2 inch gage length on each specimen using the jig provided.*
- *Measure the initial diameter of each specimen.*
- *Follow the procedure given by the laboratory instructor(s) for inserting the specimen in the tensile machine, attaching the extensometer, recording applied load and resulting deflection, and load at failure.*
- *Data for each tensile test will be recorded to disc so that a MatLab plot of the stress-strain curve can be generated. Each group should bring two 1.44 Mb floppy discs to lab so that the data can be stored for their tests.*

- *After failure, measure final diameter, final gage length, and observe the character of the fracture.*

PRE-LAB:

Each lab group is required to come to their lab meeting with an estimate of the highest load that the tensile test, for each specimen (1040HR and 1040CD), will reach before failure.

RESULTS:

- *Plot a stress strain curve for each specimen and determine the values indicated above.*
- *Compare test results with published values for these materials.*

DISCUSSION:

The discussion should include a comparison of the material properties found with your test to published results. Do these results compare or are they consistently high or low? Do some results compare and others not? Does this make sense?

OBJECTIVE: Failure Test

The objective of this experiment is to determine how the yield and failure loads are influenced by a stress raiser under a uniaxial stress condition. The stress raiser that will be used is a circular hole (approx. 0.5 inch diameter) drilled in a flat bar (approx. 0.25 inch thick by 1.5 inch wide) made of a hot rolled steel (1040HR). Additionally, a hole pattern will be added to this configuration with a goal of reducing or minimizing the stress raiser caused by the circular hole.

PROCEDURE:

- *Three tests will be evaluated by all lab groups in each section. The data for the three tests will be acquired in common by all groups in each lab (section).*
 - *First test: Nominal flat bar specimen. Flat bar specimen is nominally 0.25 inch thick by 1.5 inch wide.*
 - *Second test: Nominal flat bar specimen but with reduced width to give same net cross sectional area as third test. Flat bar specimen is nominally 0.25 inch thick by 1.0 inch wide.*
 - *Third test: Nominal flat bar specimen with 0.5 inch diameter hole in center of flat bar. Flat bar specimen is nominally 0.25 inch thick by 1.5 inch wide.*
- *For each test the following steps should be performed:*
 - *Measure the initial dimensions of each specimen to verify the nominal pre-lab calculations.*
 - *Follow the procedure given by the laboratory instructor(s) for inserting the specimen in the tensile machine and recording the applied load at ultimate (highest) and at failure.*

PRE-LAB:

Each group is required to come to lab with estimated ultimate (highest) for each of the three tests. Assume that the dimensions of the each flat plate are equal to the nominal values.

RESULTS:

- *Document stress concentration factors and applicable computations.*
- *Compare test results with predictions for each of the three cases based upon published values for the material used.*
- *Comment on whether it is appropriate to consider a stress raiser for the type of test conducted. Why or why not?*

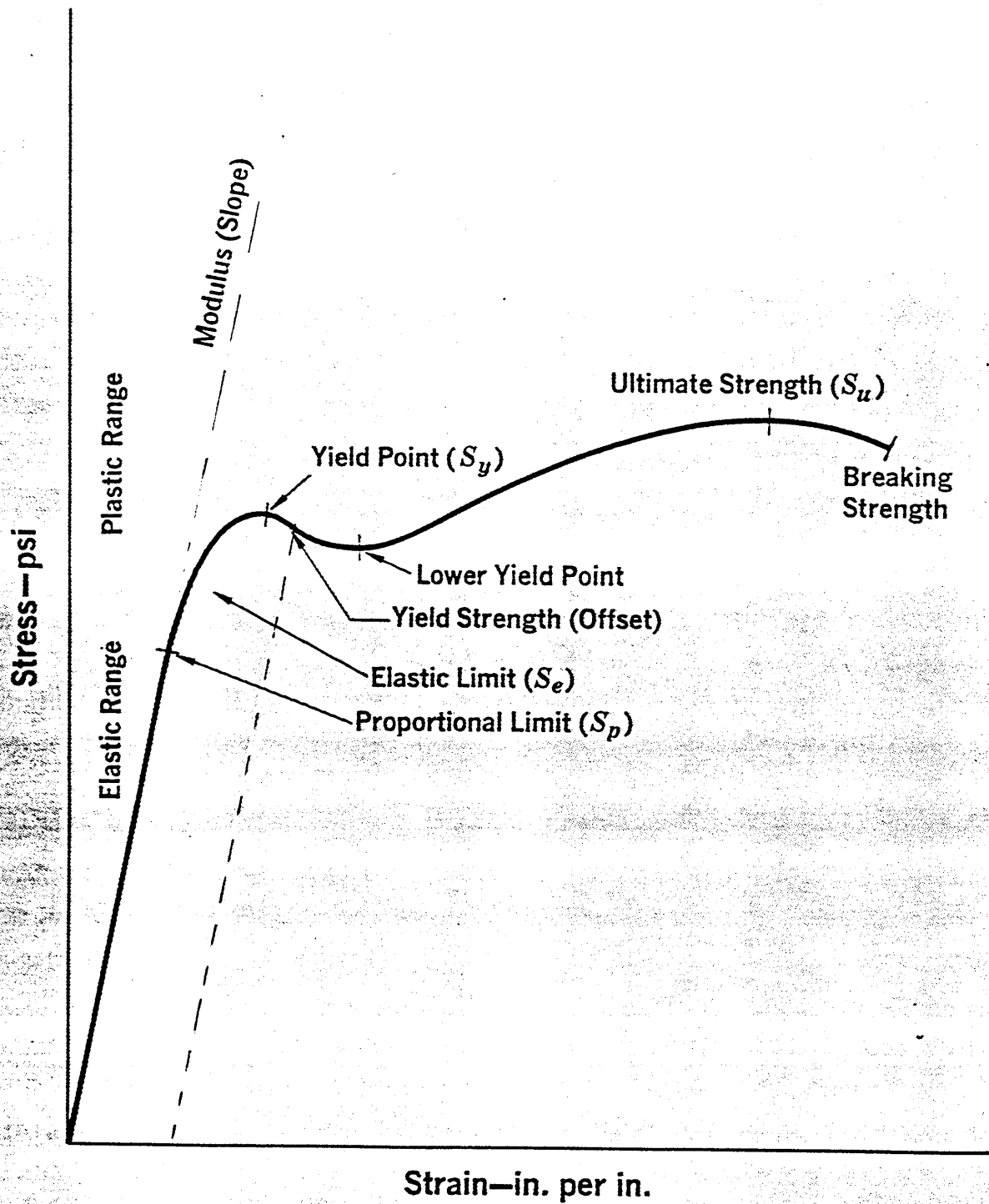
DISCUSSION:

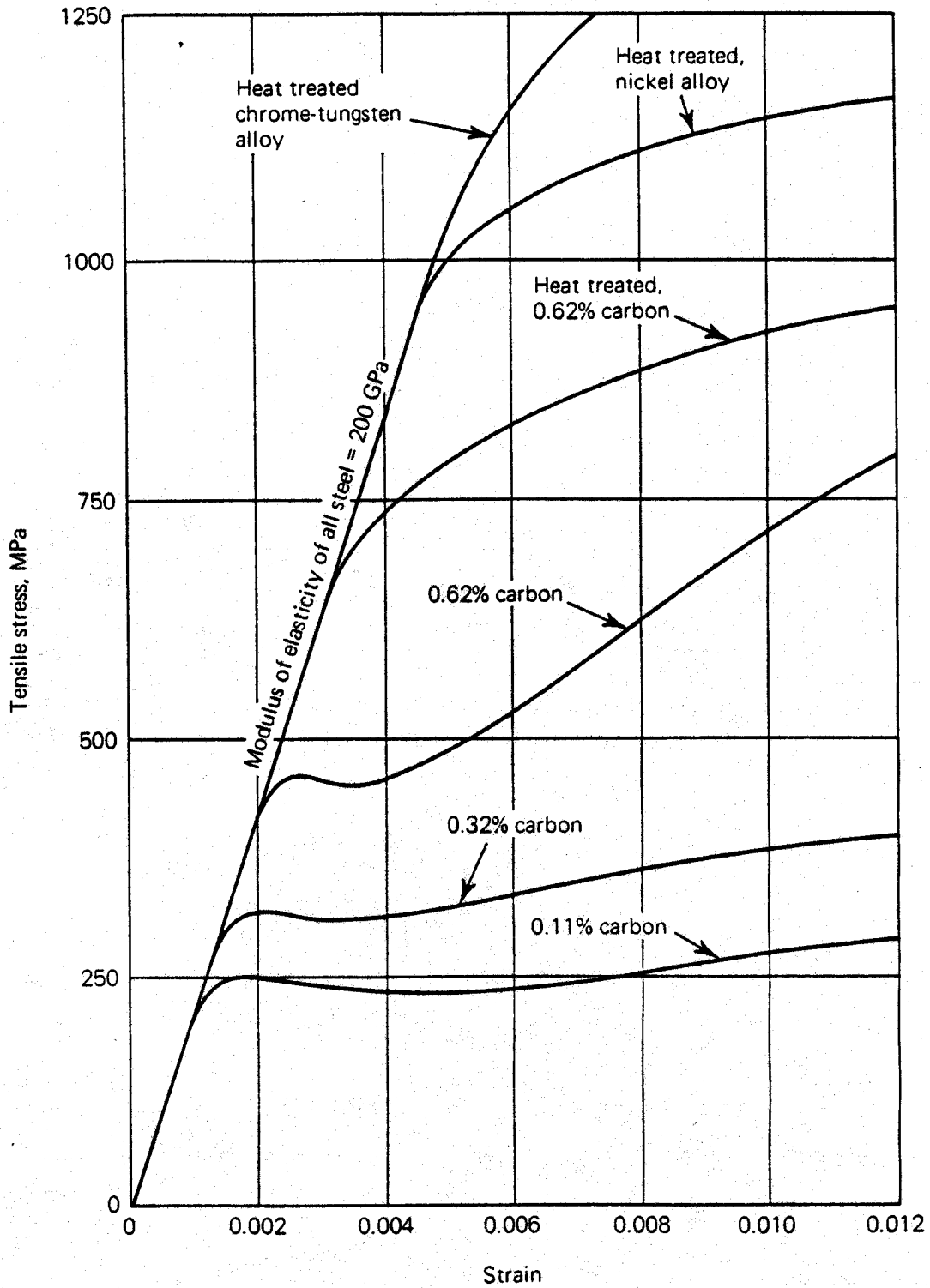
The discussion should include a comparison of your failure predictions to the actual failure value. Do these results compare or are they consistently high or low? Is the information consistent with the material properties measured in the first part of this lab? Does this make sense?

References

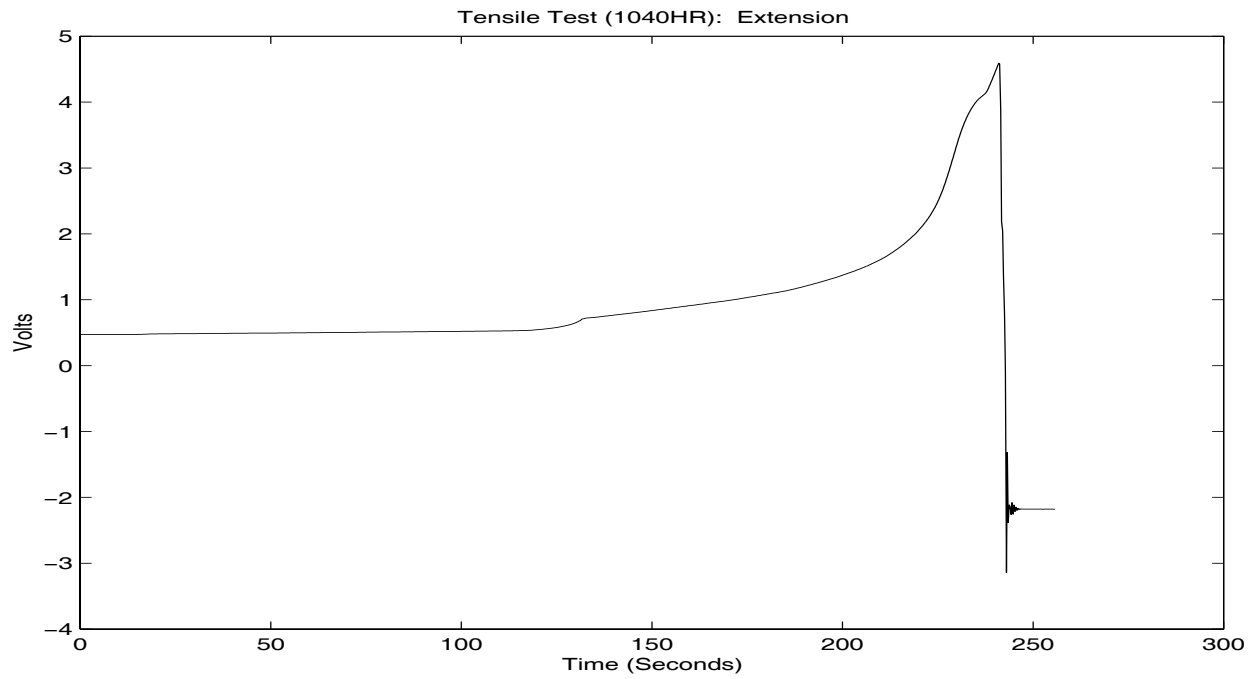
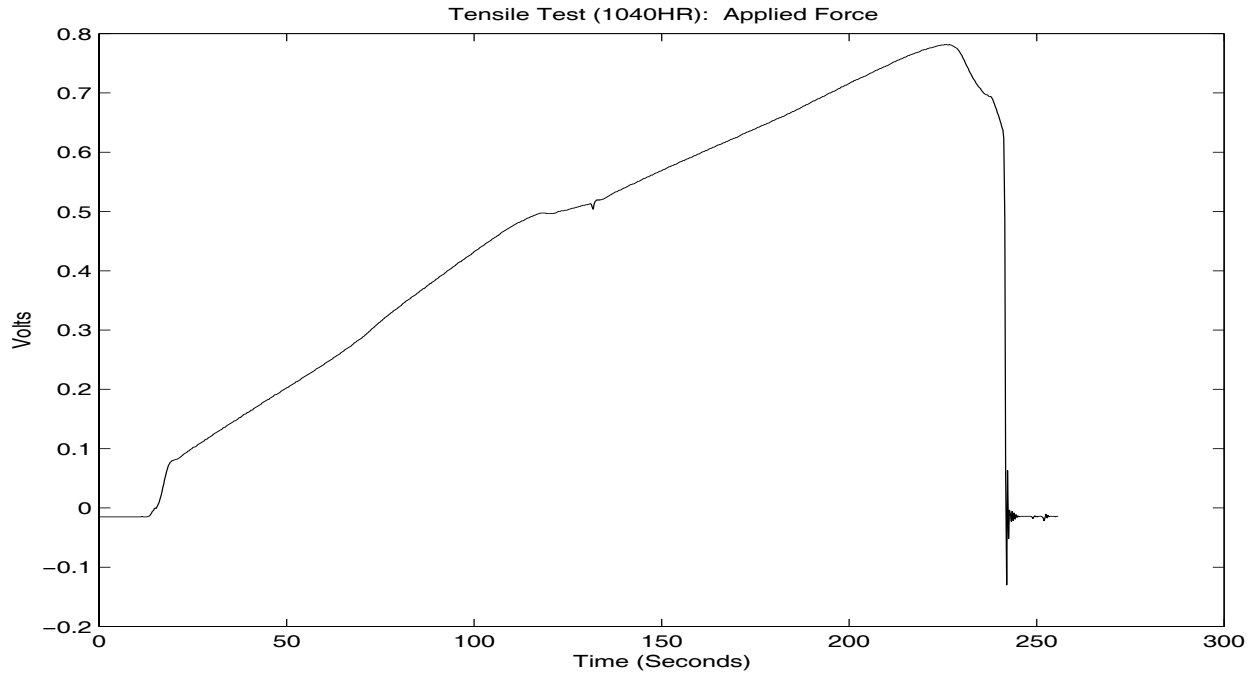
- *MatWeb (Materials Web Site), Automation Creations, Inc., <http://www.matweb.com>.*
- *Figliola, Richard S., Beasley, Donald E., **Theory and Design for Mechanical Measurements, Second Edition**, John Wiley & Sons, Inc., 1988, 478 pp.*
- *Shigley, Joseph Edward, **Mechanical Engineering Design**, McGraw Hill Book Company, 1963, 631 pp.*
- *Boresi, Arthur P., Schmidt, Richard J., Sidebottom, Omar M., **Advanced Mechanics of Materials**, John Wiley & Sons, Inc., 1993, 811 pp.*

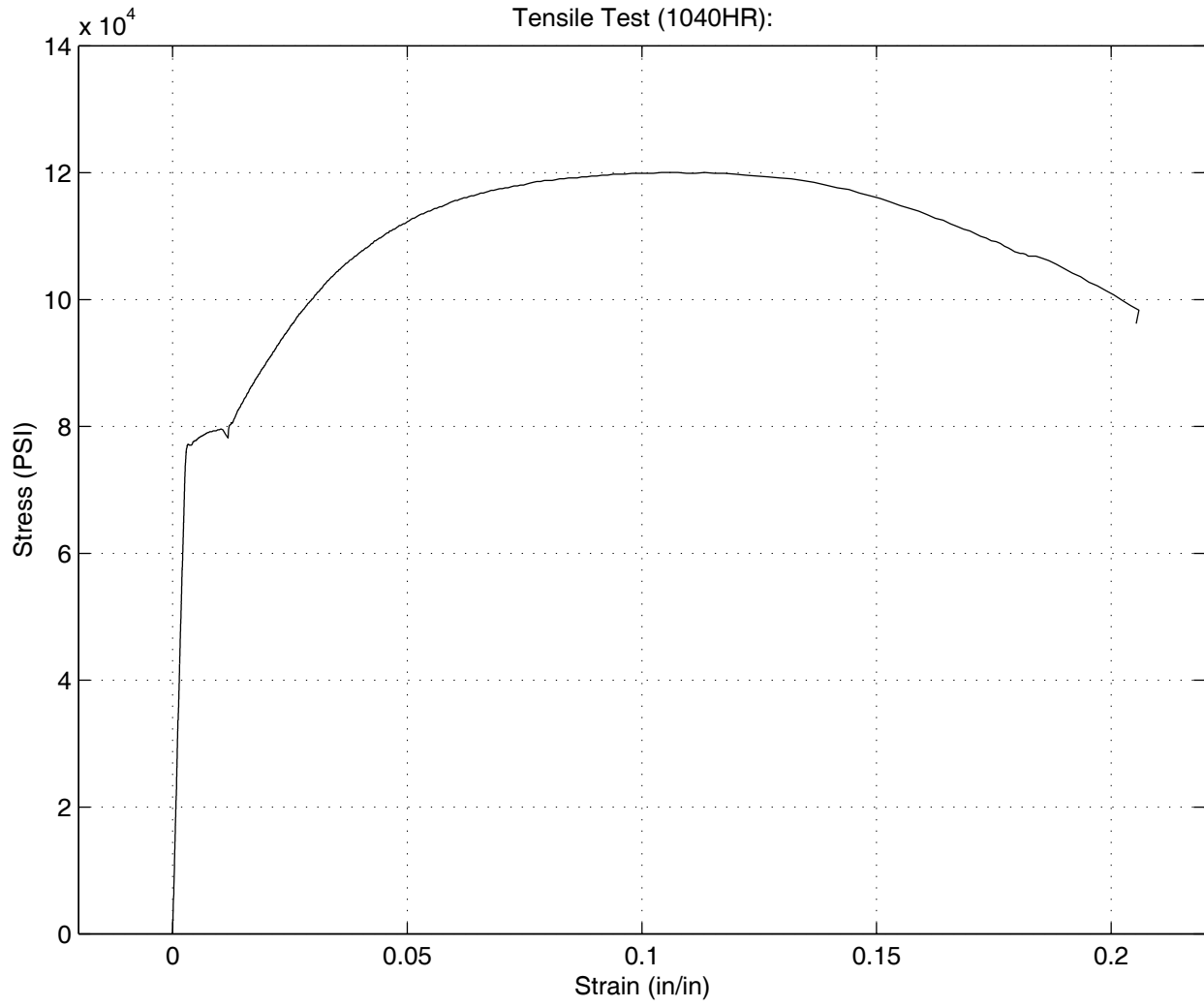
Appendix A: Tensile Test Info

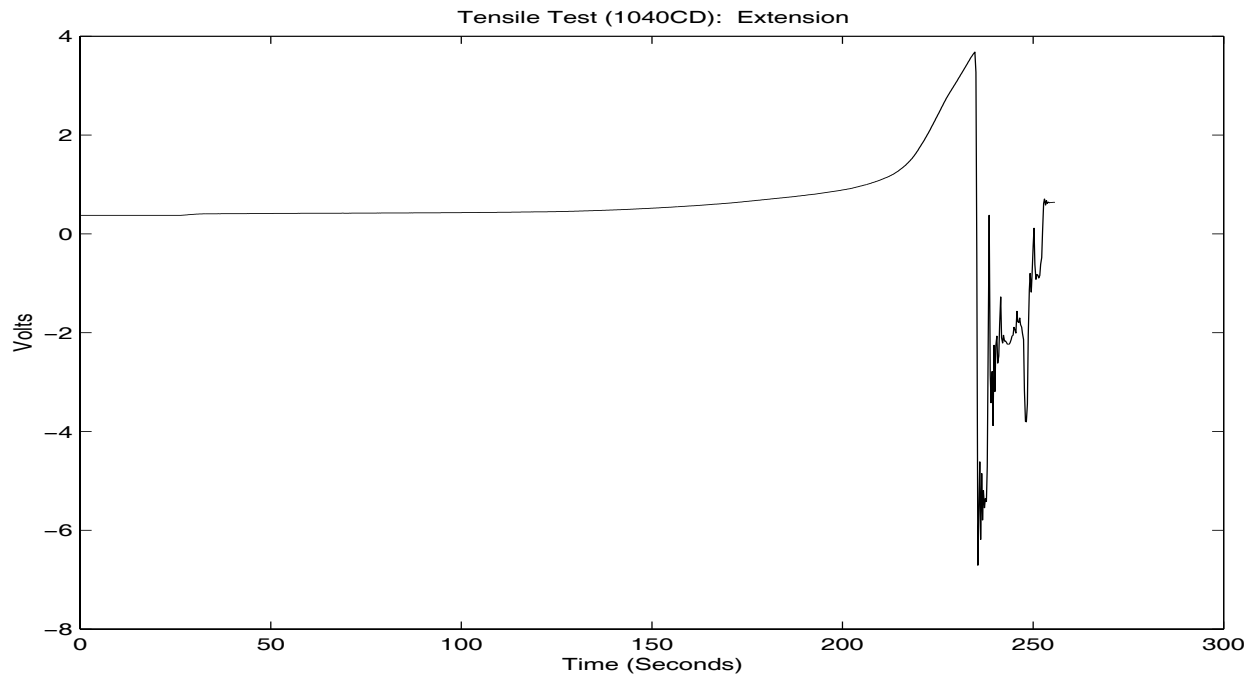
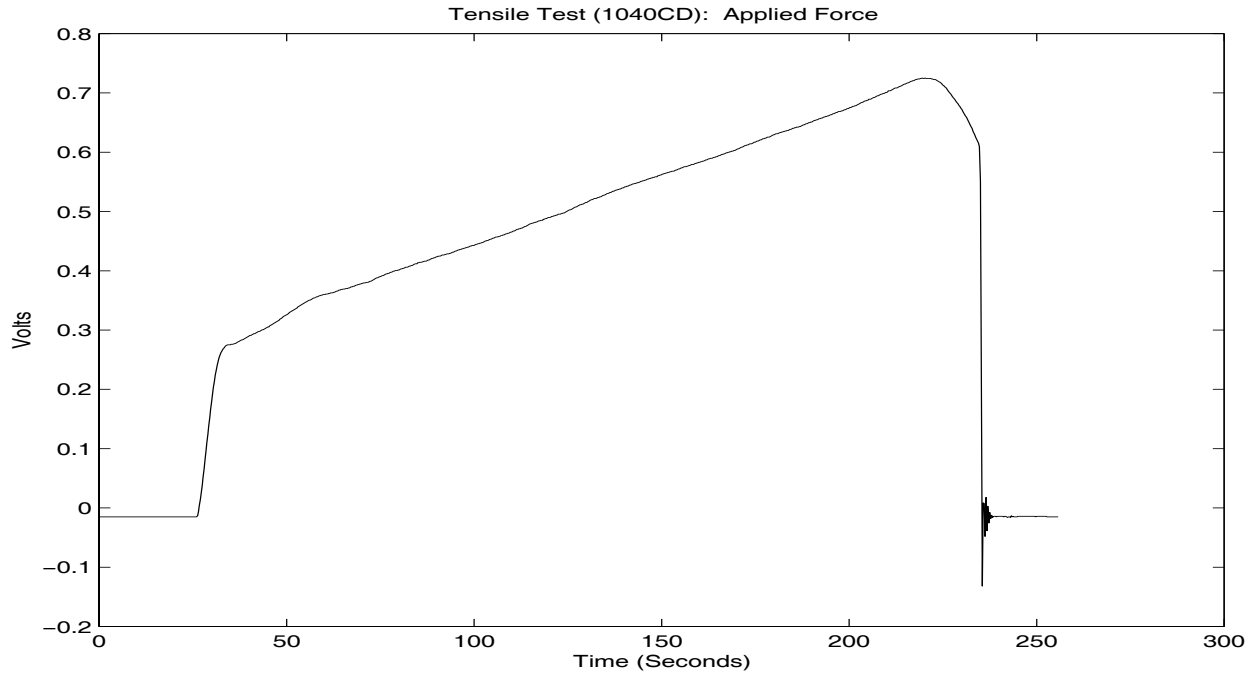


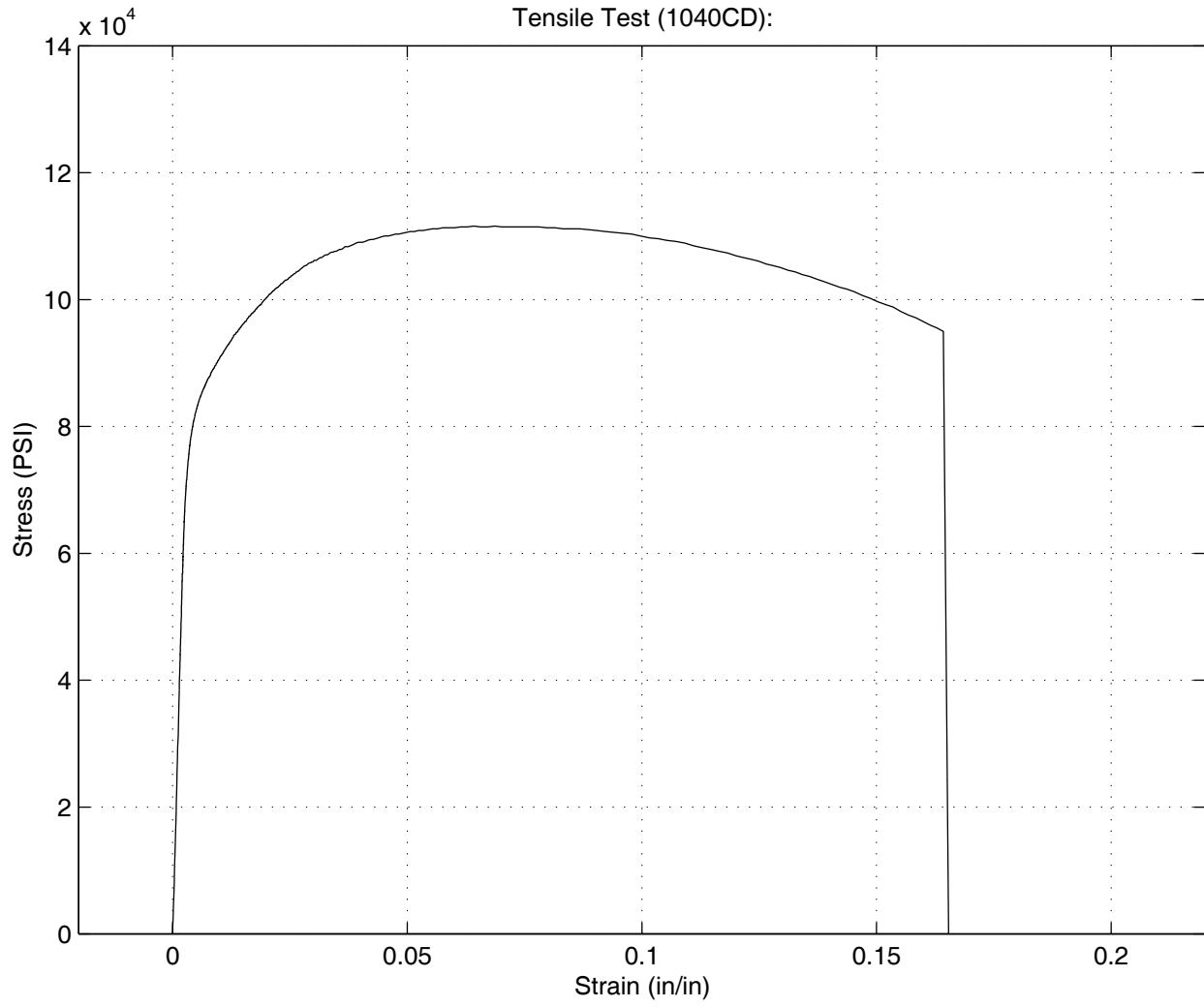


Note: 250 MPa = 36.25 ksi



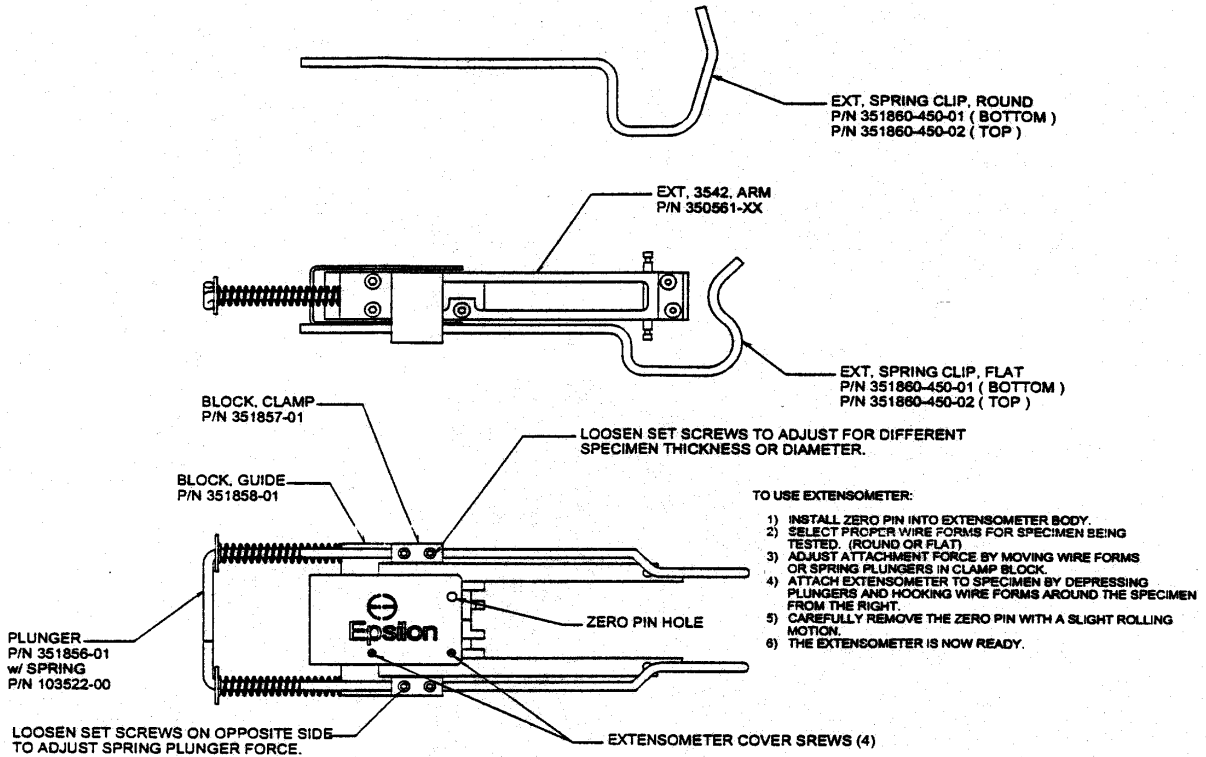






Axial Extensometers

Model: 3542 and 3600 with Quick Attach Kit



MODEL 3542 OR 3600 WITH QUICK ATTACH KIT
1" GAGE LENGTH SHOWN

<p>CONFIDENTIAL CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE DISCLOSED WITHOUT WRITTEN PERMISSION OF EPSILON</p>	UNLESS OTHERWISE SPECIFIED				 Epsilon TECHNOLOGY CORP MINNEAPOLIS, MN
	TOLERANCES				
	2 PLACE INCHES ± .03	3 PLACE INCHES ± .005	4 PLACE INCHES ± .0010	ANGLES ± 1°	
	CAP. IN MFD ± %	RES. IN OHMS ± %	± 1/4 IN		
	REMOVE ALL BURRS AND SHARP EDGES				
	MATERIAL		DFTSMN JBJ	DATE 8/96	
STOCK SIZE		ENGR SAA	DATE 8/96		
FINISH		SCALE 1X	SURFACE FINISH 63 ✓		
REVISIONS					TITLE 3542 / 3600 QUICK ATTACH KIT
			SIZE A	NUMBER 3542-IS	REV
			SHEET 1	OF 1	

Epsilon Extensometer Calibration Certificate

Model: 3542-0200-050-ST	Date: 8/29/97
Extensometer S/N: E80236	
Gage Length: 2.000 in.	Travel (Tens): +1.000 in.
	Compression: -.500 in.

Travel (in.)	Output (Volts)	
	UP	DOWN
0.000	0.000	-0.005
0.200	1.994	1.982
0.400	3.992	3.977
0.600	5.995	5.980
0.800	7.998	7.989
1.000	10.002	10.002

Linearity (best fit)=	0.050 % F.S.
Full Scale Span (best fit)=	10.007 Volts
Full Scale Span (best fit)=	1.001 Volts/Volt
Max Hysteresis =	-0.150 % F.S.
Slope =	10.004 Volts/in.
Intercept =	-0.005 Volts
Zero Output (with pin in):	0.00 Volts
Tension Span (end pt):	1.000 Volts/Volt
Compression span (ep):	-0.495 Volts/Volt
Excitation Voltage:	10.000 VDC

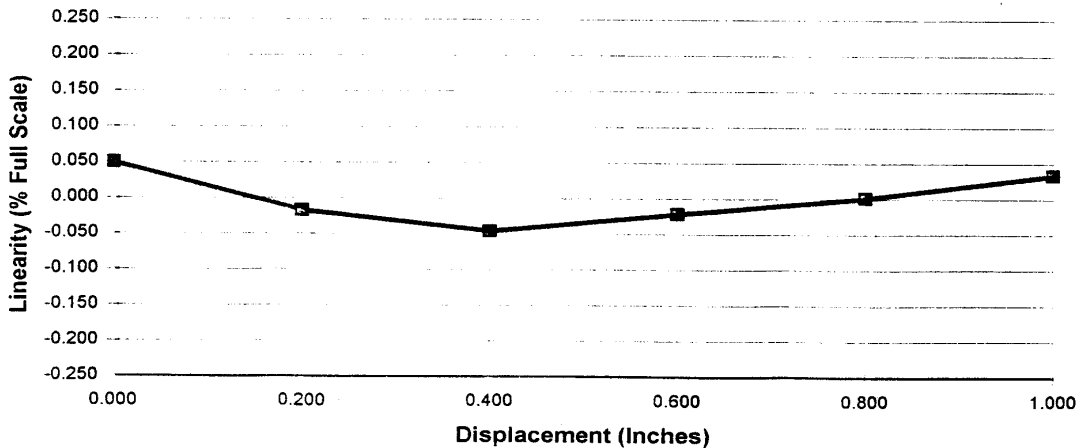
Connections for + output on tension:

FUNCTION	PIN	COLOR
Excitation (+)	1	Red
Excitation (-)	2	Black
Output (+)	3	Green
Output (-)	4	White
Shield	5	

Amp CPC 9 socket connector.
Calibrated with SCM-1

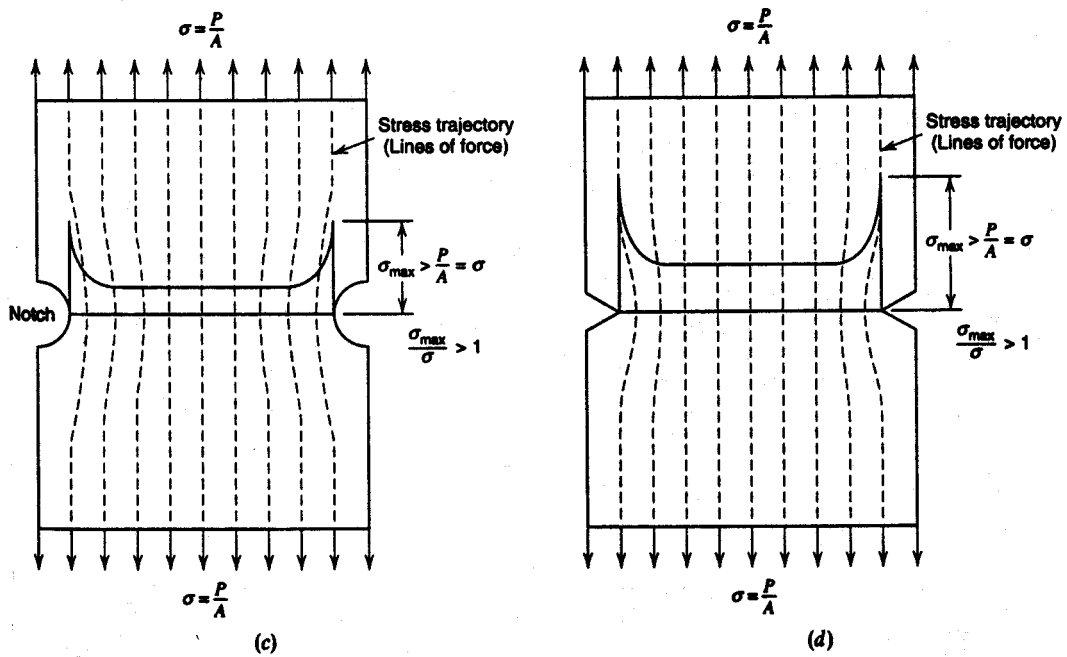
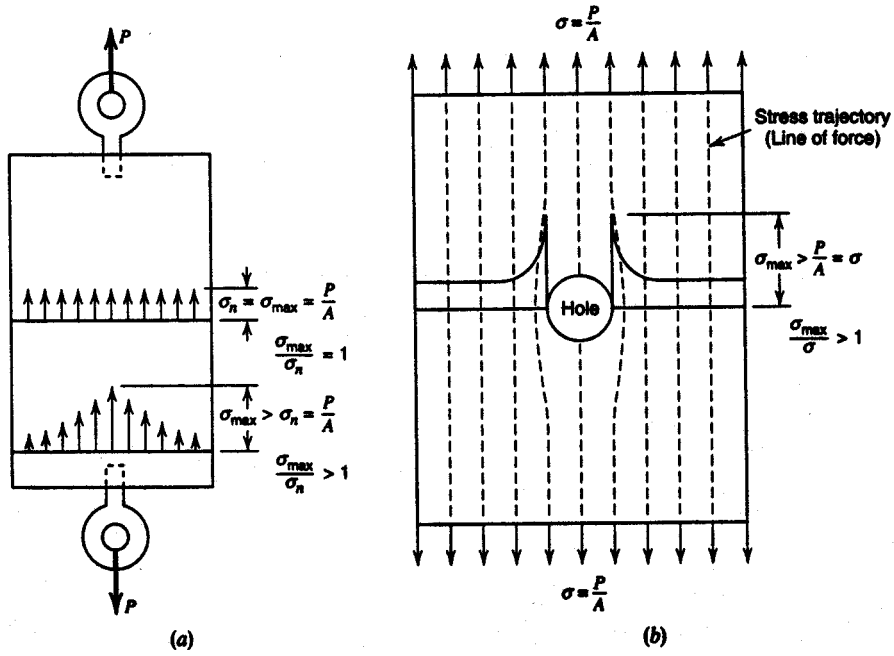
Shunt Calibration Data:	
Shunt Resistor:	SCM ohms
Shunted Reading:	0.528 Volts/Volt
Shunted Reading:	26.367 % strain
(With Shunt Cal. Module plugged in)	

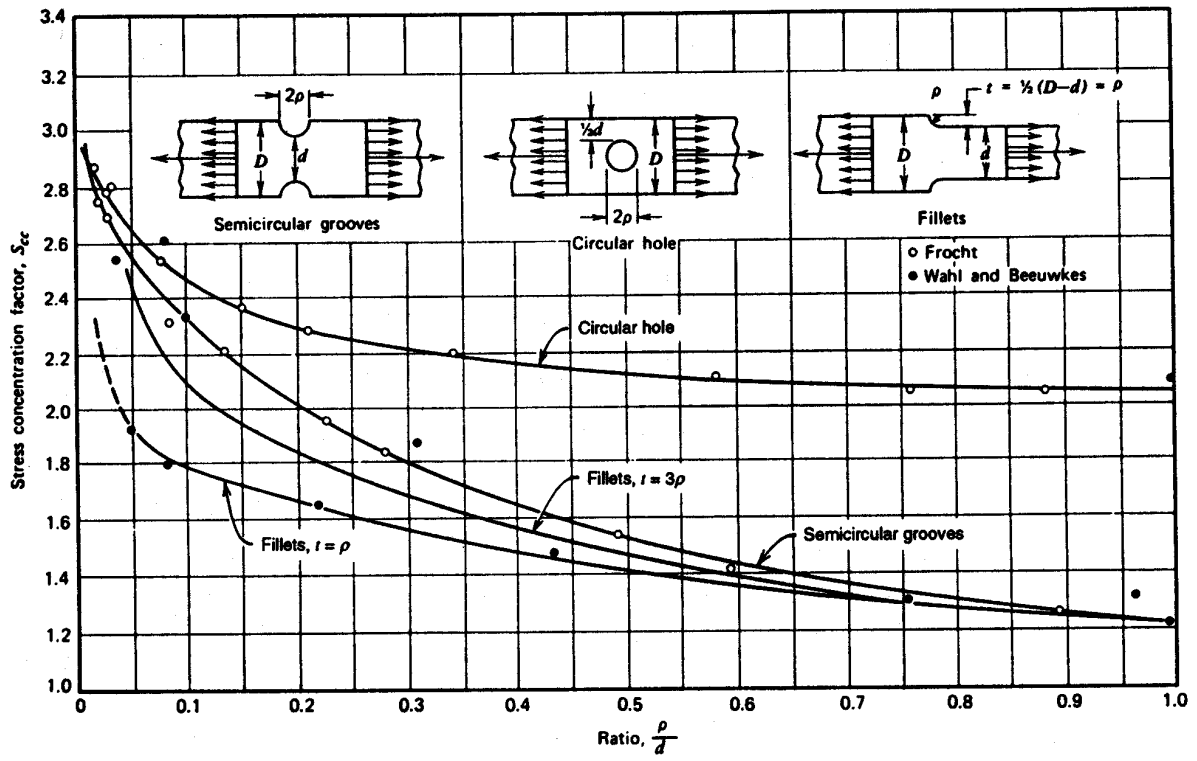
Meter: Fluke 8840A	S/N: 6155009
Calibrator: Epsilon 3590	S/N: A3761
Traceable to NIST standards	



Calibrated by: AA Date: 8-29-97
 Epsilon Technology Corp.
 Jackson, WY PHONE: (307) 733-8360 FAX: (307) 733-8375

Appendix B: Failure Test Info





Appendix C: Familiarization Exercise

The following familiarization exercise is to be performed and the data recorded and plotted by MATLAB. The exercise should be presented in an Appendix of the Lab Report. No discussion/results are required but the ability to perform later labs (Beam Vibration, Balancing of Rotating Systems) will depend upon developing familiarization with the lab equipment and measurements used in these exercises.

Exercise Number 1:

Experiment with the Zonic Medallion Data Analyzer in acquiring transient data with an impact hammer and accelerometer on the aluminum beam. The goal in a future lab will be to determine the natural frequencies of the deformation modes of the free-free beam. Evaluate setting the trigger level and pre-trigger delay in order to capture all of the force signal. Impact (lightly) at the center of the beam. Measure the acceleration next to the point where you impact.

Record the following:

- *Case I*
 - *Typical time domain domain history (trace) of an impact force signal (AC Coupled, 1600 Hz Fmax, Single Average).*
 - *Typical frequency domain domain power spectra (trace) of an impact force signal (AC Coupled, 1600 Hz Fmax, Single Average).*
 - *Typical time domain domain history (trace) of an accelerometer response to the impact force.*
 - *Typical frequency domain power spectra (trace) of an accelerometer response to the impact force.*
 - *Typical frequency response function (acceleration divided by force) and the associated coherence function using 5-10 averages.*
- *Case II*
 - *Typical time domain domain history (trace) of an impact force signal (AC Coupled, 400 Hz Fmax, Single Average).*
 - *Typical frequency domain domain power spectra (trace) of an impact force signal (AC Coupled, 400 Hz Fmax, Single Average).*
 - *Typical time domain domain history (trace) of an accelerometer response to the impact force.*
 - *Typical frequency domain power spectra (trace) of an accelerometer response to the impact force.*
 - *Typical frequency response function (acceleration divided by force) and the associated coherence function using 5-10 averages.*

