Creep Test on HDPE and RFG Using the Stepped Isothermal Method. Temperature Control Instrument

SMART 2009

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Background Information

- Coastal communities are now required to build above the *Advisory Base Flood Elevations,* If they wish to receive funds in the event of a disaster.

(FEMA release Release Date: February 6, 2006
Release Number: HQ-06-024FactSheet1)

- Using plastic pilings has advantages compared to wood or metals in these situations.
  - No termite damage
  - The use of plastics keeps much out of landfills.

(**COMPRESSIVE CREEP BEHAVIOR OF HDPE USING TIMETEMPERATURE SUPERPOSITION**
Amir Bozorg-Haddad[1], Magued Iskander, PhD, PE[2],)

Abstract

- An extrapolation method is applied to predict the behavior of the specimen when time is prolonged.
- We have opted for an apparatus that will control the temperature of a specimen as it is being tested for creep. A load is applied to the specimen while the temperature changes.
- Data is collected and analyzed to determine the effect of temperature change on the specimen strength and strain

Materials

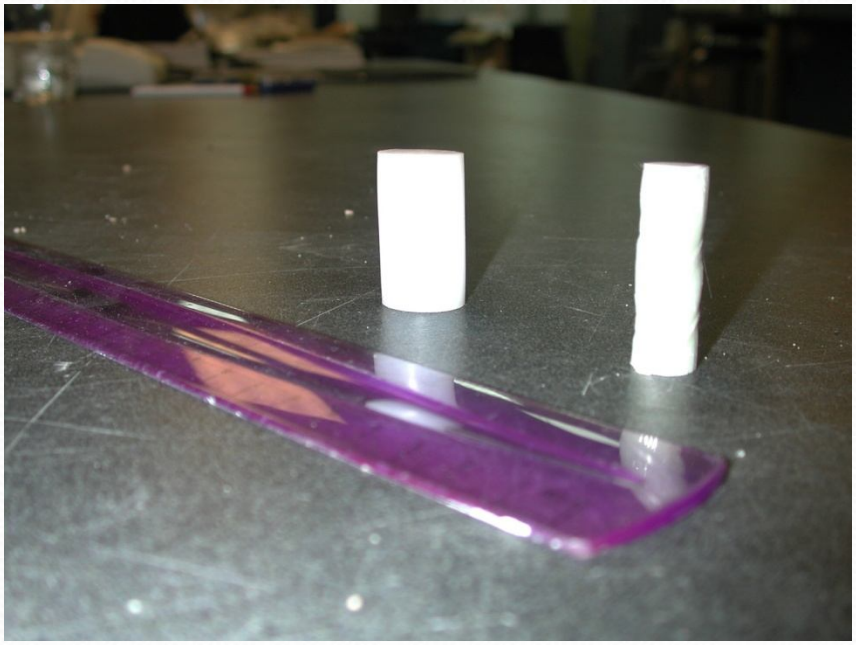
Omega Kapton® Insulated Flexible Heater Kapton®	Basic stamp 2p 40-pin module
2N3904 NPN Transistor	Solid State Relay
Parallax 2x16 serial LCD .	DS 2760
Board of education Serial Version	Instron FastTrack™ 8801 Series servo hydraulic testing system

The Experiment

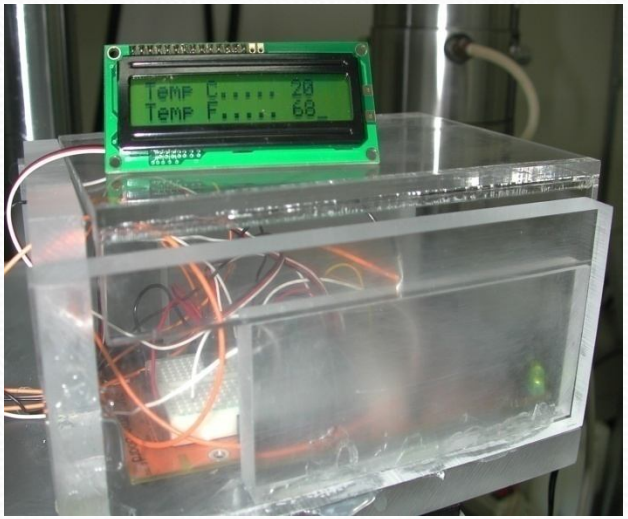
- Our experiment follows that of Zornberg & Byler (2004) for virgin HDPE rod and Reinforced Fiberglass rod in compression.
- The specimen is immersed into a metallic container filled with water.
- The specimen is subjected to an increasing load until we reach a desired load.
- An insulated flexible heating element is attached to the base of the metallic container to heat the water surrounding the specimen.
- A probe attached to TCI measures the temperature the water as the experiment progresses.
- The TCI controls the temperature of the water within 2C

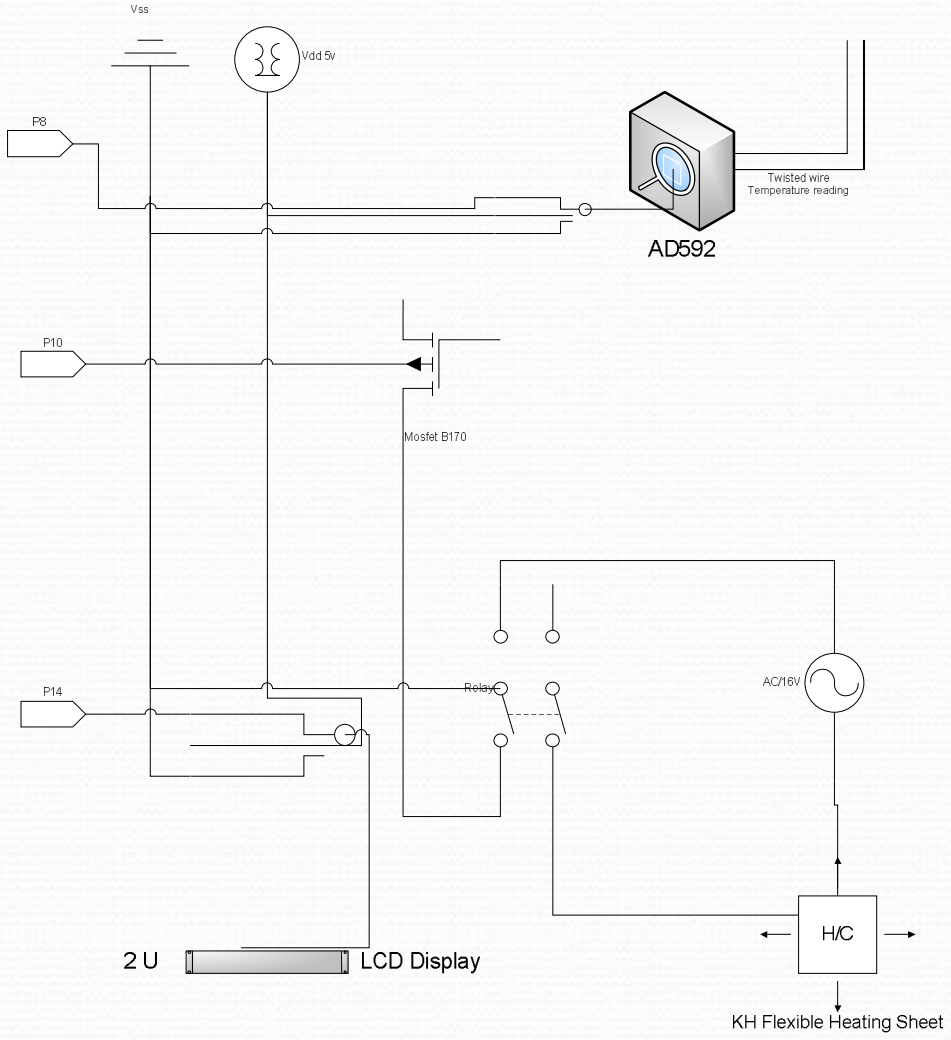
Test Specimens

- The sample are virgin High Density Polyethylene (HDPE) rods with a diameter of .75 in. and a length of 1.5 in. and the reinforced fiberglass rods with a diameter of .5 in. and a length of 1.25.



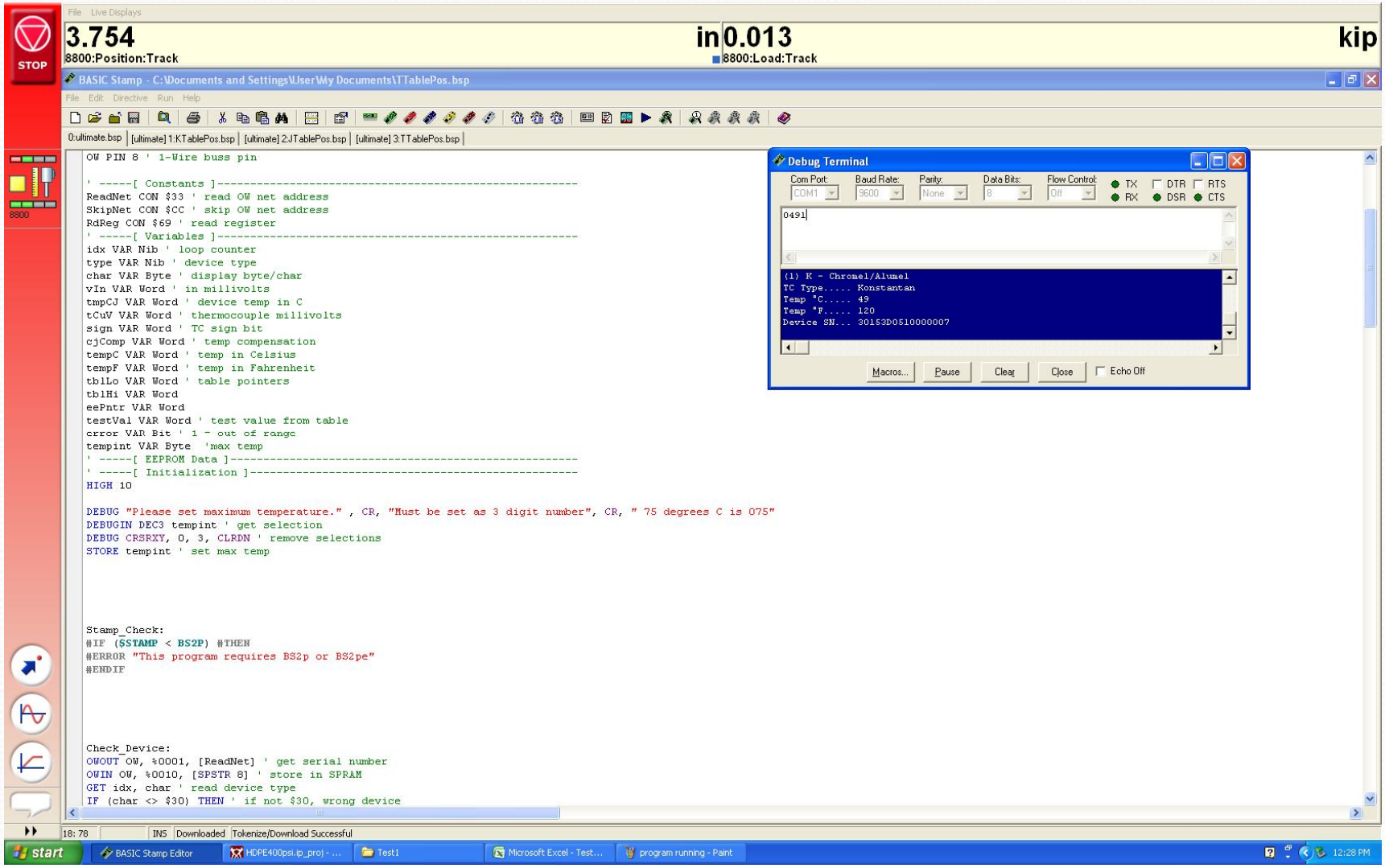
The Temperature Control Instrument (TCI)



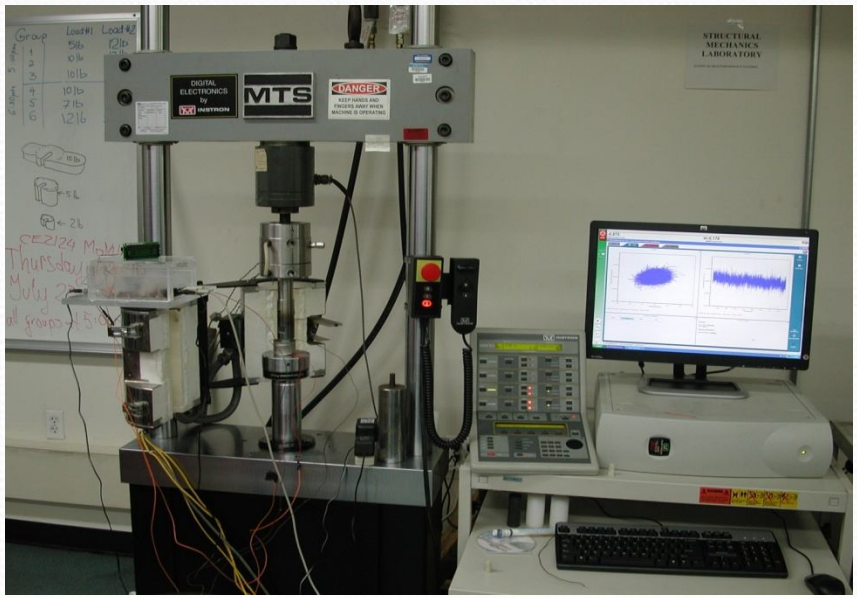


Temperature Control Instrument

BasicStamp

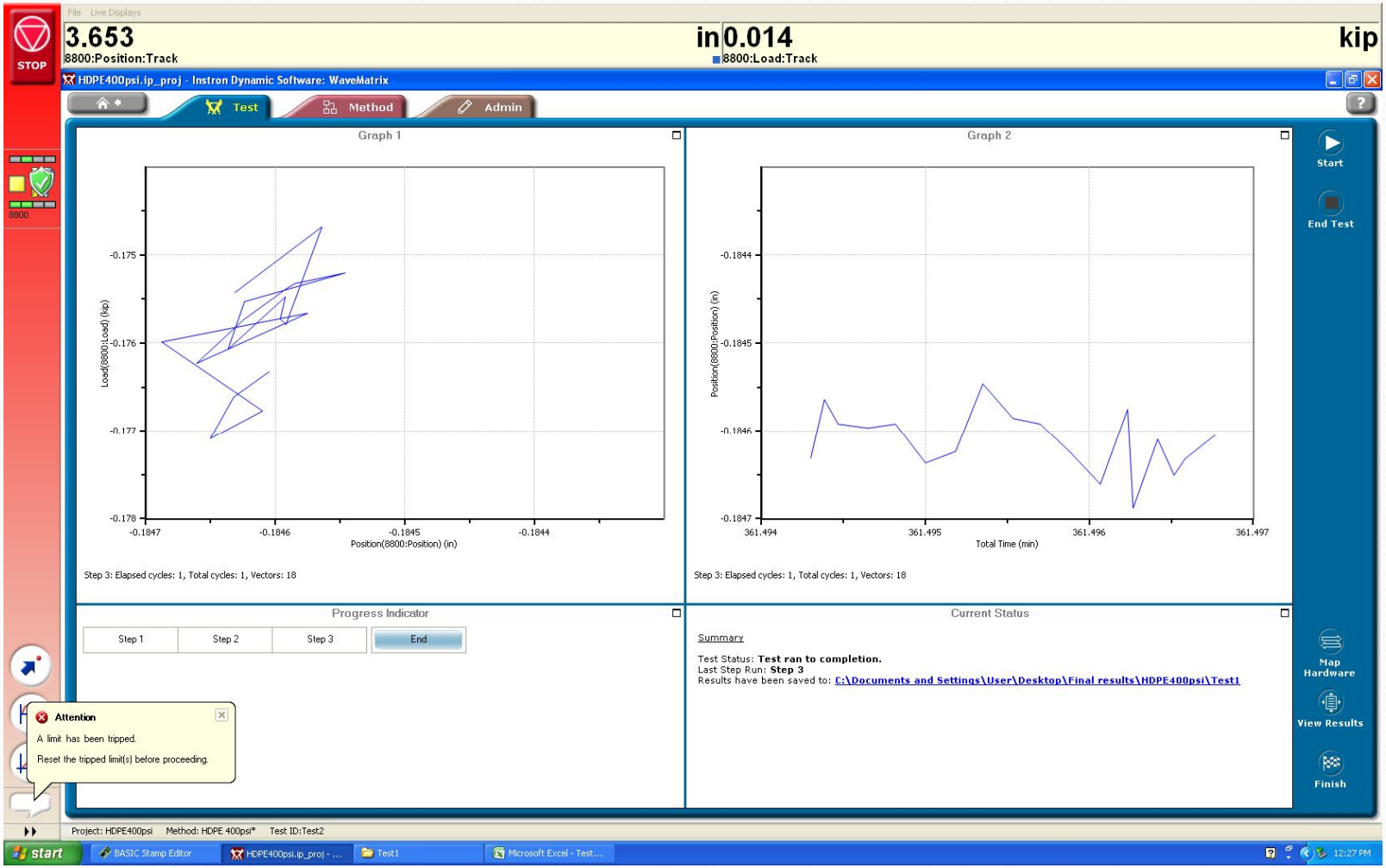

STOP
3.754
8800:Position:Track
in 0.013
8800:Load:Track
kip
BASIC Stamp - C:\Documents and Settings\User\My Documents\TTablePos.bsp
Debug Terminal
0491
(1) K - Chromel/Alumel
TC Type..... Konstantan
Temp °C..... 49
Temp °F..... 120
Device SN... 30153D0510000007
Macros...
Pause
Clear
Close
Echo Off
OW PIN 8 ' 1-Wire buss pin
ReadNet CON $33 ' read OW net address
SkipNet CON $CC ' skip OW net address
RdReg CON $69 ' read register
idx VAR Nib ' loop counter
type VAR Nib ' device type
char VAR Byte ' display byte/char
vIn VAR Word ' in millivolts
tmpCJ VAR Word ' device temp in C
tCuV VAR Word ' thermocouple millivolts
sign VAR Word ' TC sign bit
cjComp VAR Word ' temp compensation
tempC VAR Word ' temp in Celsius
tempF VAR Word ' temp in Fahrenheit
tblLo VAR Word ' table pointers
tblHi VAR Word
eePntr VAR Word
testVal VAR Word ' test value from table
error VAR Bit ' 1 = out of range
tempint VAR Byte 'max temp
HIGH 10
DEBUG "Please set maximum temperature." , CR, "Must be set as 3 digit number", CR, " 75 degrees C is 075"
DEBUGIN DEC3 tempint ' get selection
DEBUG CRSRXY, 0, 3, CLRDN ' remove selections
STORE tempint ' set max temp
Stamp_Check:
#IF ($STAMP < BS2P) #THEN
#ERROR "This program requires BS2p or BS2pe"
#ENDIF
Check_Device:
OWOUT OW, %0001, [ReadNet] ' get serial number
OWIN OW, %0010, [SPSTR 8] ' store in SPRAM
GET idx, char ' read device type
IF (char <> $30) THEN ' if not $30, wrong device
18: 78
INS
Downloaded
Tokenize/Download Successful
start
BASIC Stamp Editor
Test1
Microsoft Excel - Test...
program running - Paint
12:28 PM

Laboratory Set-Up



- The Instron MTS 8800 loading matching applies a load to the specimen.
- The loading machine is started, and the load is applied for each desired stress value. After that, temperature is changed every 2 hours to the desired temperature (22C, 38C, 49C, or 56C) to get the 8 hours isothermal results.

Wavematrix


STOP
3.653
8800:Position:Track
in 0.014
8800:Load:Track
kip
HDPE400psi.ip_proj - Instron Dynamic Software: WaveMatrix
Test
Method
Admin
Graph 1
Load(8800:Load) (kip)
-0.175
-0.176
-0.177
-0.178
-0.1847
-0.1846
-0.1845
-0.1844
Position(8800:Position) (in)
Step 3: Elapsed cycles: 1, Total cycles: 1, Vectors: 18
Graph 2
Position(8800:Position) (in)
-0.1844
-0.1845
-0.1846
-0.1847
361.494
361.495
361.496
361.497
Total Time (min)
Step 3: Elapsed cycles: 1, Total cycles: 1, Vectors: 18
Start
End Test
Progress Indicator
Step 1
Step 2
Step 3
End
Current Status
Summary
Test Status: Test ran to completion.
Last Step Run: Step 3
Results have been saved to: C:\Documents and Settings\User\Desktop\Final results\HDPE400psi\Test1
Map Hardware
View Results
Finish
Attention
A limit has been tripped.
Reset the tripped limit(s) before proceeding.
Project: HDPE400psi
Method: HDPE 400psi*
Test ID:Test2
start
BASIC Stamp Editor
HDPE400psi.ip_proj - ...
Test1
Microsoft Excel - Test...
12:27 PM

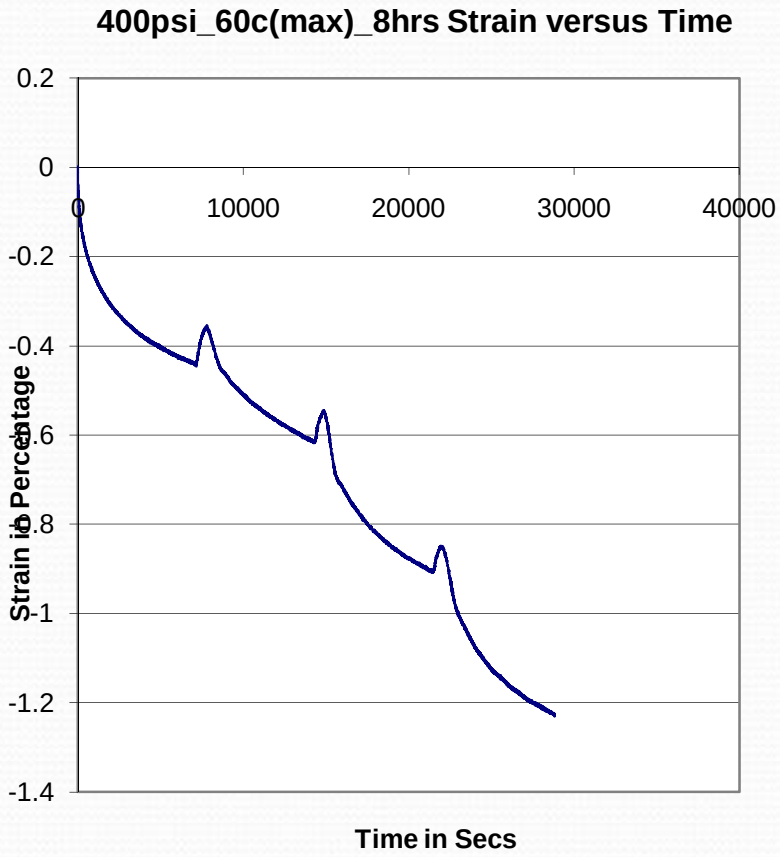
Tabulation of load for both specimens.

HDPE sample L=1.5 in. d=.75 in. Area=.44 sq.in.	Fiberglass sample L=1.25 in. d=.5 in area=.20 sq.in.

Desired stress(psi)	Desired Load P (lbs)	Desired stress(psi)	Desired Load P (lbs)
400 800	480 628	400	176

Typical Test Results HDPE 400 psi

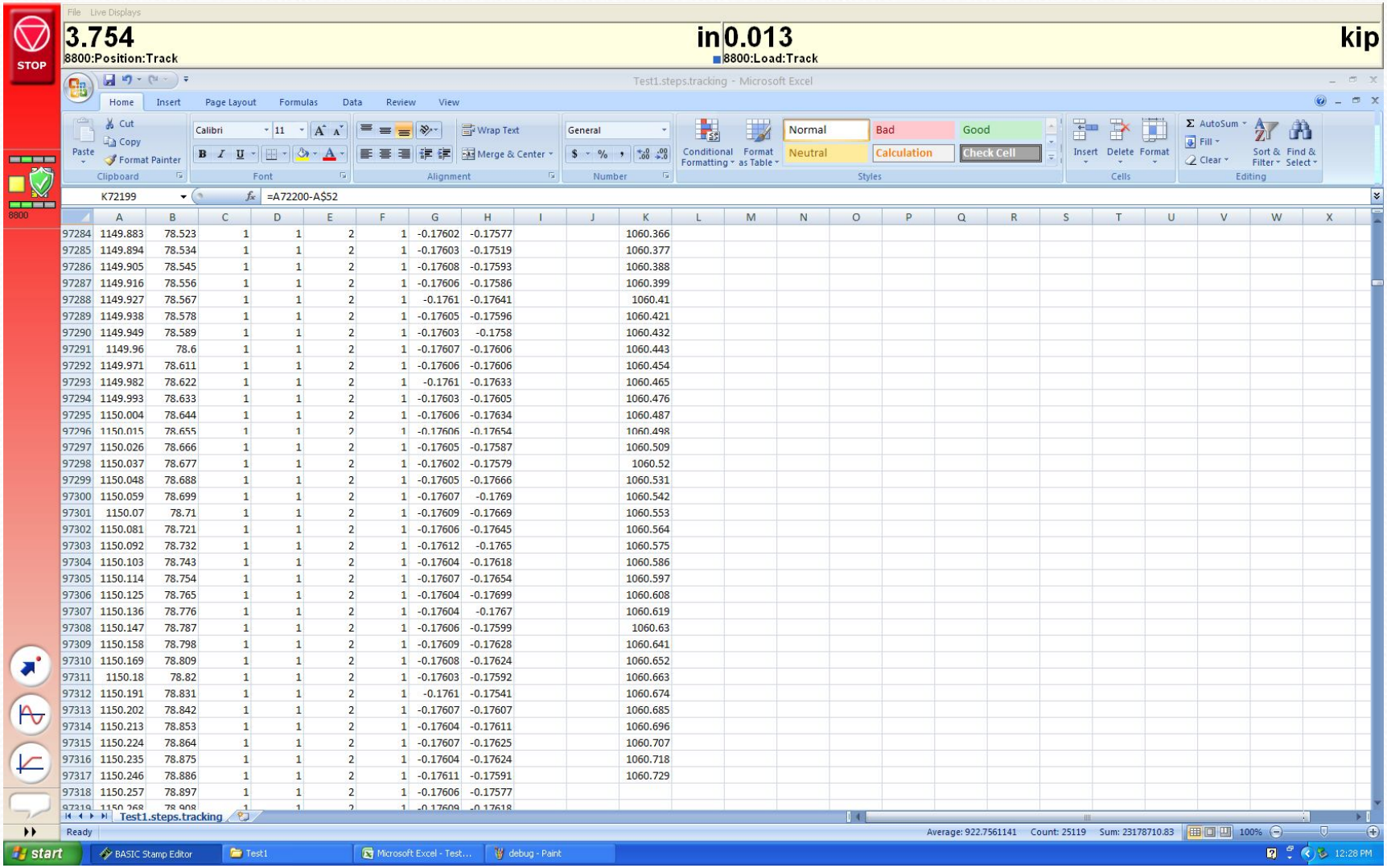
Typical Results: Saumil Parikh



Our Results

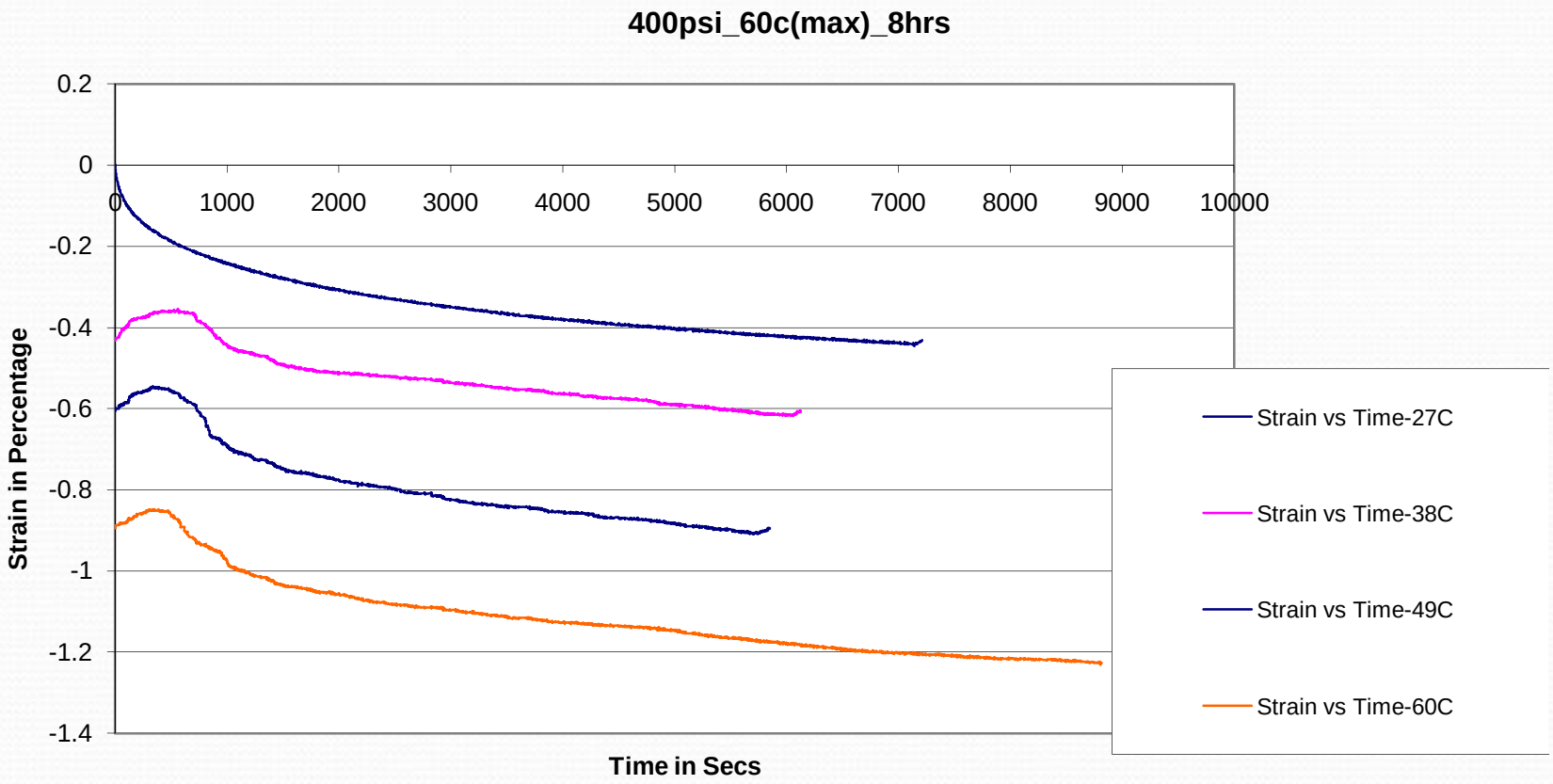
- NOT Graphical

Raw Data (1,000,500 lines+)....



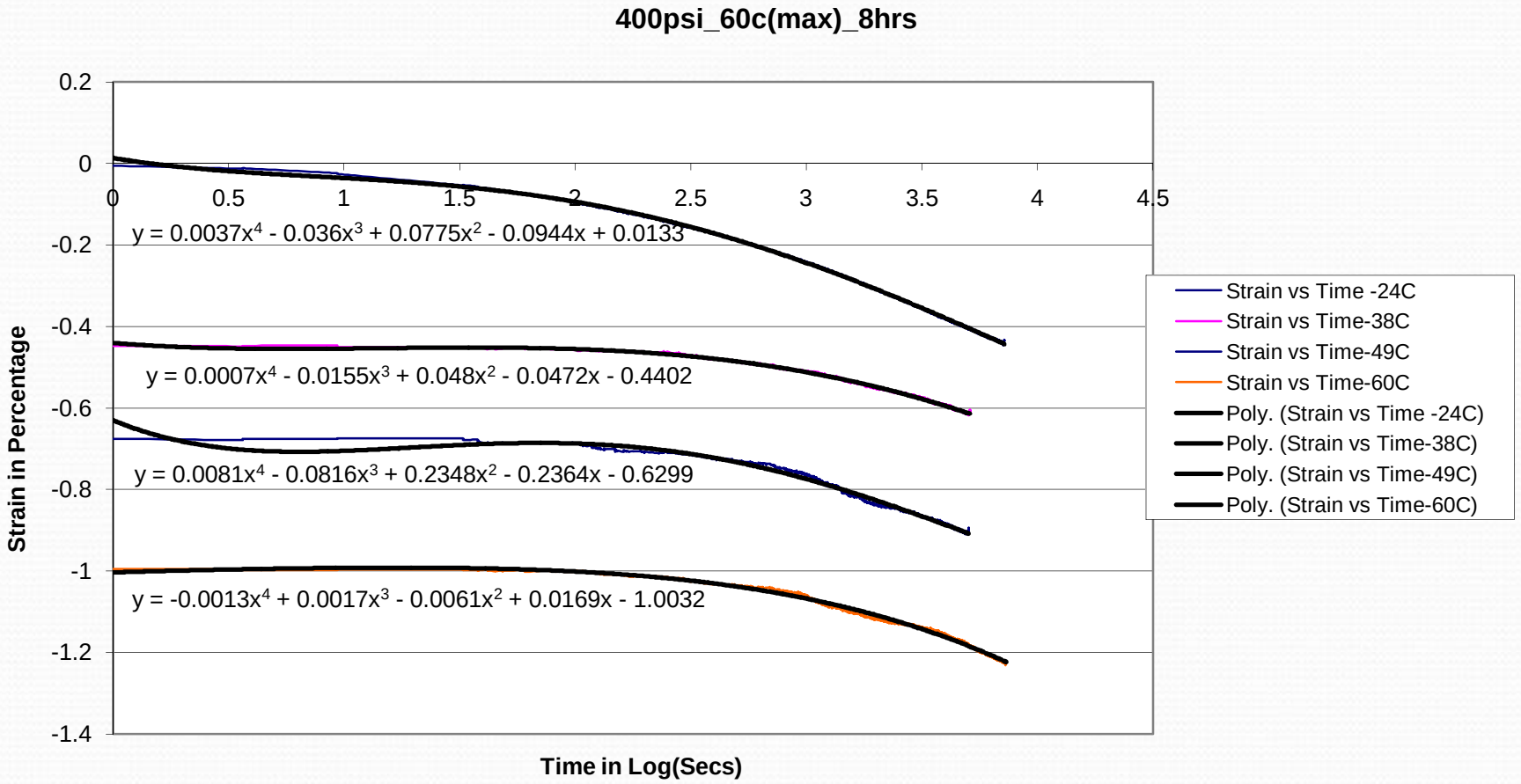
	A	B	C	D	E	F	G	H	I	J	K
97284	1149.883	78.523	1	1	2	1	-0.17602	-0.17577			1060.366
97285	1149.894	78.534	1	1	2	1	-0.17603	-0.17519			1060.377
97286	1149.905	78.545	1	1	2	1	-0.17608	-0.17593			1060.388
97287	1149.916	78.556	1	1	2	1	-0.17606	-0.17586			1060.399
97288	1149.927	78.567	1	1	2	1	-0.1761	-0.17641			1060.41
97289	1149.938	78.578	1	1	2	1	-0.17605	-0.17596			1060.421
97290	1149.949	78.589	1	1	2	1	-0.17603	-0.1758			1060.432
97291	1149.96	78.6	1	1	2	1	-0.17607	-0.17606			1060.443
97292	1149.971	78.611	1	1	2	1	-0.17606	-0.17606			1060.454
97293	1149.982	78.622	1	1	2	1	-0.1761	-0.17633			1060.465
97294	1149.993	78.633	1	1	2	1	-0.17603	-0.17605			1060.476
97295	1150.004	78.644	1	1	2	1	-0.17606	-0.17634			1060.487
97296	1150.015	78.655	1	1	2	1	-0.17606	-0.17654			1060.498
97297	1150.026	78.666	1	1	2	1	-0.17605	-0.17587			1060.509
97298	1150.037	78.677	1	1	2	1	-0.17602	-0.17579			1060.52
97299	1150.048	78.688	1	1	2	1	-0.17605	-0.17666			1060.531
97300	1150.059	78.699	1	1	2	1	-0.17607	-0.1769			1060.542
97301	1150.07	78.71	1	1	2	1	-0.17609	-0.17669			1060.553
97302	1150.081	78.721	1	1	2	1	-0.17606	-0.17645			1060.564
97303	1150.092	78.732	1	1	2	1	-0.17612	-0.1765			1060.575
97304	1150.103	78.743	1	1	2	1	-0.17604	-0.17618			1060.586
97305	1150.114	78.754	1	1	2	1	-0.17607	-0.17654			1060.597
97306	1150.125	78.765	1	1	2	1	-0.17604	-0.17699			1060.608
97307	1150.136	78.776	1	1	2	1	-0.17604	-0.1767			1060.619
97308	1150.147	78.787	1	1	2	1	-0.17606	-0.17599			1060.63
97309	1150.158	78.798	1	1	2	1	-0.17609	-0.17628			1060.641
97310	1150.169	78.809	1	1	2	1	-0.17608	-0.17624			1060.652
97311	1150.18	78.82	1	1	2	1	-0.17603	-0.17592			1060.663
97312	1150.191	78.831	1	1	2	1	-0.1761	-0.17541			1060.674
97313	1150.202	78.842	1	1	2	1	-0.17607	-0.17607			1060.685
97314	1150.213	78.853	1	1	2	1	-0.17604	-0.17611			1060.696
97315	1150.224	78.864	1	1	2	1	-0.17607	-0.17625			1060.707
97316	1150.235	78.875	1	1	2	1	-0.17604	-0.17624			1060.718
97317	1150.246	78.886	1	1	2	1	-0.17611	-0.17591			1060.729
97318	1150.257	78.897	1	1	2	1	-0.17606	-0.17577			
97319	1150.268	78.908	1	1	2	1	-0.17609	-0.17618			

Data Reduction
All Test-Temperatures Shifted to Zero



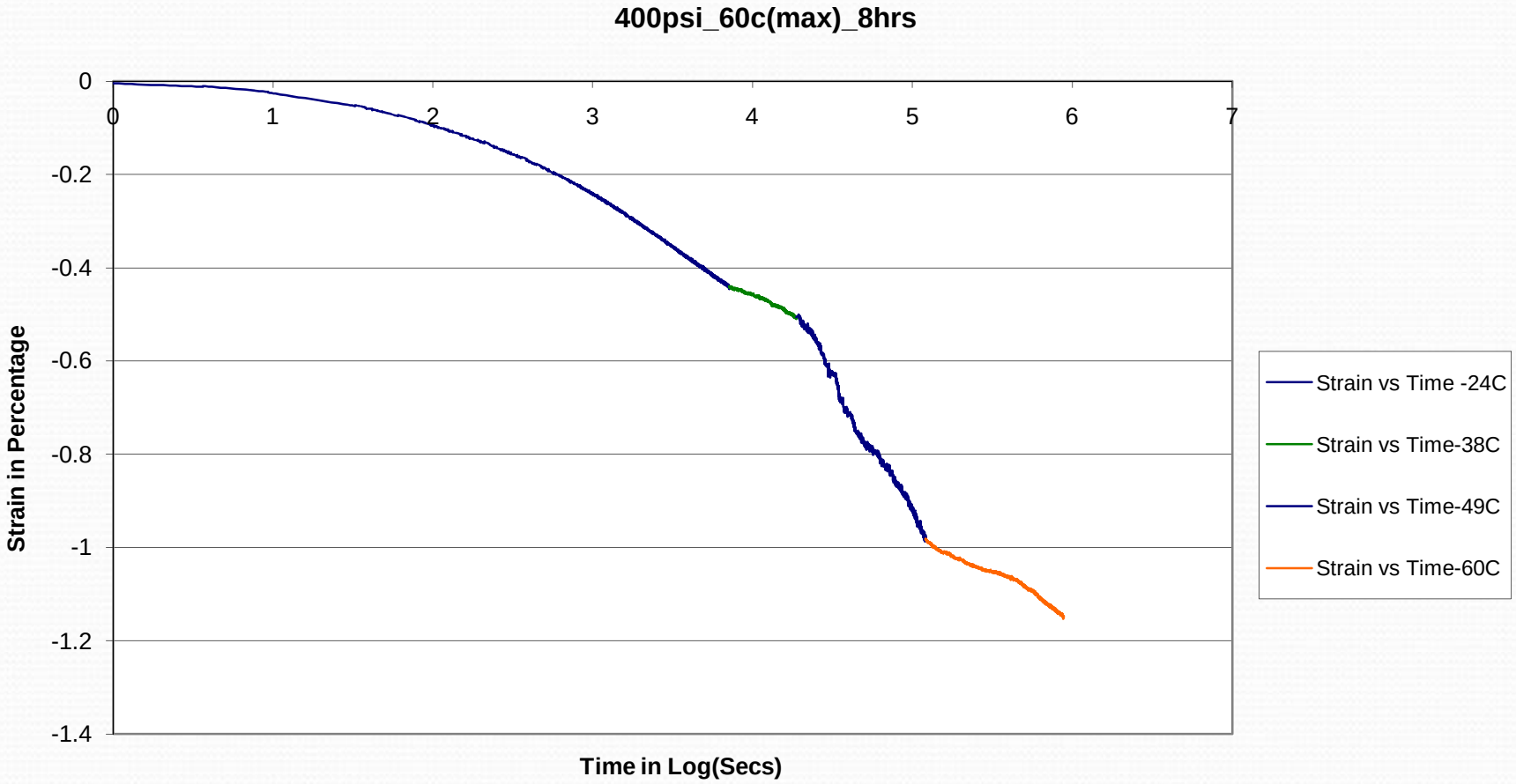
Typical results (Parikh 2007)

Best Fit Polynomial Function of Test Results



Typical results (Parikh 2007)

Master Creep Curve (HDPE)
Points with similar slopes attached to each other



Typical results (Parikh 2007)

Conclusion/ Recommendation

- The research would need more time to allow for the 8 hour tests. Data needs to be recorded in larger time interval to be adequately processed and graphed.
- The program held too many variables for excel to graph. The console software of the Instron MTS compression machine need to be configured properly.
- A larger footprint of the insulated heater .

Sample of our Lesson Plan

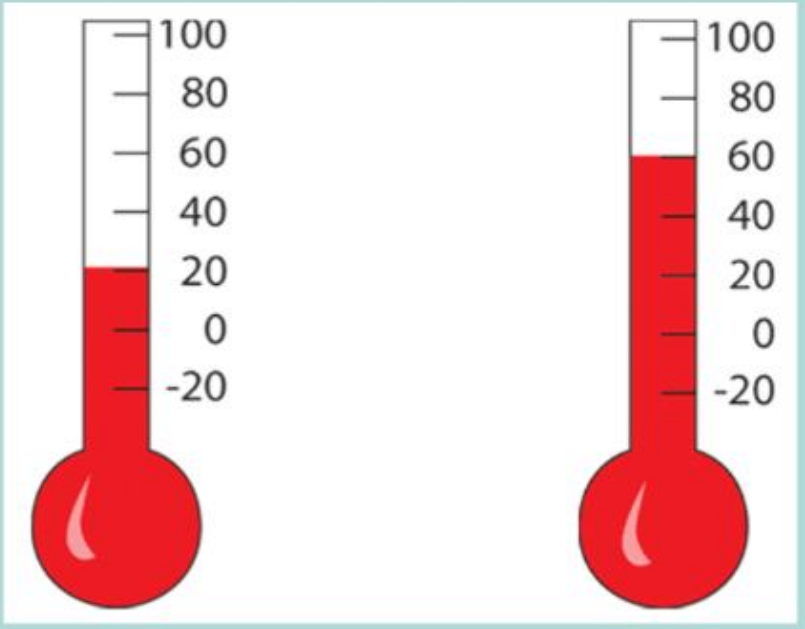
Do Now:

"A watched pot never boils."
Based on that expression what can you tell me about water?

Why is the expression not,
"A watched piece of metal does not get hot?"

Problem

How long does it take various materials to heat up?



Hypothesis

There are 3 sample materials in front of you; water, sand and metal filings.

Write your hypothesis as to which material will heat up the quickest.

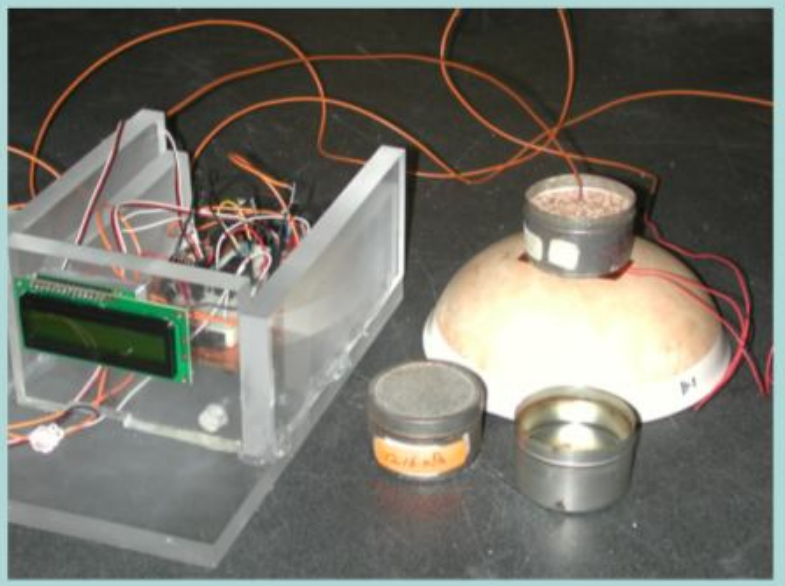
What about the slowest. _____

Which material do you believe will cool down the fastest, and the slowest? _____

Explain the reasoning for your answers.

Material Check

Does your station look like the diagram below?



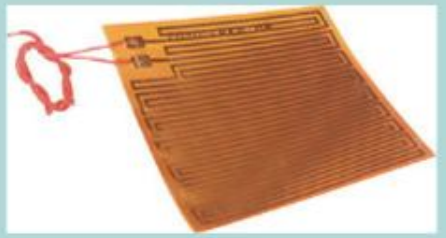
Raise your hand if you are missing any of the equipment.

Procedure

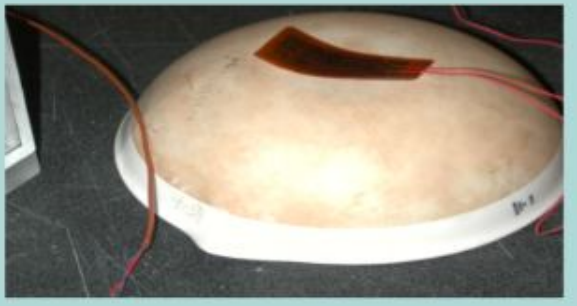
Working in your groups (of 4-5) you are going to be asked to measure the rate of heating and cooling of the materials in front of you. Using the data chart record the temperature every minute for 5 minutes. Then record the cooling rate of each material every minute for 5 minutes.

Sand	Heating						
	0 min	1 min	2 min	3 min	4 min	5 min	Rate of Change (use ESRT)
Remember to plug in the heat strip.	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C/min
	Cooling						
	6 min	7 min	8 min	9 min	10 min	Rate of Change (use ESRT)	Average temperature / 10 minutes
Remember to unplug the Heat Strip!	_____*C	_____*C	_____*C	_____*C	_____*C	_____*C/min	_____*C/min

Place the sample being tested on top of your heating strip. The heating strip should have already been placed on top of the ceramic plate.



IT SHOULD NEVER LEAVE THE TOP OF THE CERAMIC PLATE!



Instructions

Run the TCI program from basicstamp. Identify your thermocouple as type 1 to start. After program is already running and specimen is in place, plug in the AC adapter for the heating strip.

Disconnect the power for heat strip after each 5 minute test interval.

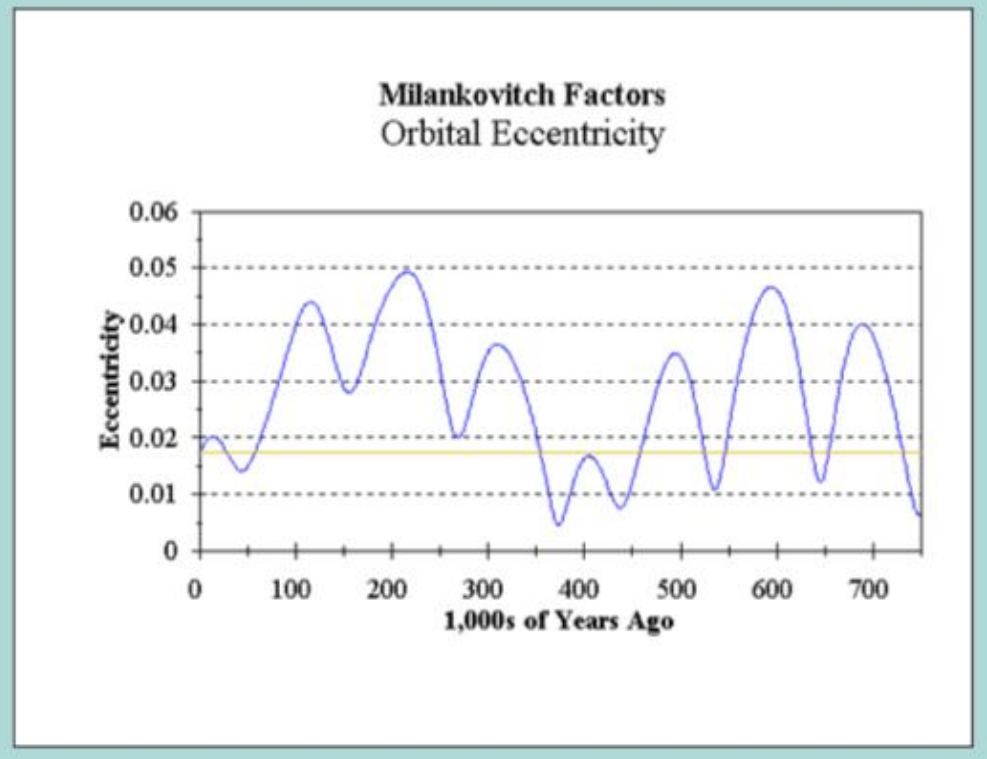
You may want to have roles for each group member;

- Recorder or heating
- Materials manager
- Programmer/ Time keeper
- Recorder of cooling
- (If 5th member) Facilitator

Graph your results!

Make sure to include title, labeled axis, and connect data points with a solid line.

Example:



Acknowledgements

- This work is supported by the Research Experience for Teachers Site Program of National Science Foundation under grant EEC-0807286: Science and Mechatronics Aided Research for Teachers (SMART).
- Special thanks for their helpful comments and suggestions.
  - Professor Magued Iskander
  - Saumil Parikh
  - Professor Vikram Kapilla
  - Chandresh Dubey

This work was conducted in summer 2009 in the Soil Mechanics and Civil Engineering Lab at the Polytechnic Institute of New York University and authors fondly acknowledge the hospitality and support of the lab personnel.