International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 4 Apr. 2024, pp: 751-766 www.ijaem.net ISSN: 2395-5252

The impact of loading conditions on the development of creep-fatigue damage.

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Date of Submission: 13-04-2024 Date of Acceptance: 26-04-2024

Abstract
This research investigate the performance of a spring stiffness machine with an attempt to design ,develop and evaluate it's performance. This work is fabricated as an experimental rig for Engineering laboratory. The inception of this machine was prompted by the lack of laboratory equipment in many facilities in this region. It was designed to prioritize affordability, operational efficiency, and ease of use for students during practical sessions. The materials used in its construction were sourced from Owode Onirin market, located on the outskirts of Lagos, Nigeria. Autodesk Inventor software was utilized to create design diagrams, and the construction process involved various fabrication techniques such as cutting, benching, welding, grinding, drilling, machining, casting, and screw fastening. Tests conducted on the machine validated its functionality, yielding a linear equation representing spring stiffness (k) values of 0.153, 0.268, 0.458, and 0.024 for tension springs A, B, C, and compression spring D, respectively. These findings demonstrate the machine's adherence to Hooke’s Law and its ability to maintain a consistent force against extension relationship.

Keywords – Cycling frequency, Loading conditions, Stress levels, Temperature effects, : Creep-fatigue.

I. INTRODUCTION

The durability of materials under varying mechanical loads that change over time is a key focus in engineering. Creep and fatigue, separate forms of wear and tear, can combine synergistically, causing what's known as creep-fatigue damage. It's crucial to know how different loads affect the development of this damage to create resilient structures that endure prolonged and repetitive stress.

The structural robustness of materials when subjected to dynamic and time-dependent mechanical loads is a significant concern in engineering. Creep and fatigue, distinct mechanisms of deterioration, often interact synergistically, resulting in what is termed as creep-fatigue damage. Understanding the impact of loading conditions on the progression of such damage is vital for designing resilient structures capable of enduring extended periods of cyclic stress.

The literature in this field has made significant strides in elucidating specific aspects of creep and fatigue behaviors. However, a comprehensive synthesis of how loading conditions, individually and collectively, impact the overarching process of creep-fatigue damage evolution remains a gap in current research. This paper seeks to address this gap by integrating experimental studies and establishing connections between the key variables influencing material degradation.

This research holds significant importance as it has the potential to guide the design and upkeep of structures exposed to fluctuating and continuous mechanical pressures. As industries explore new frontiers in materials and structural design, a detailed comprehension of creep-fatigue damage under diverse loading scenarios becomes essential to guarantee safety, dependability, and durability over timeThe subsequent sections delve into the existing literature, detailing studies that explore temperature effects, stress levels, cycling frequency, microstructural changes, testing methodologies, and predictive models. By synthesizing this wealth of information, we aim to contribute to a more robust framework for comprehending and predicting the influence of loading conditions on creep-fatigue damage evolution, ultimately advancing the field of materials science and engineering.

1.1 SIGNIFICANCE OF THE PROJECT

This study holds a significance as it can contribute to a better understanding of how loading

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conditions impact creep-fatigue damage, offering insights into material behaviour under various stress scenerios.the finding may have inmplications for designing more resilient structures and improving safety assessment in engineering applications.

II. MATERIALS AND METHODS

The experiment was carried out in the strength of material mechanical laboratory using Tec equipment SM 1006 creep machine coupled with other accessories that came along with the machine which includes ,three sets of 0.5 kg weights,200grammes weight, 100gramme weight,Venier Caliper cool pack,Sets of Lead specimen,Thermometer,Digital display ,Versatile Data Acquisition System (VDAS),Transparent glass load hanger and a laptop.

Fig.2.0 Vdas and Equipment

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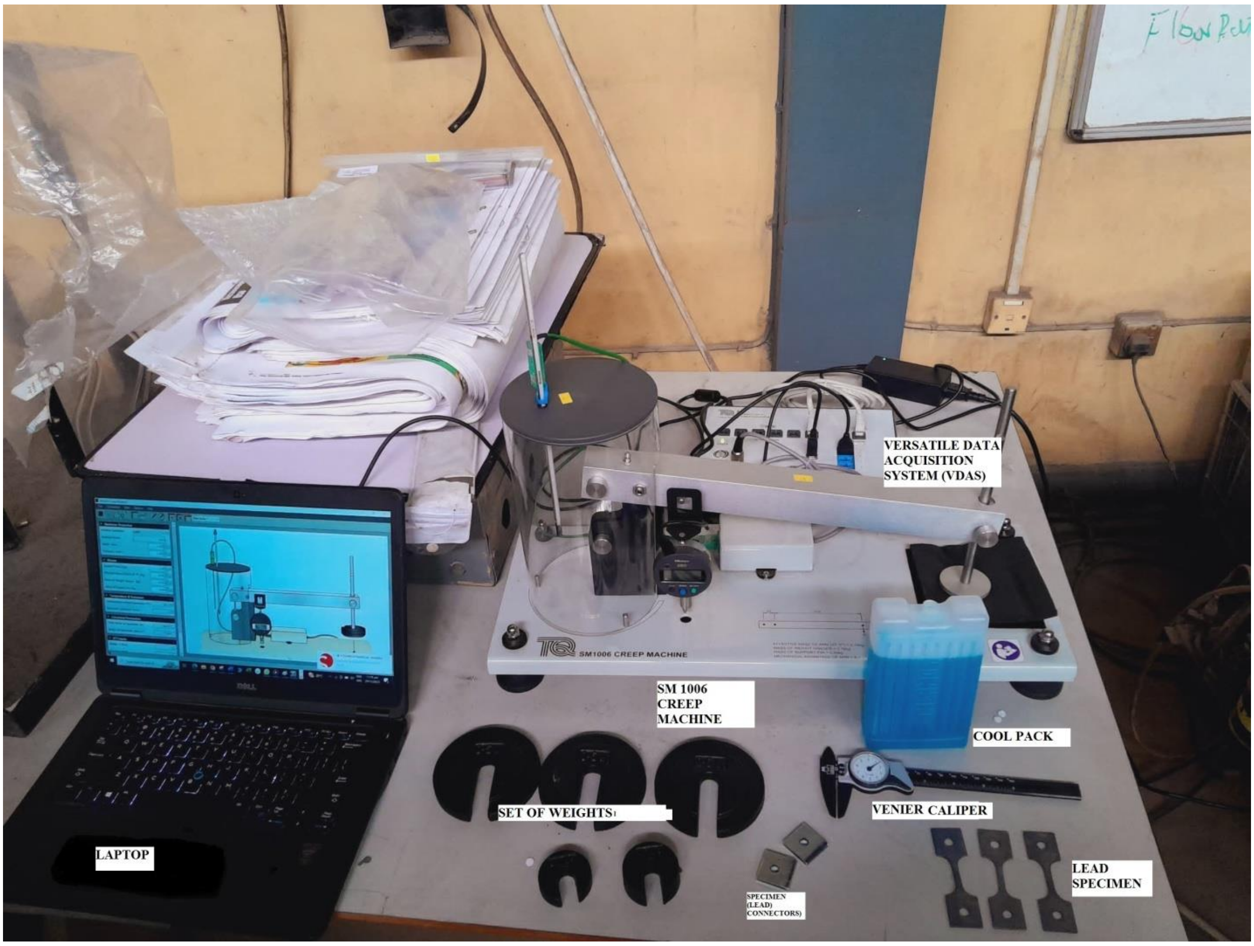

Fig 2.1 Complete display of system, Materials and equipment

The above shows the full composition of the materials, and the equipment used to get the influence of loading conditions creep- fatigue damage evolution.

Connections were made between the VDAS and the creep machine to serve as a linkage/interaction to the laptop system installed with Tec equipment software of the SM 1006 creep machine..

In the experiment,Lead material was also used as our specimen but with different load (weight) range applied on the material lead specifically, to know the influence of the load, thereby studying the factors resulting to the evolution of creep-fatigue damage..

First ly, the Lead material Width,Thickness, and gauge were measured before fixing with the aid of stainless support metal to the machine,Widthwas 0.7mm,thickness was for each of the Lead specimen one ,two and three.

.The coolpack was then placed inside the plane glass isolating the enviromental temperature and condition interference with lead under study.

The thermometer was then inserted through the glass cover in line with the interraction signal cable measuring the ineer environmental condition while the experiment was ongoing.

The load was then lifted to secure the material lead with the pin support holder, while the hangers were adjusted to create clearance from the base class in preparation for attaching the weight. VDAS was connected and turned on, the laptop was powered on, and the software booted up. All parameters were configured, the lead was selected, and the measurements of its thickness and width were manually entered as indicated below.

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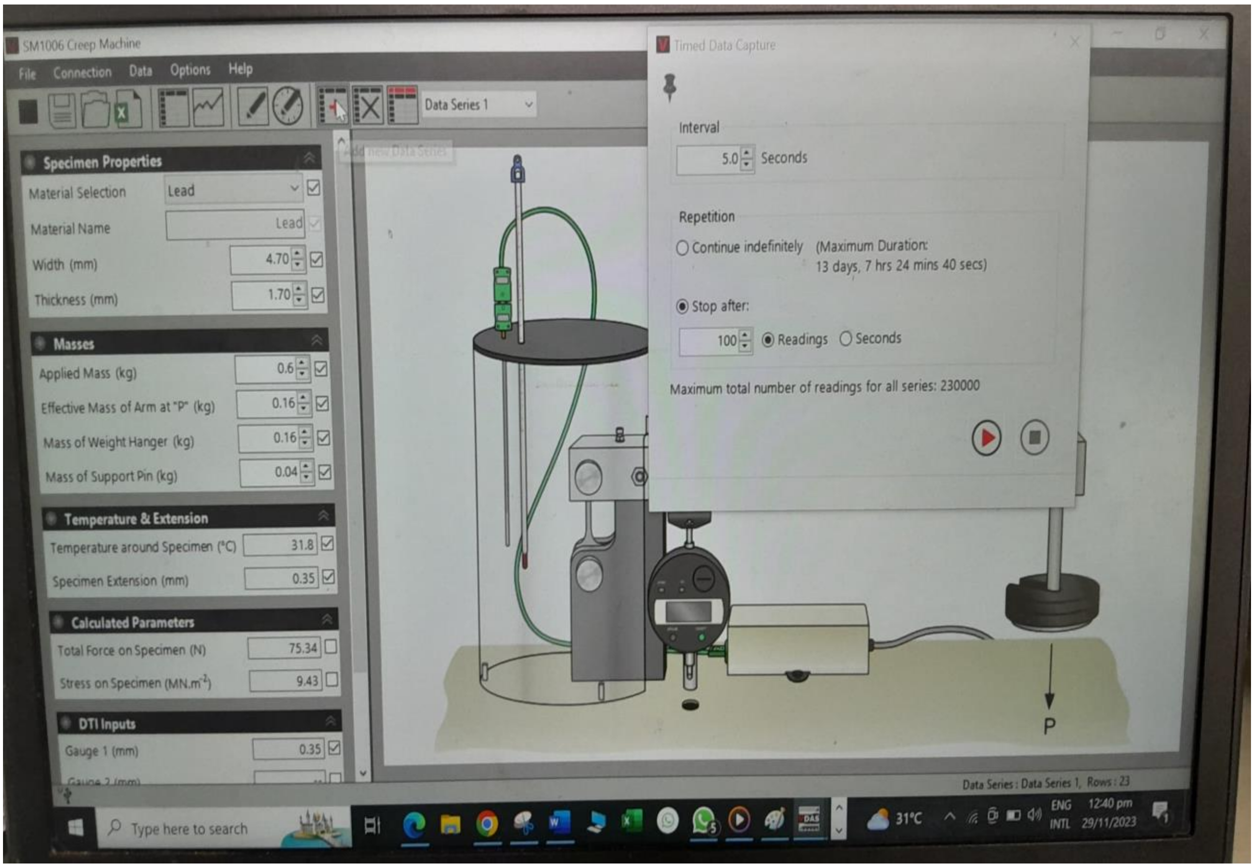

Fig.2.2 Digital display of readings

while other parameters indicated on the machine such as effective mass of arm(AT "P"}=0.16kg,mass of weight hanger=0.16kg,mass of support pin= 0.04kg, mechanical advantage of arm= 8:1 were automatically fixed on the system in readiness for the experimental take off.

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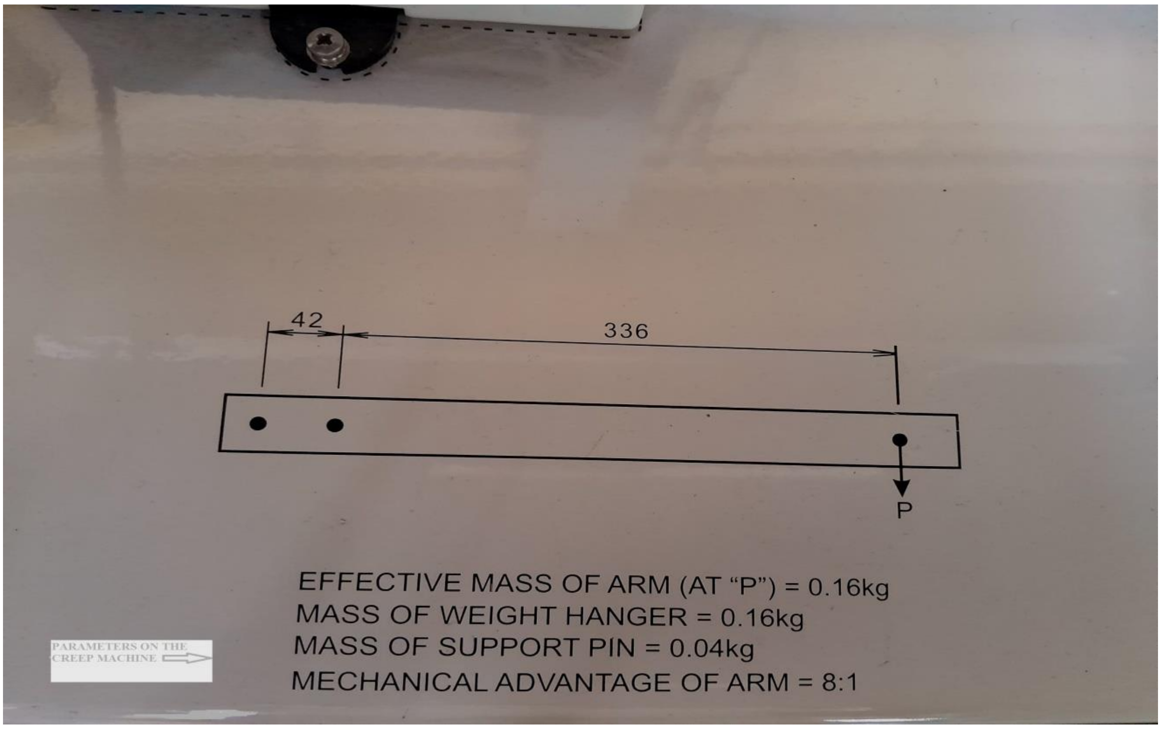

Fig 2.3Mass written on the base plate of the creep machine

The load is then connected, and the digital display is zeroed for both the initial and subsequent readings during the activation process, including the number of readings and the duration of time.

2.1 EXPERIMENTAL PROCEDURES

1. The gauge length and cross-sectional area was measured for each of the 3 test pieces of lead, using a vernier calliper.
2. Creep stress was then calculated using the test rig . As of the design of the test rig, we had to calculatethe total mass at the end of arm point "P by adding together,The value of the weight to be added to the anger + The effective mass of the arm at "P" + Mass of the weight hanger + Mass of the support pin.
3. A sample test piece was placed into the rig and was held vertically using locking pins beside the dial.
4. A load of 0.6kg was added to the end of the lever across from the lead sample.
5. The load was gently supported by a hand underneath, while the dial used for measuring the extension of the sample, was calibrated to zero. The load was then immediately released.
6. The dial started measuring the extension length (mm) and the value was noted every 5 seconds for the first 2 minutes. After that, the extension value was checked and noted every 30 seconds. The values were noted like this for a maximum range of 7-12 mins.

7. This same process was repeated for the two remaining lead sample test pieces, using loads of 0.7kg and 0.8kg respectively.
8. The results were laid out in a table and used to plot a graph of extension or strain against time.
9. It was ensured that the apparatus flat rigid platformto avoid shaken shaking interfarence during the experiment, as this could affect the value displayed on the dial and increase it.

2.2 READINGS
EXPERIMENT 1
EXPERIMENT (DATA) 1
Experimental Data of Lead 0.6kg: **Table1**

ime	Specimen Properties				Masses				Temperature & Extension		DTI Inputs
ime s)	Material Selection	Material Name	Width (mm)	Thickness (mm)	Applied Mass (kg)	Effective Mass of Arm at "P" (kg)	Mass of Weight Hanger (kg)	Mass of Support Pin (kg)	Temperature around Specimen (°C)	Specimen Extension (mm)	Gauge 1 (mm)
0.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.7	0.35	0.35
5.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.37	0.37
10.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.38	0.38
15.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.39	0.39
20.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.7	0.40	0.40
25.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.7	0.41	0.41
30.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.7	0.42	0.42
35.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.42	0.42
40.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.43	0.43
45.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.44	0.44
50.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.7	0.45	0.45
55.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.45	0.45
60.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.46	0.46
65.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.47	0.47
70.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.48	0.48
75.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.48	0.48
80.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.7	0.49	0.49
85.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.49	0.49
90.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.50	0.50
95.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.51	0.51
100.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.51	0.51
105.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.52	0.52
110.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.52	0.52
115.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.53	0.53
120.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.53	0.53
125.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.54	0.54
130.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.54	0.54
135.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.55	0.55
140.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.55	0.55
145.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.56	0.56
150.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.57	0.57
155.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.57	0.57
160.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.58	0.58
165.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.58	0.58
170.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.59	0.59
175.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.59	0.59
180.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.59	0.59
185.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.60	0.60
190.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.60	0.60
195.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.61	0.61
200.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.61	0.61
205.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.62	0.62
210.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.62	0.62
215.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.63	0.63
220.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.63	0.63
225.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.63	0.63
230.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.64	0.64
235.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.64	0.64
240.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.64	0.64
245.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.65	0.65
250.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.65	0.65
255.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.8	0.66	0.66
260.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.66	0.66
265.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.66	0.66
270.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.67	0.67
275.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.67	0.67
280.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.68	0.68
285.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.68	0.68
290.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.68	0.68
295.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.69	0.69
300.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.69	0.69
305.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.69	0.69
310.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.70	0.70
315.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.70	0.70
320.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.70	0.70
325.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.71	0.71
330.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.71	0.71
335.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.71	0.71
340.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.72	0.72
345.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.72	0.72
350.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.73	0.73
355.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.73	0.73
360.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.73	0.73
365.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.73	0.73
370.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.74	0.74
375.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.74	0.74
380.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.74	0.74
385.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.75	0.75
390.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.75	0.75
395.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.75	0.75
400.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.76	0.76
405.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.76	0.76
410.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.76	0.76
415.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.77	0.77
420.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.77	0.77
425.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.77	0.77
430.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.78	0.78
435.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.78	0.78
440.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.78	0.78
445.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.79	0.79
450.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.79	0.79
455.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.79	0.79
460.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	31.9	0.80	0.80
465.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.80	0.80
470.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.80	0.80
475.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.81	0.81
480.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.81	0.81
485.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.82	0.82
490.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.82	0.82
495.0	Lead	Lead	4.70	1.70	0.6	0.16	0.16	0.04	32.0	0.82	0.82

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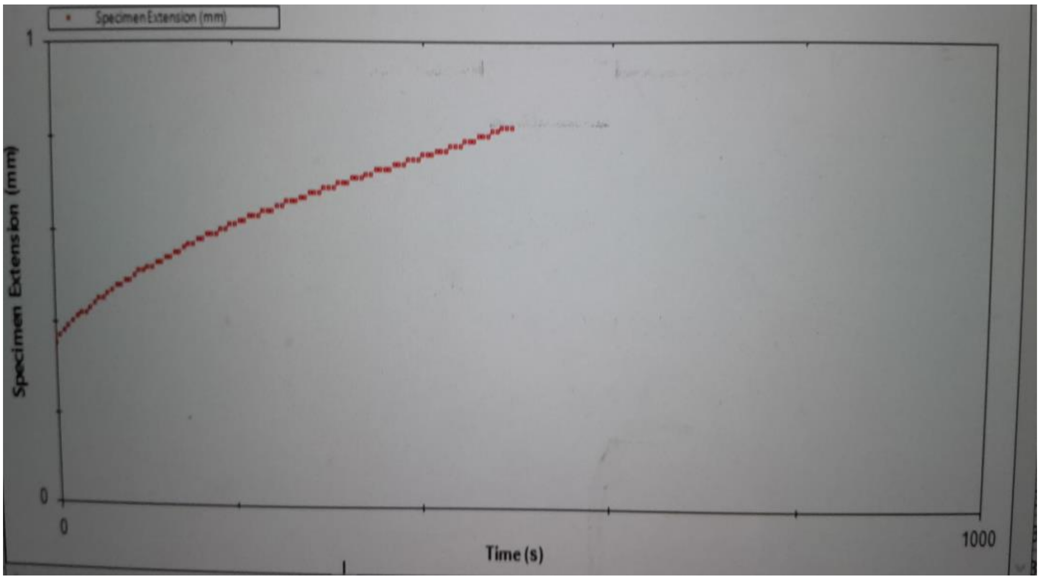
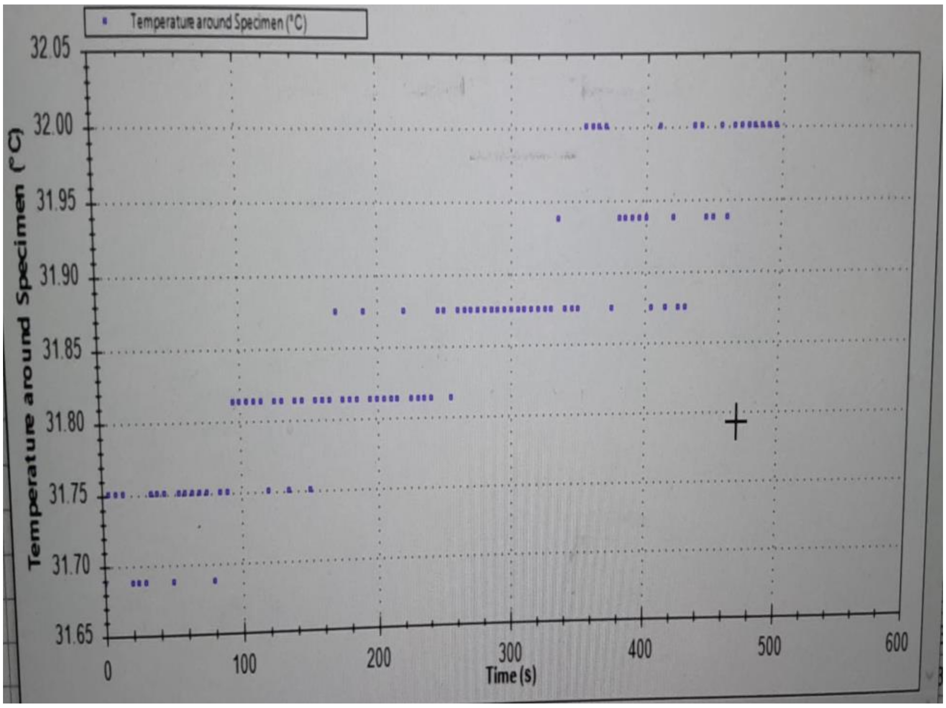


Graph 1.0 (Lead 0.6kg): **Extension (Strain) versus Time**



Graph 1.1 (Lead 0.6kg): **Temperature versus Time**

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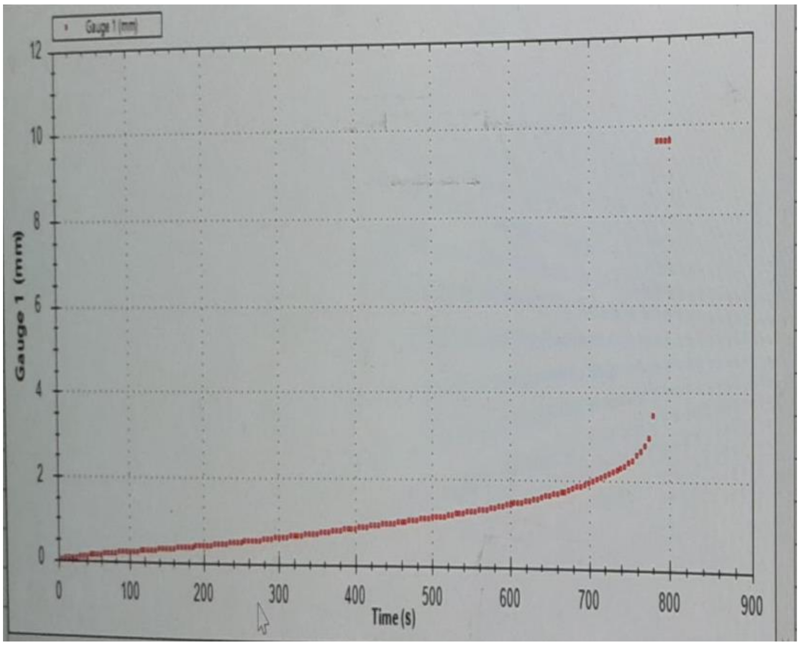
EXPERIMENT (DATA) 2- Experimental Data of Lead 0.7kg : **Table 2**

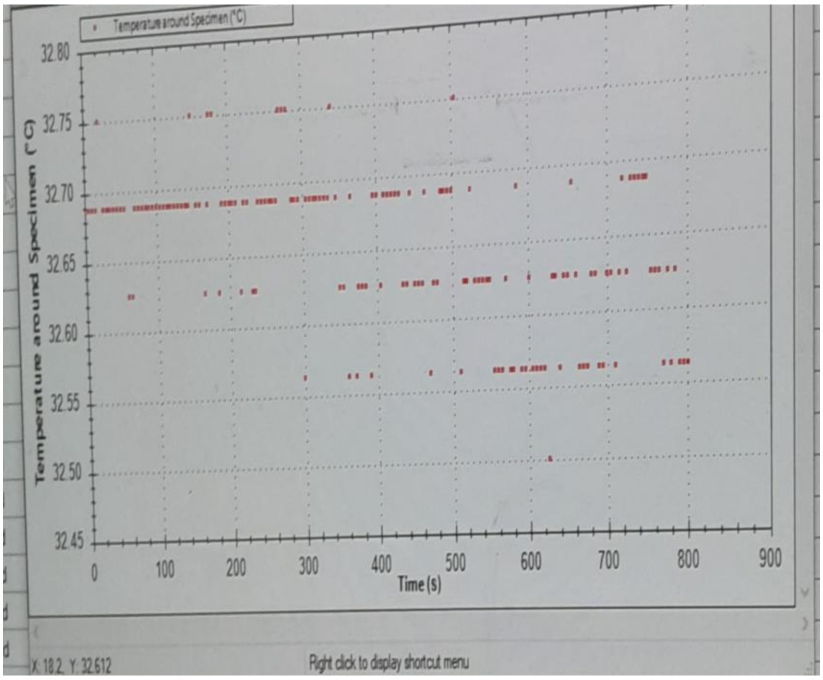
Time	Specimen Properties				Masses				Temperature & Extension		DTI Inputs
Time (s)	Material Selection	Material Name	Width (mm)	Thickness (mm)	Applied Mass (kg)	Effective Mass of Arm at "P" (kg)	Mass of Weight Hanger (kg)	Mass of Support Pin (kg)	Temperature around Specimen (°C)	Specimen Extension (mm)	Gauge 1 (mm)
0.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.00	0.00
5.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.02	0.02
10.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.04	0.04
15.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.05	0.05
20.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.06	0.06
25.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.07	0.07
30.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.09	0.09
35.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.10	0.10
40.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.11	0.11
45.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.12	0.12
50.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.13	0.13
55.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.14	0.14
60.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.15	0.15
65.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.16	0.16
70.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.17	0.17
75.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.18	0.18
80.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.19	0.19
85.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.20	0.20
90.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.21	0.21
95.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.21	0.21
100.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.22	0.22
105.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.23	0.23
110.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.24	0.24
115.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.25	0.25
120.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.26	0.26
125.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.26	0.26
130.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.27	0.27
135.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.28	0.28
140.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.29	0.29
145.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.30	0.30
150.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.31	0.31
155.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.32	0.32
160.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.32	0.32
165.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.33	0.33
170.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.34	0.34
175.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.35	0.35
180.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.36	0.36
185.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.37	0.37
190.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.38	0.38
195.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.39	0.39
200.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.40	0.40
205.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.40	0.40
210.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.41	0.41
215.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.42	0.42
220.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.43	0.43
225.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.44	0.44
230.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.45	0.45
235.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.46	0.46
240.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.47	0.47
245.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.48	0.48
250.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.49	0.49
255.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.50	0.50
260.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.51	0.51
265.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.52	0.52
270.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.53	0.53
275.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.54	0.54
280.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.55	0.55
285.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.57	0.57
290.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.58	0.58
295.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.59	0.59
300.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.60	0.60
305.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.61	0.61
310.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.62	0.62
315.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.63	0.63
320.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.64	0.64
325.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.65	0.65
330.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.66	0.66
335.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.68	0.68
340.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	0.69	0.69
345.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.70	0.70
350.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.71	0.71
355.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.73	0.73
360.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.74	0.74
365.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.75	0.75
370.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.77	0.77
375.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.78	0.78

380.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.79	0.79
385.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.80	0.80
390.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.82	0.82
395.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.83	0.83
400.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.84	0.84
405.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.85	0.85
410.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.86	0.86
415.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.88	0.88
420.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.89	0.89
425.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.90	0.90
430.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.92	0.92
435.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.93	0.93
440.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.94	0.94
445.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	0.96	0.96
450.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.97	0.97
455.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	0.99	0.99
460.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.00	1.00
465.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.01	1.01
470.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.03	1.03
475.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.04	1.04
480.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.05	1.05
485.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.06	1.06
490.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.07	1.07
495.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.09	1.09
500.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.10	1.10
505.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.8	1.11	1.11
510.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.13	1.13
515.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.14	1.14
520.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.16	1.16
525.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.17	1.17
530.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.19	1.19
535.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.20	1.20
540.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.22	1.22
545.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.23	1.23
550.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.25	1.25
555.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.26	1.26
560.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.28	1.28
565.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.30	1.30
570.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.31	1.31
575.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.33	1.33
580.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.35	1.35
585.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.37	1.37
590.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.39	1.39
595.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.41	1.41
600.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.43	1.43
605.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.45	1.45
610.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.47	1.47
615.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.48	1.48
620.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.50	1.50
625.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.5	1.52	1.52
630.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.54	1.54
635.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.57	1.57
640.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.59	1.59
645.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.62	1.62
650.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.64	1.64
655.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	1.66	1.66
660.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.68	1.68
665.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.71	1.71
670.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.74	1.74
675.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.77	1.77
680.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.80	1.80
685.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.83	1.83
690.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.87	1.87
695.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.90	1.90
700.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.93	1.93
705.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	1.97	1.97
710.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.01	2.01
715.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.05	2.05
720.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	2.09	2.09
725.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.13	2.13
730.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	2.18	2.18
735.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	2.23	2.23
740.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	2.28	2.28
745.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	2.33	2.33
750.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.7	2.40	2.40
755.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.47	2.47
760.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.56	2.56
765.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.66	2.66
770.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.78	2.78
775.0	Lead	Lead	4.70	1.70	0.7	0.16	0.16	0.04	32.6	2.95	2.95

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 4 Apr. 2024, pp: 751-766 www.ijaem.net ISSN: 2395-5252



Graph 2.0 (Lead 0.7kg): **Gaugeor Extension against Time**



Graph 2.1 (Lead 0.7kg): **Temperature against Time**

International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 4 Apr. 2024, pp: 751-766 www.ijaem.net ISSN: 2395-5252

EXPERIMENT (DATA) 3 Experimental Data of Lead 0.8kg : **Table 3**

Time	Specimen Properties				Masses				Temperature & Extension		DTI Inputs
Time (s)	Material Selection	Material Name	Width (mm)	Thickness (mm)	Applied Mass (kg)	Effective Mass of Arm at "P" (kg)	Mass of Weight Hanger (kg)	Mass of Support Pin (kg)	Temperature around Specimen (°C)	Specimen Extension (mm)	Gauge 1 (mm)
0.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	0.86	0.86
5.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	0.91	0.91
10.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	0.94	0.94
15.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	0.98	0.98
20.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.01	1.01
25.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.04	1.04
30.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.07	1.07
35.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.10	1.10
40.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.13	1.13
45.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.15	1.15
50.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.18	1.18
55.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.20	1.20
60.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.24	1.24
65.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.27	1.27
70.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.31	1.31
75.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.34	1.34
80.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.38	1.38
85.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.42	1.42
90.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.47	1.47
95.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	1.52	1.52
100.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.58	1.58
105.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.64	1.64
110.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.71	1.71
115.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.78	1.78
120.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.86	1.86
125.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	1.95	1.95
130.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	2.03	2.03
135.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	2.12	2.12
140.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	2.21	2.21
145.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.1	2.31	2.31
150.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	2.42	2.42
155.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	2.51	2.51
160.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	2.62	2.62
165.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	2.72	2.72
170.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	2.82	2.82
175.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	2.91	2.91
180.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.00	3.00
185.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.09	3.09
190.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.18	3.18
195.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.27	3.27
200.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.35	3.35
205.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.44	3.44
210.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	3.53	3.53
215.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.62	3.62
220.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	3.71	3.71
225.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.82	3.82
230.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	3.92	3.92
235.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	4.03	4.03
240.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	4.15	4.15
245.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	4.28	4.28
250.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	4.41	4.41
255.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	4.56	4.56
260.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	4.72	4.72
265.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	4.89	4.89
270.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	5.07	5.07
275.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	5.27	5.27
280.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	5.49	5.49
285.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	5.72	5.72
290.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	5.98	5.98
295.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	6.27	6.27
300.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	6.60	6.60
305.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	6.99	6.99
310.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	7.45	7.45
315.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.2	8.05	8.05
320.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	8.90	8.90
325.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	9.85	9.85
330.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	9.96	9.96
335.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	9.99	9.99
340.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.01	10.01
345.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.03	10.03
350.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.05	10.05
355.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.05	10.05
360.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.73	10.73
365.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.73	10.73
370.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.73	10.73
375.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.74	10.74

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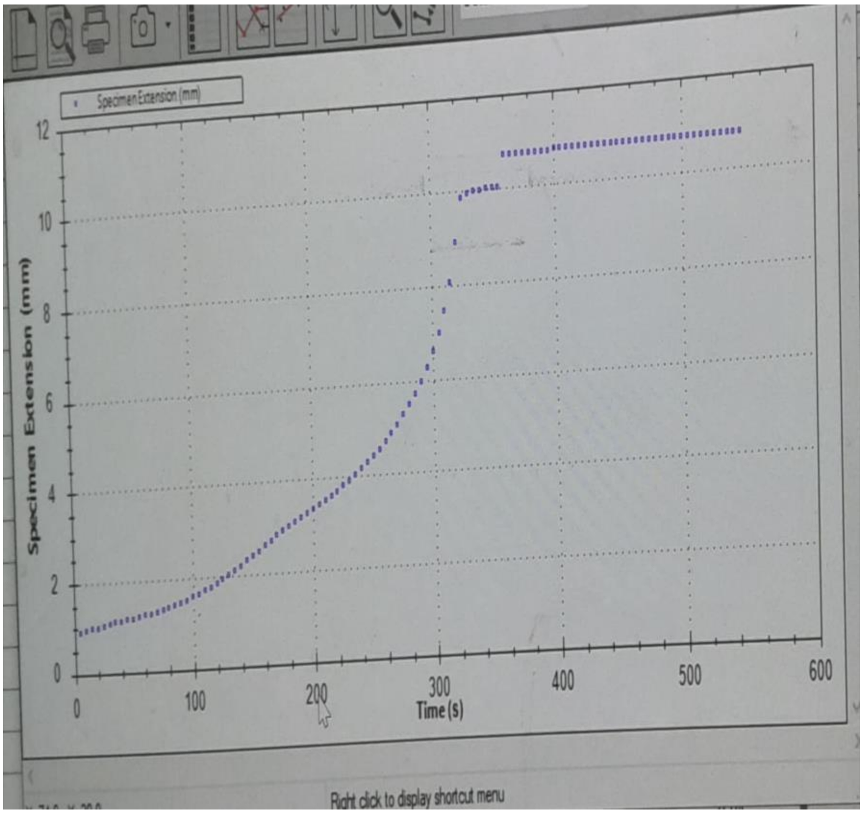
380.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.74	10.74
385.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.74	10.74
390.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.74	10.74
395.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.74	10.74
400.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.75	10.75
405.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
410.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
415.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
420.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
425.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
430.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
435.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.75	10.75
440.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
445.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.75	10.75
450.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
455.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
460.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
465.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
470.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
475.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
480.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76
485.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76
490.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
495.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
500.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76
505.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76
510.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76
515.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
520.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76
525.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
530.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76
535.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
540.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.3	10.76	10.76
545.0	Lead	Lead	4.70	1.70	0.8	0.16	0.16	0.04	33.4	10.76	10.76



Graph 3,0 (Lead 0.8kg): **Gauge or Extension against Time**

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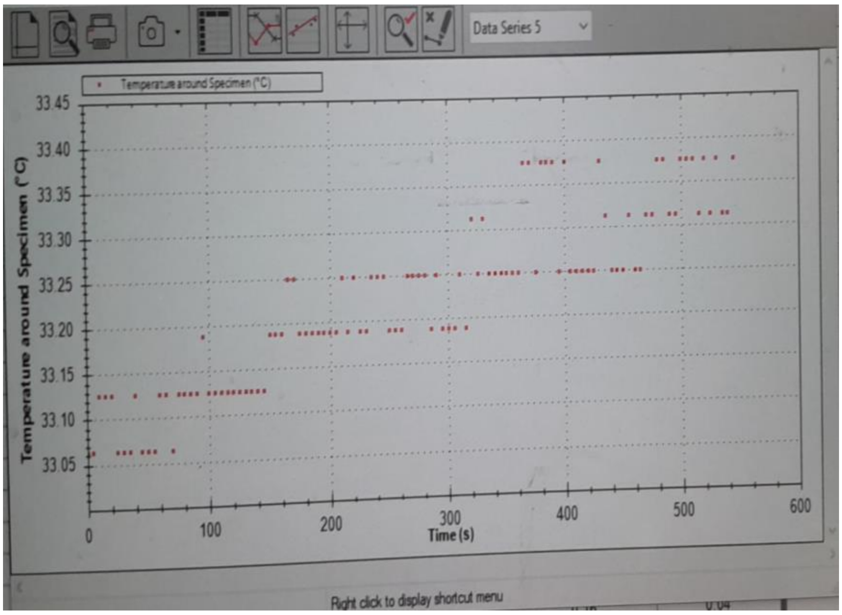

Graph3.1 (0.8kg): **Temperature against Time**

Physical Influence of loading conditions on the Lead material creep- fatigue damage

Fig.2.4

Fig 2.5

Fig.2.6

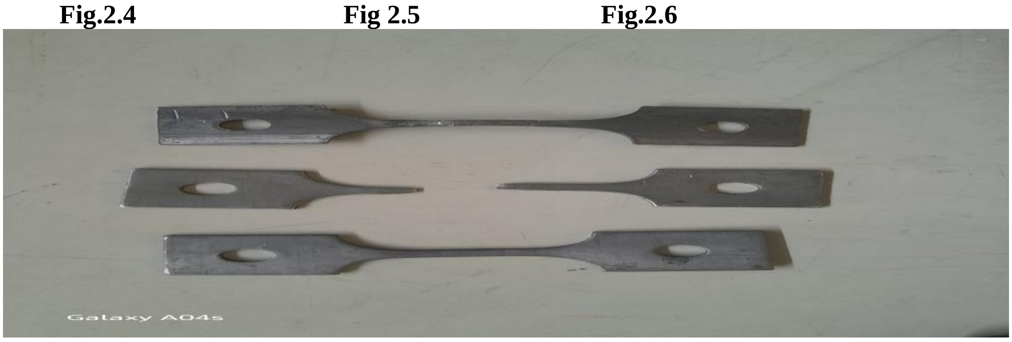

Fig. 2.7

III. RESULT

From Experimental Data of Lead material 0.6kg : Table1,
Width of the 0.6 Lead specimen = 4.70mm
Thickness of the Lead material was = 1.70mm
Applied mass =0.6kg
Effective mass of arm at "p" in kg =0.16
Mass of support pin in kg =0.04
Mechanical advantage of the arm=8.1 (from fig.4.3 given above on the creep machine)
Temperature Temperature around specimen(lead)= 31.7degrees centigrade

Therefore,
stress on 0.6 lead (total mass of "P" lead specimen =Total mass at theend of the arm(point" P")=The value of the weight to be added to the weight hanger + The effective mass of the arm at "P" +mass of the weight hanger +mass of the support pin = 0.6+0.16+0.16.+0.14=0.96kg
Total force on the Lead specimen =stress on lead specimen or total mass at "P" X mechanical advantage x Acceleration due to gravity=0.96kg x 8.1 x 9.81= 76.28N

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Cross sectional area of 0.6kg lead= width of Lead material x Thickness of lead material
=4.70mm x 1.70mm =7.99mm^2
Total stress= Total Force / Cross sectional area of Lead
=76.28/7.99 =9.54 N/mm^2

Likewise,from Experimental Data of Lead material 0.7kg : Table 2,
Width of the 0.7 Lead specimen = 4.70mm
Thickness of the Lead material was = 1.70mm
Applied mass =0.7kg
Effective mass of arm at "p" in kg =0.16
Mass of support pin in kg =0.04
Mechanical advantage of the arm=8.1 (from fig.4.3 given above on the creep machine)
Temperature Temperature around specimen(lead)= 32.8 degrees centigrade

Stress on 0.7 lead (total mass of "P" lead specimen =Total mass at theend of the arm(point" P")= 0.7+0.16+0.16.+0.14=1.16kg
Total force on the Lead specimen =stress on lead specimen or total mass at "P" X mechanical advantage
x Acceleration due to gravity=1.16kg x 8.1 x 9.81= 92.17N
Cross sectional area of 0.6kg lead= width of Lead material x Thickness of lead material
=4.70mm x 1.70mm =7.99mm^2
Total stress = Total Force / Cross sectional area of Lead
=92.17/7.99 = 11.67N/mm^2

Also, from Experimental Data of Lead material 0.8kg : Table 3,
Width of the 0.7 Lead specimen = 4.70mm
Thickness of the Lead material was = 1.70mm
Applied mass =0.8kg
Effective mass of arm at "p" in kg =0.16
Mass of support pin in kg =0.04
Mechanical advantage of the arm=8.1 (from fig.4.3 given above on the creep machine)
Temperature around specimen(lead)= 33.1 degrees centigrade

Stress on 0.8 lead (total mass of "P" lead specimen =Total mass at theend of the arm(point" P")= 0.8+0.16+0.16.+0.14=1.26kg
Total force on the Lead specimen =stress on lead specimen or total mass at "P" X mechanical advantage
x Acceleration due to gravity=1.26kg x 8.1 x 9.81= 100.12N
Cross sectional area of 0.8kg lead= width of Lead material x Thickness of lead material
=4.70mm x 1.70mm =7.99mm^2
Total stress = Total Force / Cross sectional area of Lead
=100.12/7.99 = 12.53N/mm^2

Graph 1.0,Graph 2.0 and Graph 3.0 represents Stress (ε) vs Time (s) of three different stress levels tested on the material Lead. Each dotted line represents a separate stress level with its own unique values and have been labelled on the legend. The temperature has been noted on the Graph. 1.0,Graph 2.0 and Graph 3.0.

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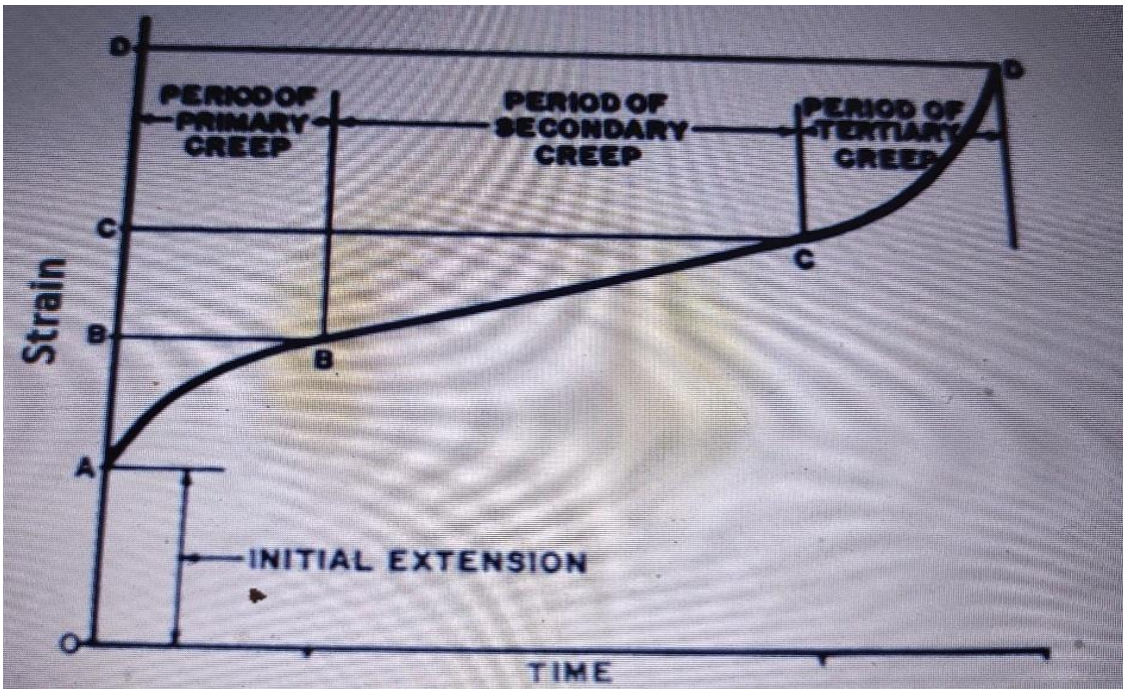

Fig.3.0 Strain(Extension) vs. Time graph presented on the Lab manual on loop.

Using fig 3.0 to analyse Graph 1.0,Graph 2.0 and Graph 3.0 .The Primary Creep is much more defined on the 0.6kg load than it is on all the other loads. Secondary Creep region behind showed for all loads except the 0.6kg It is known to be the straight-line part of the graph. Tertiary Creep is the region where the material begins to deform drastically compared to the other stages..

3.1 Discussion

The experiment involved testing three samples of lead under different loading conditions: 0.6kg, 0.7kg, and 0.8kg weights. The results and graphs aligned with expectations, resembling the Strain vs. Time graph outlined in the lab manual. Primary creep, where the test piece initially extends at an accelerating rate before stabilizing, was not very evident in these results. However, the initial values in each table indicate its presence. For instance, the values do not increase uniformly until the third or fourth value, after which they show a consistent rise resembling a straight line.

From this, it can be inferred that stress levels of 9.54 N/mm², 11.67 N/mm², and 12.53 N/mm² contribute to the rate of damage accumulation. Higher stress amplitudes can intensify fatigue, while sustained loads contribute to creep. Analysis of the table and graph confirms that higher temperatures can expedite creep and fatigue damage, highlighting the impact of temperature variations on material behavior and long-term structural integrity.
Regarding cycling frequency, observations suggest that fatigue damage can be influenced by the frequency of applied stress, whereas creep is typically time-dependent.

3.2 Conclusions

- From the above we have been able to establish the fact that there is creep- fatigue damage evolution Influence of loading conditions that involve some factors such as temperature, stress levels, and cycling frequency
- From each test, it was observed, that under a constant load, lead will eventually fail It was then proven that with greater loads lead will fail faster.
- Based on this experimental research of the stress-strain graphs it is reasonable to say that materials under creep will change depending on certain variables such as load. This proves that the rate of change of creep is proportional to the load. However, if the temperature is increased the rate of change of creep will vary
- From the results and conclusions, the experiment was performed properly.

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