Abstract:

found exp and compared with th. values.

In this experiment the stress& strain were calculated using the reading of the amplifier and substituting in the equation shown in the subsequent sections.

The load was installed softly so no impact happens during loading, elongation occur in the strain gauges attached to the steel bar due to bending moment caused by loading causing a voltage difference amplified and then read from the LED display .

Using the data observed from the amplifier the experimental stress was calculated.

Experimental values of stress were then compared to those calculated theoretically from the radius of the arm and the load on the holder.

Stress strain curves where drawn for loading and unloading and hysteresis of the steel beam was investigated.

Values!!

- list of symbols (missing)

Objectives:

1- To be familiar with different types of strain gauge,
2- Learn how different types of strain gauge works.
3- Test the hysteresis of the steel bar.

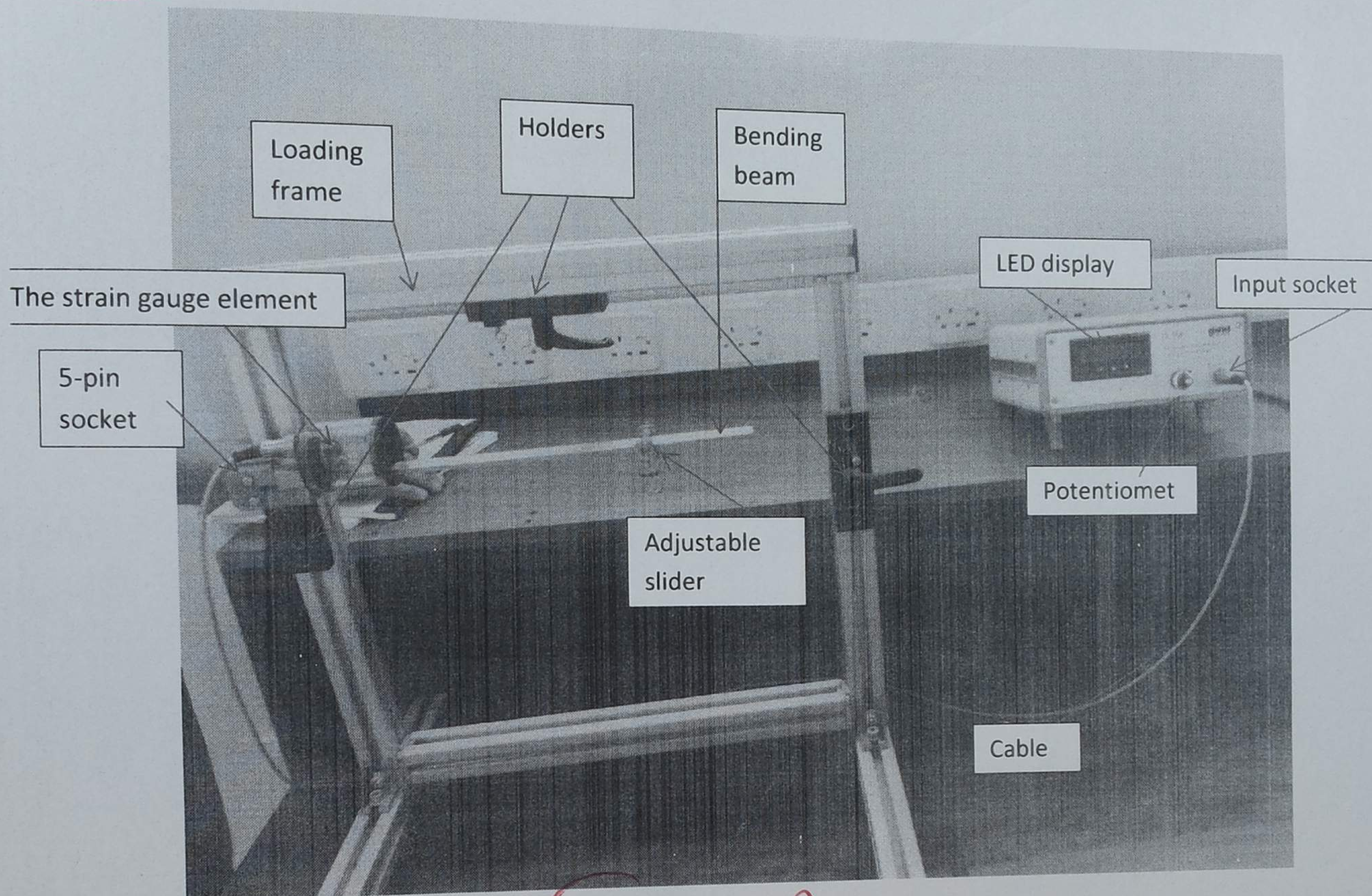
Procedure:

1- The operator calibrated the apparatus for zero error.

Did You do this!?

2- The weight carrier was hinged on the cantilever bar.
3- The weight was increased according to the loading table and the readings of the amplifier were taken.
4- The load was decreased and the readings of the amplifier were taken.

Apparatusused:



Figure(1

How it work?
Strain gauge is used to measure the amount of strain on an object.
A metallic specimen is fixed on the object, due to strain the electrical resistance of the specimen change and that causes a voltage difference amplified by an amplifier and read off an LED display screen.

Types of strain gauges:
1-semi conductor
2-wire

Results and discussion: → given data

L
w
h
E
K

Observed data:

Table 1: Title

Bending experiment, lever arm 250 mm							
Load in N	0	1	2	3	4.5	5.5	6
Reading in mV/V*10^{-3} (increasing load)	0.000	-0.034	-0.070	-0.104	-0.156	-0.191	-0.208
Reading in mV/V*10^{-3} (decreasing load)	-0.002	-0.035	-0.070	-0.104	-0.156	-0.191	-0.208

Calculated data:

Table2: title

Load	0	1	2	3	4.5	5.5	6
Strain ϵ *10^{-5}	0	-1.6585	-3.415	-5.073	-7.91	-9.31	-1.0146
Stress σ_{exp} (N/mm^2)	0	-3.48	-7.1715	-10.6533	-15.981	-19.566	-21.3066
Stress σ_{theo} (N/mm^2)	0	-3.366	-6.733	-10.0996	-15.15	-18.52	-20.1993

Sample Calculation:

A Load of (3N) was used to do the sample:

First calculate the strain using:-

$$\varepsilon = \frac{1}{K}\frac{U_A}{U_E}$$

where K is Sensitivity factor,
U_A is the output signal.
U_E is the feed voltage.

$$= \frac{1}{2.05}\left(-0.104 \times 10^{-3}\right)$$

$$\varepsilon = -5.073 \times 10^{-5}.$$

Next calculate the experimental stress using:-

$$\sigma_{exp} = E\,\epsilon$$

where E is the modulus of elasticity.
ϵ is the strain.

$$= 210000\,\frac{N}{mm^2} \times -5.073 \times 10^{-5}$$

$$\sigma_{exp} = -10.6533\ N/mm^2$$

Finaly calculate the theoretical stress using:-

$$\sigma_{theor} = \frac{M}{W_y}$$

where M is the bending moment $M = -F \cdot L$
and $F = mg$, L = arm radius.

W_y is the section modulus for the bar.

$$W_y = \frac{b h^2}{6}$$

where b is the width = 19.75 mm.
h is the height = 4.75 mm.

$$W_y = \frac{19.75 (4.75)^2}{6} = 74.26 \text{ mm}^3$$

$$\sigma_{theor} = \frac{-3 \times 250}{74.26} = -10.0996 \text{ N/mm}^2$$

the error is :-

$$\sigma_{theo} - \sigma_{exp} = -10.0996 - -10.6533 = 0.5537 \text{ N/mm}^2$$

the error percentage :-

$$\text{Error \%} = \left| \frac{\sigma_{theo} - \sigma_{exp}}{\sigma_{theo}} \right| \times 100\%$$

$$= \left(\frac{-10.0996 - -10.6533}{-10.0996} \right) \times 100\%$$

$$= 5.48\%$$

the device uncertainty :-

$$= \frac{\text{Smallest division}}{2}$$

$$= \frac{0.001}{2}$$

$$= 0.0005 \text{ mV/V}$$

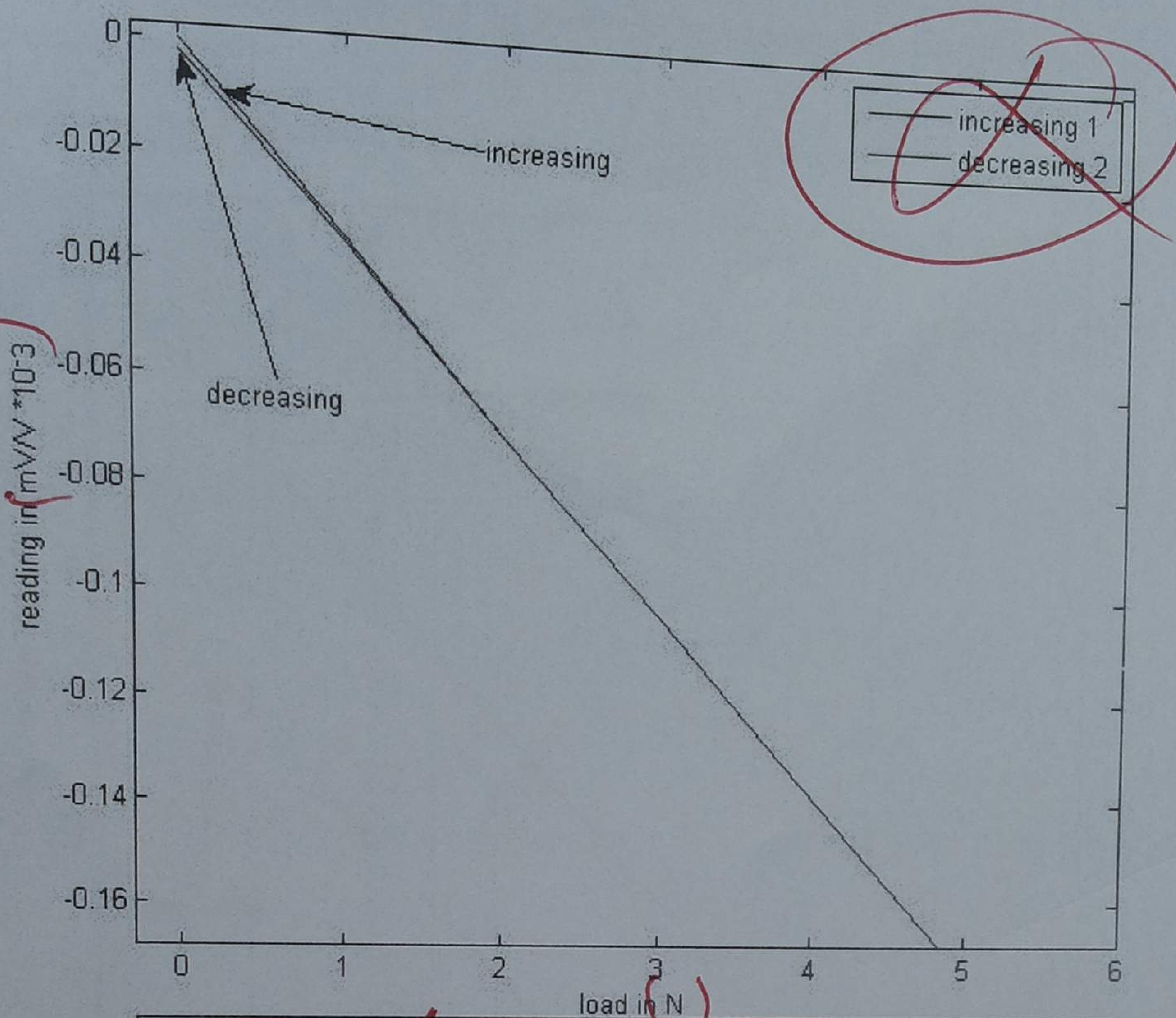


fig.1
variation of amplifier reading as a result of changing the load

- points
- R^2, $Y=mx+c$

The graph has been zoomed to find the hysteresis between the two data (increasing and decreasing the load)

The hysteresis error is calculated from fig.2:

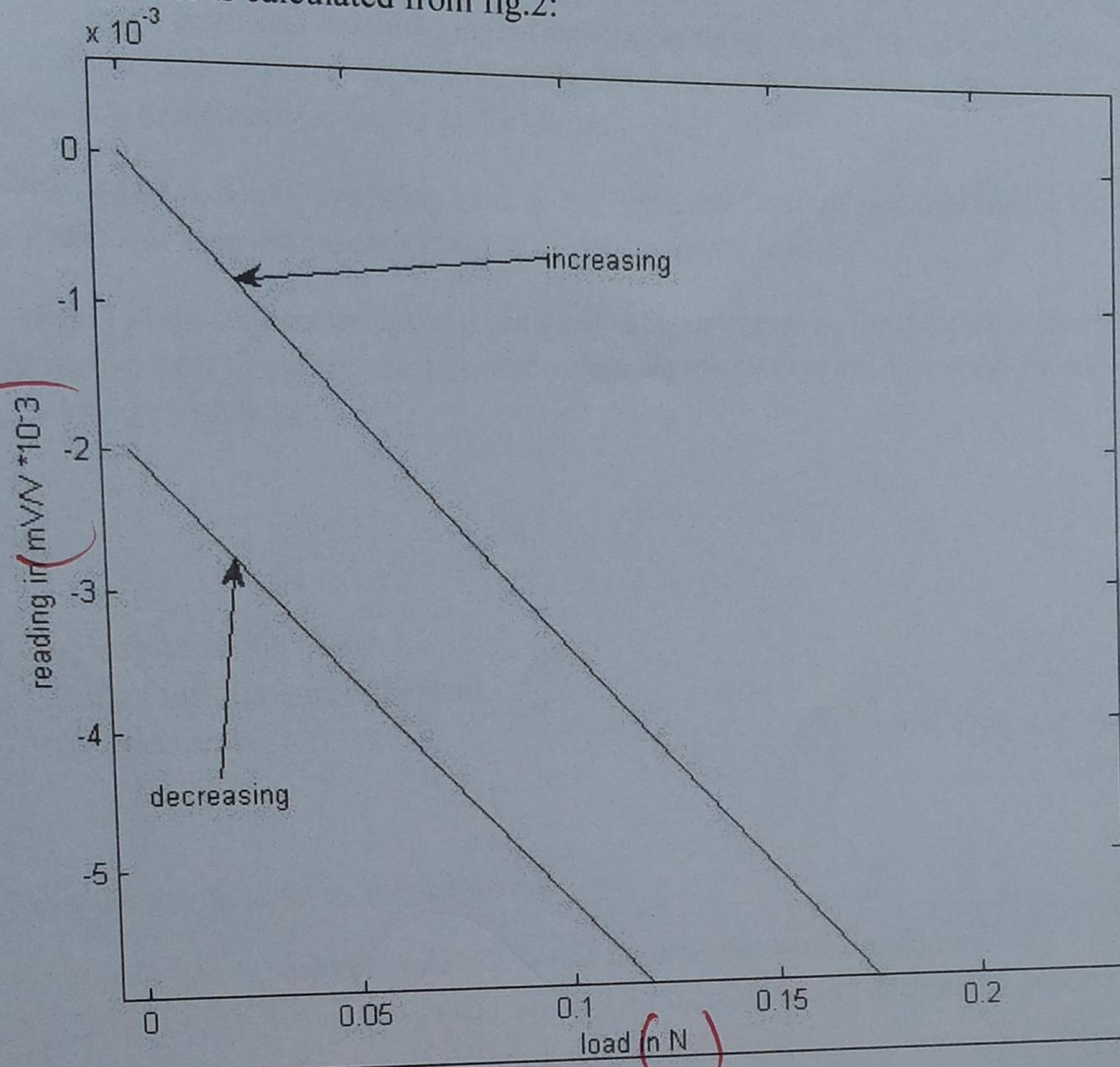


Figure 2
variation of amplifier reading as a result of changing the load

Hysteresis error= -0.002 mV/V*10^{-3}

Discussion:

Minus sign indicated that it's a compressive load, thus a compressive stress (at lower fibers of beam) and a negative strain (the current length is lower than original length).

Hysteresis losses are too small due to smooth loading setup, removal and low temperature difference between the readings of both cases.

A difference between the experimental and theoretical stresses happens due to temperature and impurities in the bar.

Conclusion and summary:

Strain of a beam was measured in this experiment using a device called strain gauge. Strain gauge is a device that measures the strain by using Wheatstone bridge and the voltage difference that the deformation in the material causes in the bridge.

The gauge was used by adding loads to the beam and the strain was measured at each load, the strain also was measured at each load but by decreasing the load.

Stress strain diagram was plotted using the value in increasing the load and in decreasing the load, hysteresis were found and the measured values are too close to the theoretical values with 5.48 % error which is acceptable .

Errors:

1- Vibration of the frame.
2- Rough installation of the load.
3- Human errors .

Error can be reduced by the following:

1- Repeat the experiment more than one time on the same conditions.
2- Do not use constant increment in the load increasing and decreasing process.

Reference:

www.engineering toolbox.com/young-modulus-d_417.html