Quizzes

University of Jordan
Mechanical Engineering Department
Engineering Measurement Lab (0904424)
Section-3, Sem-1, 2013-14
Experiment : Block Gauges Measurements

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2-Complete the following table and Plot your results & determine the maximum error.
Table 2:

Standard block gauge mm	Standard block gauge with error mm	Reading of micrometer
0.000	0+ 0.0005 0-0.0005	
3.000	3+ 0.0005 3-0.0005	
5.000	5+ 0.0005 5-0.0005	
10.000	10+ 0.0005 10-0.0005	
15.000	15+ 0.0005 15-0.0005	
20.000	20+0.0005 20-0.0005	

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ال quiz
عملي !!
Yay

What are the sources of error in measurement with block gauges? State (4)

1- temperature rise causes some expansion in metal block gauges
2- surfaces of block gauges is scratched and sometimes overloaded which deflect it
3- errors due to parallax in reading micrometer or vernier caliper
4- not using the minimum number of blocks which increases the error

What is the basic difference between line and end measurement?

What were the three main parts of the experiment?

1- micrometer calibration by using the block gauges
2- Vernier caliper calibration by using block gauges
3- mechanical comparator

Using the set of blocks listed in table (1) below to build a size equals to 102.733mm. Use two protective gauge blocks of 2mm each. How many blocks you need (other than the protective gauges) Show full calculations.

Table (1) : The set of Block Gauges.

9	Blocks	of	0.001mm	increment series -	from	1.001mm	to 1.009mm
49	Blocks	of	0.01mm	increment series -	from	1.01mm	to 1.49mm
1	Block	of	0.5mm				
18	Blocks	of	0.5mm	increment series -	from	1.0mm	to 9.5mm
9	Blocks	of	10mm	increment series -	from	10mm	to 90mm
2	Blocks	of	2mm each as wear blocks				

102.733

⑤ 1.003 − → 101.73

④ 1.23 − → 100.5

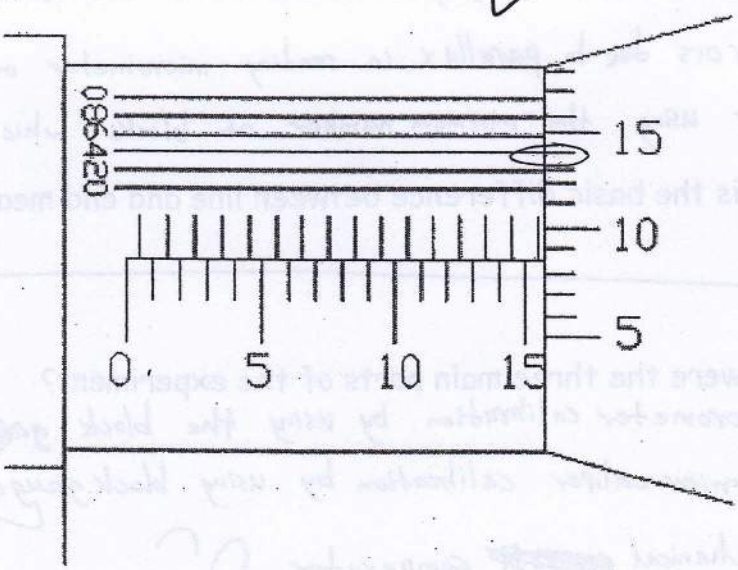
③ 0.5 − → 100

② 90 − → 10

① 10 − → 0

Five blocks

The accuracy of the vernier micrometer below is 0.001 mm And its reading is 16.141 mm



16 + 14(0.01) + (0.001)(4)

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Department Of Mechanical Engineering
Engineering Measurement Lab (0904424)
Quiz-1, Sect-3, 2013-2014, Sem-2. 12-03-2014

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Name: .....[redacted].

Based on the Flow Measurement Experiment the following data was observed:

Given Data:
Dynamic viscosity of water is 1.08×10^{-3} N-s/m^2. Water density = 1000 kg/m^3
The piezometers' levels are in mm H_2O.
Observed Data:

	Venturi	Orifice
Inlet diameter (mm)	30	50
Throat diameter (mm)	15	25
Piezometer reading at inlet	400	300
Piezometer reading at outlet	95	150

Float height for the rotamter = 22.5cm.
Time needed to collect 7.5kg of water was 17.00 seconds. $\rightarrow \dot{m} = 0.441$ kg/s (actual)

Calculate using the equation sheet and Figure above, the following:

1. The discharge coefficient for both venturi and orifice plate.

$$\dot{m}_{th,V} = \frac{\rho Y (\frac{\pi}{4})(d_2)^2}{\sqrt{1-\beta^4}} \sqrt{2g(\Delta h)_{1-2}}$$

$$= \frac{1000(1)(\frac{\pi}{4})(0.015)^2}{\sqrt{1-(\frac{15}{30})^4}} \sqrt{2 \times 9.81 (0.4 - 0.095)}$$

$$= 0.446 \text{ kg/s} \rightarrow C_{D,V} = \frac{\dot{m}_{act}}{\dot{m}_{th}} = \frac{0.441}{0.446} = 0.989$$

$$\dot{m}_{th,O} = \frac{\rho Y (\frac{\pi}{4})(d_4)^2}{\sqrt{1-\beta^4}} \sqrt{2g(\Delta h)_{3-4}}$$

$$= \frac{1000(1)(\frac{\pi}{4})(0.025)^2}{\sqrt{1-(\frac{25}{50})^4}} \sqrt{2 \times 9.81 \times (0.3 - 0.15)}$$

$$= 0.87 \text{ kg/s} \rightarrow C_{D,O} = \frac{\dot{m}_{act}}{\dot{m}_{th}} = \frac{0.441}{0.87} = 0.507$$

2. The flow rate indicated by the rotameter.

From the calibration curve of the rotameter

$\dot{m} = 0.52$ kg/s

4. Calculate the error in flow rate measurement of each one of the three devices as value and percentage of true value.

Venturi :-

$$error = \dot{m}_{th} - \dot{m}_{act} = 0.0.446 - 0.441 = +5 \times 10^{-3}\ kg/s$$

$$\%\ error = \frac{error}{\dot{m}_{act}} \times 100 = \frac{5 \times 10^{-3} \times 100}{0.441} = 1.13\ \%$$

Orifice :-

$$error = \dot{m}_{th} - \dot{m}_{act} = 0.87 - 0.441 = +0.429\ kg/s$$

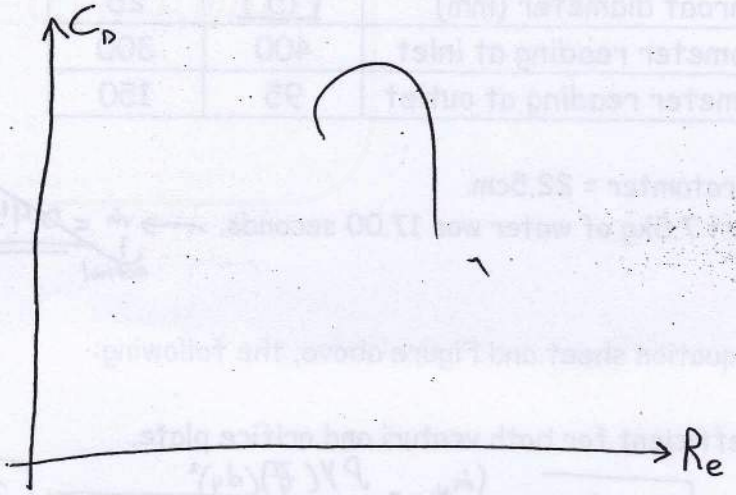
$$\%\ error = \frac{error \times 100}{\dot{m}_{act}} = \frac{0.429 \times 100}{0.441} = 97.28\ \%$$

Rotameter :-

$$error = \dot{m}_{th} - \dot{m}_{act} = 0.52 - 0.441 = +0.079\ kg/s$$

$$\%\ error = \frac{error \times 100}{\dot{m}_{act}} = \frac{0.079 \times 100}{0.441} = 17.91\ \%$$

5. Draw the relation between Reynolds' No. (on X-Axis) and CD (on Y-axis) for the orifice only. Discuss its behavior. Use proper format for the graph.



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DEPARTMENT OF MECHANICAL ENGINEERING
Engineering Measurement Lab (0904424)
Quiz-2, Section-3, 2013-2014, Sem-2, 26-03-2014

A measuring machine bed was tested for straightness using an autocollimator and reflector and gave the readings as shown in the table below. *The carriage length was 25cm*. Construct a profile graph of the surface relative to the initial line a-b, and show the maximum deviation *from the least square line*.

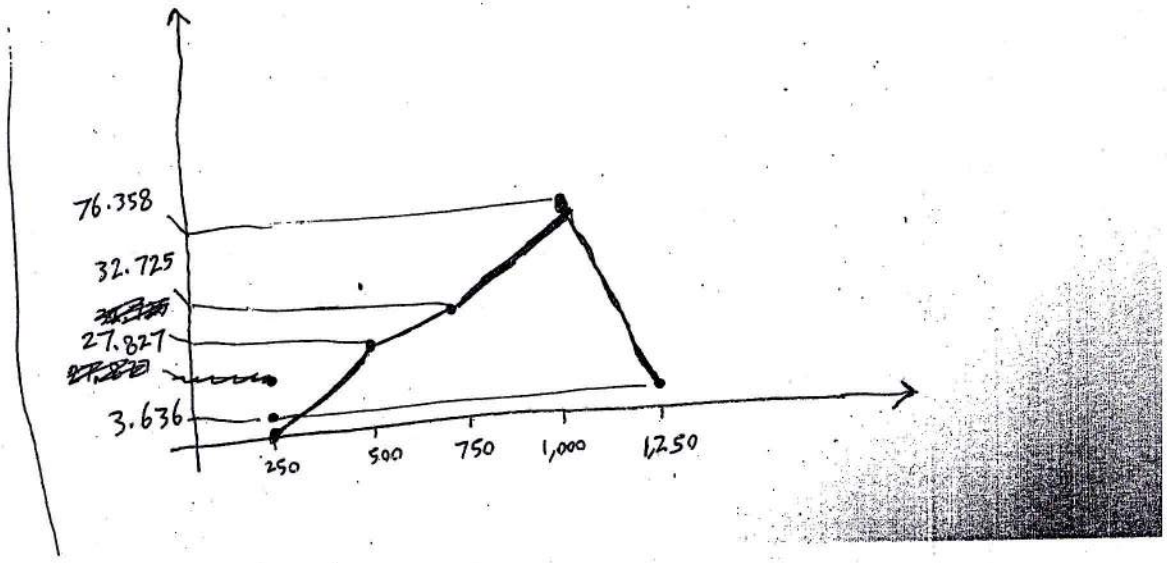
Position	Reflector Carriage (mm)	Autocollimator reading (Sec.)	Difference From First Reading (Sec)	Rise/Fall in interval "L" (micron)	Cumulative Rise/Fall wrt to line a-b (micron)					
A	0	0	0	0	0	0				
B	250	300.00	0	0	27.877	0				
C	500	323.00	+23	27.877	60.602	27.877				
D	750	350.00	+27	32.725	136.96	60.602				
E	1000	287.00	-63	76.358	140.596	136.96				
F	1250	290.00	+3	3.636		140.596				

Show one sample calculation here:

$\ell = 0.25\ m$

$h = \ell \tan\theta$

$= 0.25 \tan\left(\frac{+23}{3600}\right) = 27.877 * X10^{-6}\ m$



The Name of today's experiment is : Strain gauge :

The main objective of today's experiment is : to measure deflection of a beam Experimentally then to compare with the theoritical values and define sources of error

The device expected to be used is :

Strain rosett

[redacted]

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Experiment : Surface Roughness Measurements

In the profile attached find the value of roughness using any THREE methods other than peak-to-valley height. The line drawn **IS NOT** the center line.

Method (1) : ~~ten~~ five-points average / highest ~~two~~ five peaks and lowest five valleys

$\Sigma H_p = 101 + 92 + 75 + 75 + 73 = 416\,mm$

$\Sigma H_v = 15 + 24 + 33 + 45 + 46 = 163\,mm$

$R_{z\ method\ 1} = \frac{\Sigma H_p - \Sigma H_v}{5} \times \frac{1,000}{VM} = \frac{416 - 163}{5}\left(\frac{1,000}{15,000}\right) = 3.37\,\mu m$

Method (2) : root mean square method

Method (3) : ~~Average~~

areas

$\Delta A = \frac{1}{2} \times 6 \times 46 = 126\,mm^2$

$\Delta B = \frac{1}{2} \times 14 \times 75 = 525\,mm^2$

$\Delta C = \frac{1}{2} \times 24 \times 22 = 264\,mm^2$

$\Delta D = \frac{1}{2} \times 22 \times 101 = 1,111$

areas $\Delta A = \frac{1}{2} \times 6 \times 14 = 42\,mm^2$

$\Delta B = \frac{1}{2} \times 14 \times 16 = 112\,mm^2$

$\Delta C = \frac{1}{2} \times 22 \times 36 = 396\,mm^2$

$\Delta D = \frac{1}{2} \times 22 \times 42 = 462\,mm^2$

$\Delta E = \frac{1}{2} \times 16 \times 28 = 224\,mm^2$

$\Delta F = \frac{1}{2} \times 26 \times 33 = 429\,mm^2$

$\Delta G = \frac{1}{2} \times 15 \times 10 = 75\,mm^2$

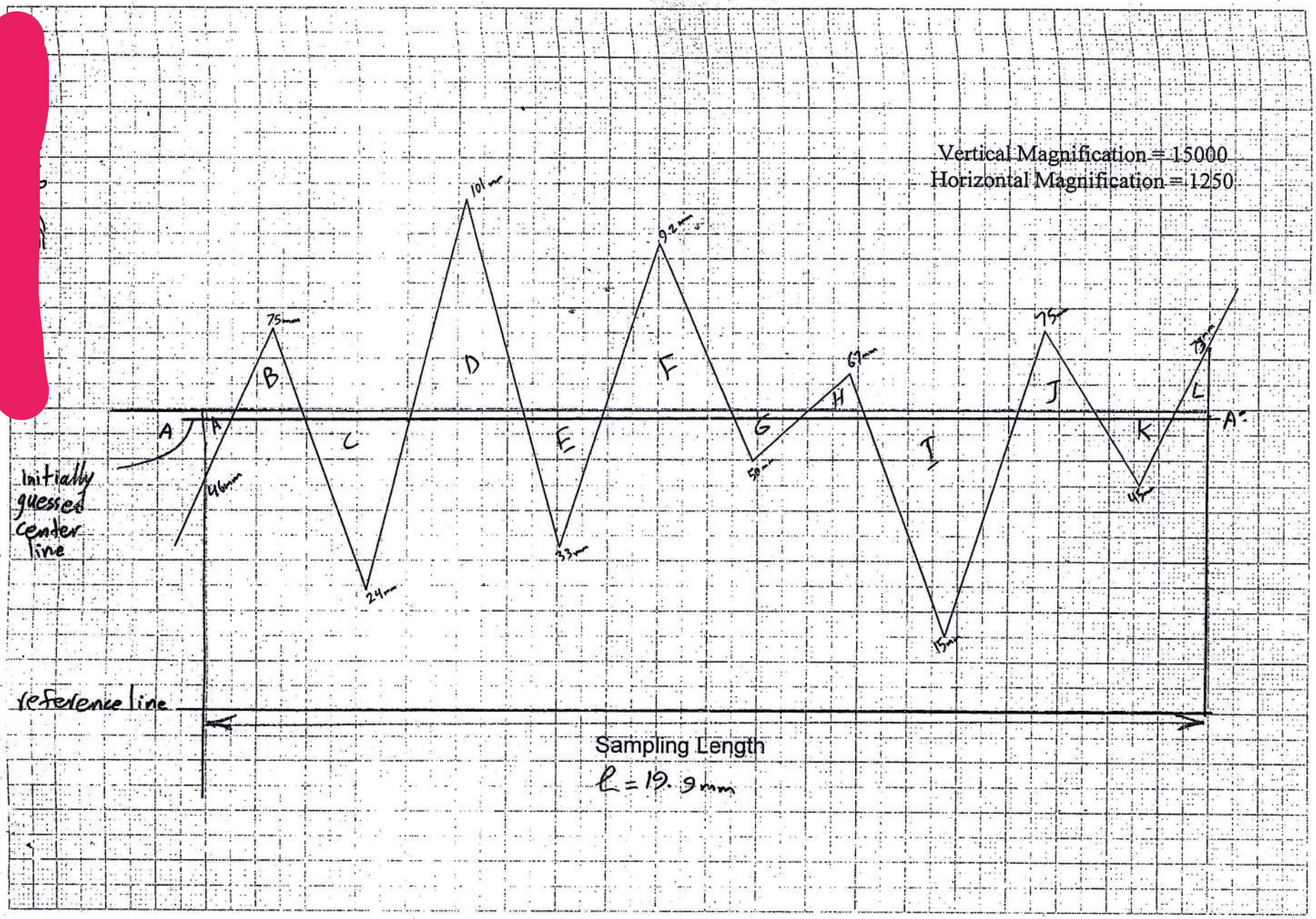
$\Delta H = \frac{1}{2} \times 11 \times 7 = 38.5\,mm^2$

$\Delta I = \frac{1}{2} \times 31 \times 44 = 682\,mm^2$

$\Delta J = \frac{1}{2} \times 15 \times 16 = 120\,mm^2$

$\Delta K = \frac{1}{2} \times 16 \times 15 = 120\,mm^2$

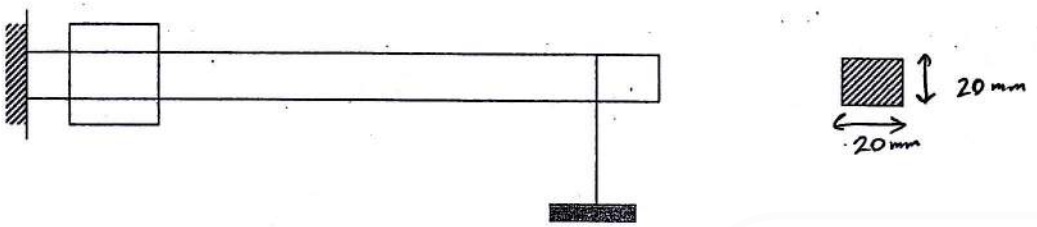
$\Delta L = \frac{1}{2} \times 6 \times 13 = 39\,mm^2$


Vertical Magnification = 15000
Horizontal Magnification = 1250
A
A
B
C
D
E
F
G
H
I
J
K
L
A
75mm
46mm
24mm
101mm
33mm
92mm
50mm
67mm
15mm
75mm
41mm
78mm
Initially guessed center line
reference line
Sampling Length
$\ell = 19.9$ mm

يوم الأربعاء

Experiment (Strain Gauges)

A beam having square cross section as shown in figure below with thickness 20mm and width 20mm. The total length of the beam is 400mm. The beam is subjected to bending test and the stress and strain are to be measured with the help of strain gauge setup. If the distance between the applied load and the strain gauge is 250mm, the strain gauge has gauge factor 2.05 and the beam is having modulus of elasticity 10000 N/mm^2. When 3N of load was applied, the display device gave output reading of -0.000105 V/V.



A) Calculate the value of the stress both actual and theoretical.

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B) Calculate the value of the error both as value and percentage.

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C) How the wheatstone circuit is used in the measurement the strain.

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D) What was the main objective from this experiment.

① to measure the hysterisis of strain gauge by doing increasing decreasing analysis

② to find the stress resulted from a load by strain measuring using a strain gauge

E) What is meant with Gauge Factor (K)?

gauge factor (K) represents the sensitivity of the strain gauge being used. This sensitivity is a measure of how the output can change relative to the input $\rightarrow K = \frac{\%\text{ change in output}}{\%\text{ change in input}} = \frac{\frac{\Delta R}{R}}{\frac{\Delta L}{L}}$.

(A) $M_b = -FL = -3(250\times10^{-3}) = -0.75\ N.m$

$W_y = \frac{bh^2}{6} = \frac{(20\times10^{-3})(20\times10^{-3})^2}{6} = 1.33\times10^{-6}\ m^3$

$\varepsilon = \frac{-1}{k}\left(\frac{U_A}{U_E}\right) = \frac{1}{2.05}(-0.000105) = -5.122\times10^{-5}$

$\sigma_{actual} = \frac{M_b}{W_y} = \frac{-0.75}{1.33\times10^{-6}} = -563.91\ kPa$

the minus sign indicates ~~the downward direction~~ the compression stress

$\sigma_{theoritical} = E\varepsilon = (10\times10^9)(-5.122\times10^{-5}) = -512.2\ kPa$

(B) ~~error = $ true value ...~~

error = ~~actual value~~ theoritical value − actual value

$= (-512.2) - (-563.91) = +51.71\ kPa$

$error\% = \left|\frac{\text{theoritical value} - \text{actual value}}{\text{theoritical value}}\right| \times 100 = \left|\frac{-512.2-(-563.91)}{-512.2}\right| \times 100$

$= 10.1\ \%$

Check

Actual: $\varepsilon = -\frac{1}{k}\frac{U_A}{U_E}$

$\sigma = E\varepsilon$

Theoretical: $\sigma = \frac{M_b}{W_y}$

$\varepsilon = \frac{\sigma}{E}$

يوم الأربعاء

A metallic strain gauge having nominal resistance of 120Ω, gauge factor of 2 and is attached to an Aluminum bar having modulus of elasticity 69 G N/m2 and is subjected to stress of 0.2 G N/m2 . Calculate the change of the resistance dute to this new load:

$R_o = 120\,\Omega$ / $K = 2$ / $E_{Al} = 69\,GPa$ / $\sigma = 0.2\,GPa$ / $(\Delta R = ?)$ /

$$\sigma = E\varepsilon \rightarrow \varepsilon = \frac{\sigma}{E} = \frac{0.2\times10^{9}}{69\times10^{9}} = 2.899\times10^{-3}$$

$$K = \frac{\frac{\Delta R}{R}}{\frac{\Delta L}{L}} = \frac{\frac{\Delta R}{R}}{\varepsilon}$$

$$K\varepsilon = \frac{\Delta R}{R} \rightarrow \Delta R = K\varepsilon R = 2(2.899\times10^{-3})(120)$$

$$= 0.696\,\Omega$$

Ans. Quiz

Total Beam Length	Distance between loading and Strain gauge	Load	Modulous of Elasticity	Gauge factor	Output reading	Beam Shape	Height	Width
400	250	3	10000	2.05	0.000105	Square	20	20
	mm	N	N/mm^2				mm	mm

Theoretical		
Mb =	750	N-mm
Wy =	1333.333333	mm^3
Stress =	0.5625	N/mm^2
Strain =	0.00005625	
Error in Stress =	0.050304878	N/mm^2
Error in Strain =	5.03E-06	

Experimental	
Strain =	5.12E-05
Stress =	0.51219512
Percentage Error =	8.94308943
Percentage Error =	8.94308943