Group [8]

Experiment one linear measurments

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Questions: Vernier Caliper

Q① No Vernier Caliper doesn't Confirm to Abbes principle Because Abbes Principle states that measument must be directly in dine with axis measured to minimize errors in this Case, error may be substional.

Q2 Error of a Vernier Caliper $\frac{1}{20} = 0.05$

Q3 function of Sliding blade (movable Jaw), we can use it to measure outer and inner diameter and also measuring depth

Q4 direct Reading have arrow sliding blade attached to Sliding Jaw yes it applies Cause Caliper also have sliding Blades, depth

Q5 Sources of error in Caliper parallax error (not Reading with aligment), Surface error, user error, bias error, Random error, systematic error

Q6 if locking screw isn't used The reading might shift Slightly during measurment which will Result in error in Reading

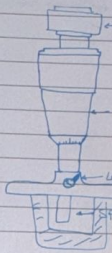
Q7 yes we can Consider it as final Reading but we Can Consider Compartor

Q8 its Considered line standard Cause reading is taken directly from dine

Q9 measure internal and external and depth and Larger measuring Range, easier to use

Micrometer

1.



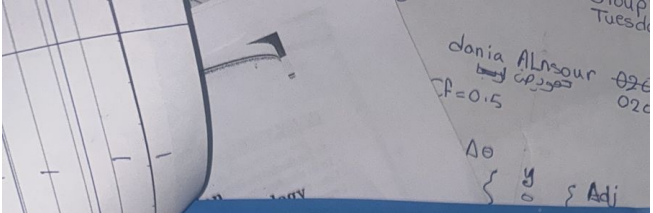
2- 2 threads

3- Yes, the axis of the spindle is aligned with the axis of the screw thread that controls measurement

4- 0.5 mm

5- over tightening can cause:
- damage to the spindle or anvil
- inaccurate reading
- damage to the measuring object
- wear on internal components

4- Yes, micrometer can be used as comparitor



curacy is based on the precision of Screw thread, could be inaccure measurments because of the movemet of Specimen.

6 - * least count micrometer
* accuracy of Screw thread
* ability to read scale

7 - * parallex error
* wear on Spindle

8 - yes, rotating, it can cause friction on the Surface of the object & introduce Small error.

Measuring instrument	D_1	D_2	D_3	D_4	D_5	D_6	D_c	D_d	H_1	H_2	H_3	H_4	H_5
Vernier Caliper	18.30	24.00	31.00	46.50	9.80	unfound	21.50	29.70	–	–	–	10.75	71.10
Outside micrometer	18.32	25.97	30.84	46.30	–	–	–	–	–	–	–	–	–

all in (mm)

accuracy is based on the precision of Se
could be inaccure measurements beca
the movement of Specimen.

6 – * least count micrometer
* accuracy of S
* abilit

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Group (8)

Subject _____ Day _____ Date _____

Q. Discussion:

* to know how to use the measuring tool & take reading & it requires accuracy & precision

* Any unknown projections will cause to enduce errors in the angle measured.

~~For the building of the slip~~

~~* yes, for~~ * The overall time required for the measurment would depend on the complexity of the component.

* ~~Yes~~ I will use the Sine bar for measuring (4) one component, because ~~precise bar takes~~ setting up the sine bar takes time.

	angle 3	angle 1	angle 2
plate protractor	50°	out of range	83°
vernier protractor	51° 5'	32° 10'	83° 20'
Clinometer	—	32° 41'	—

0.01 mm

$\frac{1}{1000}$ → كل خط بالمعيرة رقم ورقم

EXPERIMENTAL PROCERUDE:

After being familiar with the blocks and the available rang of lengths complete the following procedure.

1-Use minimum number of block gauges to build the following size length and complete table1.

Table 1:

# of gauges	59.876 mm	41.389 mm	9.999 mm
1st piece	1.006	1.009	1.009
2nd piece	1.370	1.38	1.09
3rd piece	7.50	9.00	1.4
4th piece	50.0	30.0	6.5
5th piece			
6th piece			

4Blocks all of them

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
20.000	0+ 0.0005 0-0.0005	29 + 0.167 ⇒ 29.167 0.007
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	

3-Take the piece which you want to measure its length and take its length by using vernier caliber (to take approximate length to easy the comparison)then we put it in mechanical comparator and calibrate it to get error less than 0.01 mm. Now remove the piece and put block gauges until we reach the desire value. Then we take the reading of blocks.

40

40.13
- 1.13
39
- 9
30
- 30

So we need 3 Blocks

30
9
1.13

3) Parallelism: each tow surfaces or two lines are parallel to a very high degree.

But there is four types of block gauges differ by the degree of there accuracy, quality and roughness.

Grades of gauge blocks:

1. 00
2. Calibration: this grade provides the highest level of accuracy required in normal engineering practice and is intended for calibrating other blocks in conjunction with suitably accurate comparators. They are used where tolerance are 2 micrometer or less and are not intended for generally gauge inspection.
3. 0
4. 1
5. 11

When the grades get larger the tolerance get larger and the price cheaper, the last and most expensive of all is grade 00.

USING THE BLOCK GAUGES:

Number of pieces in gauge blocks set can be:

1. 48 pieces in gauge block set
2. 87 pieces in gauge block set

The sizes found in 87 pieces gauge block set Grade II, which we use it in this experiment, are:

0.5, 1.0, 1.001-1.009 (by 0.001 steps),

1.10-1.19 (by 0.001 steps),

1.20-1.29 (by 0.001 steps),

1.30-1.39 (by 0.001 steps),

1.40-1.49 (by 0.001 steps),

1.50, 2.0, 2.5, 3.0, 3.5, 4.0,

4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5,

8.0, 8.5, 9.0, 9.5, 10.0, 20.0,

30.0, 40.0, 50.0, 60.0, 70.0, 80.0, 90.0 and 100.0mm.

As can be seen from the figure the block gauges are fitted in a wooden box, for each of the blocks there is a special place with the length written on it.

Each block has two surfaces that have high lapping; you can distinguish them by noticing that they shine the most of the six faces. The length is taken between these tow surfaces which are parallel.

- ***Instructions for wringing together two slip gauges:***

1. Surfaces must be clean and free from burrs. They should be washed in petrol benzene, carbon tetrachloride or other DE-greasing agents and wiped dry on a clean

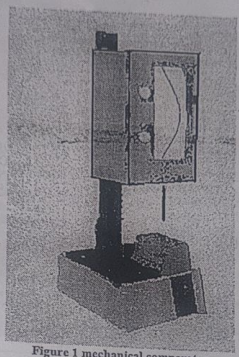

Figure 1 mechanical comparator

As seen in the figure the mechanical comparator is used to detect the correct number of blocks needed to the desired length, and it provides a rang of tolerance within the measurement is acceptable.

DISCUSSION:

1. State the difference between end standard and line standard? And state the reason that make the end standard more accurate?
2. Stat the difference between the different grades of the blocks.
3. What is the accuracy of the block gauges? How did you reach the answer?
4. Why do we always choose the minimum number of blocks combination?
5. Why do we bather ourselves with how the blocks should be attached to each other?
6. Suggest other applications for block gauges?
7. In the comparator measuring method what do we compare with?

cloth. Then be wiped with clean soft chamois leather. Slip gauges they should be held across one another at right angles and wiring them with a rotary motion; this reduces the amount of surface rubbing necessary.

2. A minute amount of grease or moisture must be present between the surfaces for them to wring satisfactory. Unless a very firm wring is obtained there is always the possibility that the wringing film maybe a micrometer thick.

- **Another way to assemble a gauge block:**

1. Remove the gauge blocks required from the protective case
2. Clean of the oil that they have been coated in using a special cleaner. It is acceptable to handle the blocks; in fact the oil from your hands will help them stick together.
3. One at a time, hold the blocks so that the faces just overlap, push the blocks together, and slide them until the faces overlap together. This will create a vacuum between the blocks that makes them stick together (this process is known as wringing).
4. Make required measurements with the gauge blocks, being careful not to damage the faces
5. Take the blocks apart, and apply the protective coating oil, and return them to their box.

In order to protect the blocks take the following points into consideration:
-Protect from dust, dirt and moister.
-Avoid magnetization.
-Handle lapped faces as little possible to prevent etching from finger acid; wipe all finger marks with chamois leather.
-Always wipe faces immediately before use even when it continuous.
-Always replace clean gauges in their box and close it after use. If gauges are not in frequent use they should be coated to prevent corrosion.
-Do not handle gauges above open box, they mat cause damage to other gauges if dropped.

It was mentioned earlier that we have to build the desired length of the blocks; the following example explains the procedure:
-Build a 30.967 mm using the minimum number of blocks.

30.967
- 1.007
29.960
-1.090
28.870
-1.370
27.500
-7.500
20.000

= 2

So we 5 blocks are used to build the desired length.

30.967
- 1.007
29.960
- 1.16

wear protective blocks

30.967

92.357
- 2
- 2
88.357
- 1.007
87.35
- 1.35
86.0
- 80
6
0

APPARATUS:

- Set of block gauges
- Granite surface plate

University Of Jordan
Faculty of Engineering and Technology
Industrial Engineering Department

Measurement Lab.

EXPERIMENT 2 :

BLOCK GAUGES

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Student Name :
Student No. :

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OBJECTIVES:-

-To familiarize students with types and applications of block gauges.
- To be able to calibrate linear measurements tools.
- Learn the correct ways of using them in measurements.
- Learn how to maintain them in the correct shape

INTRODUCTION:

In industrial applications maximum accuracy must be met in order to produce reliable products.
What is the most accurate way to measure 5mm distance?
Using a steel rule, caliber, or micrometer?
When maximum accuracy needed the use of ordinary measuring tools is not a good approach, there for some other ways is introduced to give more accuracy such as block gauges.

Block gauges are practical length standards of industry. A modern end standard consists fundamentally of a block (slip) or bar of steel or cemented carbide -generally hardened- whose end faces are lapped flat and parallel within a few tenth of a micrometer.

There are two types of length standards:

1. Line standard or Engraved scale:

In which the unit length is defined as being the distance suitably engraved lines. Like the ruler you can measure 1cm or 1.5 cm that is the whole distance is divided into sub measurements units.

2. End standard:

In which the unit of length is defined as being the distance between the end faces of the standard, these take the form of either slip, so the whole piece can measure 5mm for example but not 4.5 mm.

Gauge blocks are good examples of end standards. The name end standards indicate that these consist of sets of standard blocks or bars, and to have the desired measurement we have to build a required length from the blocks. And they have the following characteristics:

-End standard are highly accurate
-End standard have a built in datum because there measuring faces are flat and parallel
-The accuracy of end and line standard is affected by the temperature they are calibrated at 20 °C
-They are made in high-grade cast steel.

As motioned earlier, block gauges are standard bars made of hardened steel, which is heat treated. Its accuracy is 0.0005 mm. Its calibrated conditions: 20°c, 1 atm, and 60% relative humidity, they are specially machined and therefore they have the following characteristics:

1) Straightness
2) Flatness: the surfaces are made by a very accurate process named lapping therefore they are flat to a very high degree.

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- Ranem Refayeh. 0215151 VMF = 2000

1] $Ra = \frac{Peak - Valley}{VMF} = \frac{5.3 - -21}{2000} = 8.7 * 10^{-3}$

2) 10 points Height of irregularities

$R = \frac{(5.4+5+5.2)+3.8+2.6) - (-5.5-5.2-4.5-4.5-3.5)}{5 * 2000} = \frac{23.2}{5 * 2000} = 4.52 * 10^{-3}$

3) Root mean Square

$RMS = \sqrt{\frac{\sum h2}{n}} * \frac{1}{VMF} = \sqrt{\frac{3.1^2 + 1.6^2 + 1.7^2 + .9^2}{5}} * \frac{1}{2000}$

$= \frac{1.7956}{2000} = 8.978 * 10^{-4}$ cm

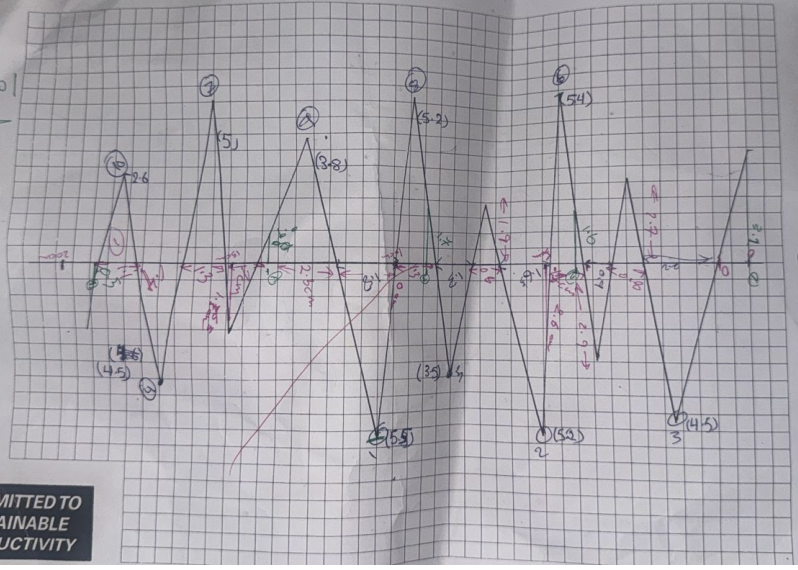
4) CLA -

$CLA = \frac{\text{area Above + area Below}}{L * VMF}$

$= \frac{1.43 + 3.25 + 4.37 + 3.38 + 0.76 + 2.7 + 1.08 + 3.15 + 0.825 + 4.95 + 2.275 + 4.27 + 1.305 + 4.95}{20 \times 2000}$

$\Rightarrow 1.0754 * 10^{-3}$ DOMS

8 marks


Group 8
Atlas Copco
CL
(2.6)
(5)
(3.8)
(5.2)
(54)
(4.5)
(3.5)
(55)
(52)
(4.5)
COMMITTED TO
SUSTAINABLE
PRODUCTIVITY

Group 8
Tuesday

Kahaf ALRefai 0217902
dalia Noor ALetyat 2210640
Yafa AL Haj 0216701

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exp → Straightness Error

Cf = 0.5

Position	θ	Δθ	Δy = Cf * Δθ	y	Adj	error
0-100	45	0	0	0	0	0
100-200	59	14	7	7	10.5	17.5
200-300	63	18	9	16	21	37
300-400	34	-11	-5.5	10.5	31.5	42
400-500	15	-30	-15	-4.5	42	37.5
500-600	-20	-65	-32.5	-37	52.5	15.5
600-700	-30	-75	-37.5	-74.5	63	-11.5
700-800	17	-28	-14	-88.5	73.5	-15
800-900	20	-25	-12.5	-101	84	-17
900-1000	37	-8	-4	-105	94.5	-10.5

$\left(\frac{-y}{n} = \frac{+105}{10} = 10.5\right)$

max error

± max Value = 42

min = -17

42 - -17 = 59 = straightness error

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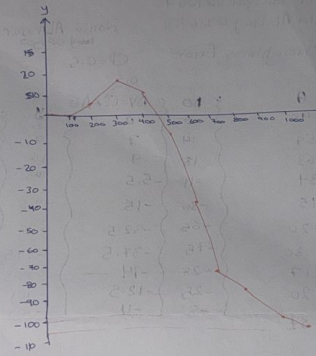
y
x
10
20
30
40
50
60
70
80
90
100
200
300
400
500
600
700
800
900
1000
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110

DETERMINATION OF STRAIGHTNESS ERROR USING AUTOCOLLIMATOR

Prepared: 30 Jan 2006

Principle: An autocollimator is an instrument which can measure small angles. They incorporate a collimating lens which is designed to transmit a parallel beam of light radiating from a source at its principal focus. A plane reflector placed in the path of the beam and normal to the geometric axis of the lens will reflect the light along the transmitted path to be refocused at the source (Fig.1). If the reflector is inclined at a small angle $\delta\theta$ to the normal, the beam is reflected at an angle equal to $2\delta\theta$ from its transmission path (Fig. 2). Any portion of the reflected beam passing through the lens will be refocused at the focal plane at a distance d from the principal focus. Consider that reflected ray which so happens to pass through the geometric centre of the lens. From the triangle made with this ray and the focal length f, $d=2f\delta\theta$. Thus the point at which the reflected beam is focused is independent of the distance of the reflector from the lens. However, as the angle increases, the amount of light that falls back onto the lens decreases and hence there is a limit to the distance that the reflector can be placed.

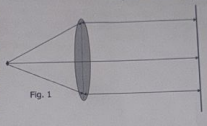

Fig. 1

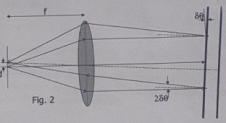

Fig. 2

An autocollimator is essentially a telescope permanently focused at infinity and fitted with means for illuminating an internal target graticule. There is also a micrometer eyepiece viewing system for measuring the displacement d of the image. A schematic diagram of the Microptic Visual Autocollimator is shown in Figure 3. The illuminated

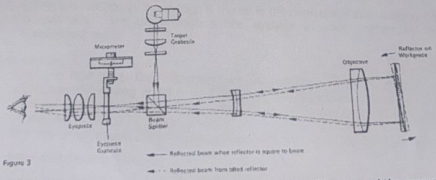

Figure 3

target graticule is situated in the principal focal plane of the objective and the emergent beam is directed along the axis of the telescope by a beam splitter. The reflected beam,

passing straight through the beam splitter, is brought to a focus on the eyepiece graticule and both the graticule and the image are viewed simultaneously through the eyepiece. The eyepiece graticule lines can be moved across the field of view by means of the micrometer, until they coincide with the reflected target image, thus enabling its displacement to be measured. The micrometer is graduated in angular units corresponding to the angular displacement of the reflector.

Measurement of straightness:
See the annexure for definition of straightness error. The principle employed for measurement is illustrated in Figure 4. The reflector is mounted on a carriage which is moved step by step from its initial position AB at one end of the slideway to successive positions BC, CD etc. along the surface. The distances between adjacent points A, B, C, D ... are equal to the nominal span of the carriage (50 mm). Any lack of straightness of the slideway will cause the carriage to tilt slightly. The angles of tilt are measured by the autocollimator and the difference in height of the two feet of the carriage can then be calculated for each position.

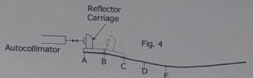

Fig. 4

Procedure:

1. Position the micrometer of the autocollimator to measure displacements in the vertical plane. Place the carriage at the nearest position AB and adjust the autocollimator base until the reflected image of the target crosslines is near the centre of the field of view.
2. Move the carriage to the other end of the bed and check that the reflected image is still within the range of measurement. If it is not, make fine levelling or rotational adjustments to the autocollimator.
3. Return the reflector carriage to position AB. Take an autocollimator reading and record it
4. Move the carriage along to its second position (BC) and take another reading. Continue thus until the carriage is at the end.
5. Repeat the readings as the carriage is moved in the reverse direction, towards the autocollimator. Take the average of the readings at each position as the measurement result.

Calculation:

1. See table next page. The "difference from first reading" column is obtained by subtracting the reading at AB (=20 in this example) from the readings at other positions. This is the variation in tilt of the reflector compared with its attitude at position AB.
2. The "rise or fall" column is the angular deviation in previous column converted into linear displacement. $1\ \text{second} = \frac{1}{3600} * \frac{\pi}{180} radians = \frac{1}{3600} * \frac{\pi}{180} * 50{,}000 \mu m$ $\equiv 0.25 \mu m$. Add a zero at the top of the column to represent the height of point A (regarded as the datum).

2. Difference between the different grades

- grade 00 - provides the highest level
calibration
extremely fine tolerance, typical

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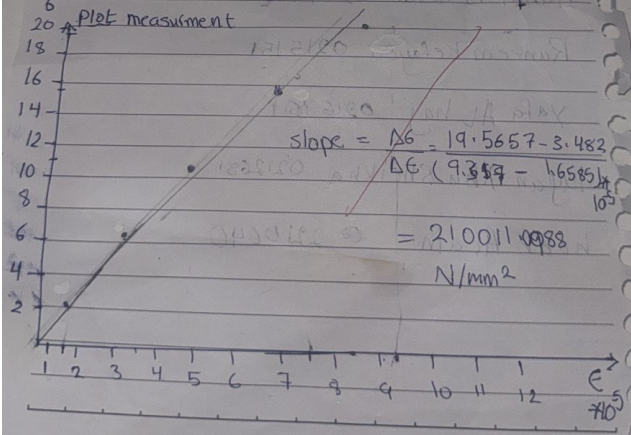
F	UA/UE	$\varepsilon = \frac{1}{k^2}\left(\frac{UA}{UE}\right)$	σ_{exp}	$\sigma_{th} = \frac{M}{W}$
0	0	0	0	0
1	-0.034	$-1.6585 * 10^{-5}$	-3.482	3.366
2	-0.069	$-3.365 * 10^{-5}$	-7.0665	6.732
3	-0.103	$-5.024 * 10^{-5}$	-10.5504	10.0985
4.5	-0.156	$-7.6098 * 10^{-5}$	-15.98	15.1478
5.5	-0.191	$-9.317 * 10^{-5}$	-19.5657	18.584



slope = $\frac{\Delta\sigma}{\Delta\varepsilon} = \frac{19.5657 - 3.482}{(9.3[illegible] - 1.6585) * 10^{-5}}$

$= 210011.0988$ N/mm²