MECHANICAL ENGINEERING LABORATORY
NEW JERSEY INSTITUTE OF TECHNOLOGY

Report Submitted by Sundeep Singh Experiment No. 5
Date Performed 10/28/2019 Date Submitted 11/04/2019
Course & Section ME 215-101 (2) Instructor Naruemon Suwattananont

Surface Topography

Experiment Title

Performed by Group A2 With TA Keven

Group Members Petros Apostolidis

Ertugrul Atlas

Christopher Chia

Anmol Sethi

Simerpreet Singh

Students are not to write below this line

GRADING

Date Received ____________

Days Late (if any) ____________

☐ Abstract	☐ Data	☐ Discussion
☐ Introduction	☐ Calculations	☐ Conclusion
☐ Theory	☐ Curves	☐ Questions & Answers
☐ Procedure	☐ Sketches	☐ See Pages ________

Comments: ____________

(For further comments see inside cover)

Graded by: ____________ Grade: ________ Date Recorded: ____________

Table of Contents

Abstract

The objectives of Experiment 5, Surface Topography, were to study variations in the surface finish produced by different manufacturing processes, learn the standard symbols used to specify the surface roughness during surface measurements, and to learn different surface measuring tools and comparators. The purpose of the Surface Topography laboratory was to learn dependence of accuracy on surface finishing. This was performed by using multiple different surface measuring tools and comparators. The three measuring tools and comparators used were the Profilometer, the Surfometer, and the Micro finish Comparator. Additional materials used in this lab were a metal plate, a plastic plate, and shaft with 3 different textures. The results show that although the machines may not produce the same roughness height, the overall trend is the same for each respective piece. For instance, Shaft 1a has the highest roughness height in both machines and the plastic plate has the lowest roughness height in both machines. Overall, the experiment helps to strengthen and expand the students' knowledge on surface topography.

Introduction

The Surface Topography laboratory experiment was meant to reinforce the students' knowledge on surface finishing's and furthermore introduce the students to roughness. Some of the objectives of this laboratory experiment included learning the dependence of accuracy on surface finishing, study variations in the surface finish produced by different manufacturing processes, learn the standard symbols used to specify the surface roughness during surface measurements, and to learn different surface measuring tools and comparators. The different surface measuring tools and comparators that will be used in this laboratory experiment are the Profilometer, the Surfometer, and the Micro finish Comparator.

The Profilometer is computer and hardware based, the Surfometer is hardware based, and the Micro finish Comparator can be subjective. The experiment involves measuring the roughness of various different objects using the three surface measuring tools and analyzing the accuracy of them. The objects are made of different materials and were made using different manufacturing processes. The importance of doing this is so students can learn about the different accuracies on surface finishing of the different manufacturing processes. Additionally, another significance of this laboratory experiment is showing students the different symbols involved with roughness that may potentially be used in the future.

Procedure

The lab started with a PowerPoint presentation on the basics of surface roughness and a quick lesson on the symbols used to specify surface roughness. Afterward, the class moved from the classroom area where the presentation was being given to the lab area. With there being two groups in the class, one group started with the Profilometer and the other started with the Surfometer. Beginning with the profilometer, Shaft 1a was placed under the stylus and the stylus was lowered into position manually. When this was done, the Ra and Rq options were selected and the “Measure” command was selected which started the measuring of the roughness. The computer displayed a graph along with the Ra and Rq values which were to be written down in the lab manual. The same process was repeated for Shaft 1b, Shaft 1c, the plastic plate, and the metal plate except that Ra and Rq did not have to be selected for each run since the settings from the previous run were saved.

Once this was complete, the groups switched. Moving onto the Surfometer, this part was a little longer. The same objects were used once again, but instead of lowering the stylus down to the object, in this case, the stylus was attached to a moving lever was placed onto the object and then a switch was flipped to turn the machine on to start recording. Three data points were recorded, the average was taken, and then the average was multiplied by 200 to find the R value. This was repeated for all the objects and recorded onto the data sheet.

Data Sheets

R. Dubrovsky
Engineering Materials & Processes, ME 215

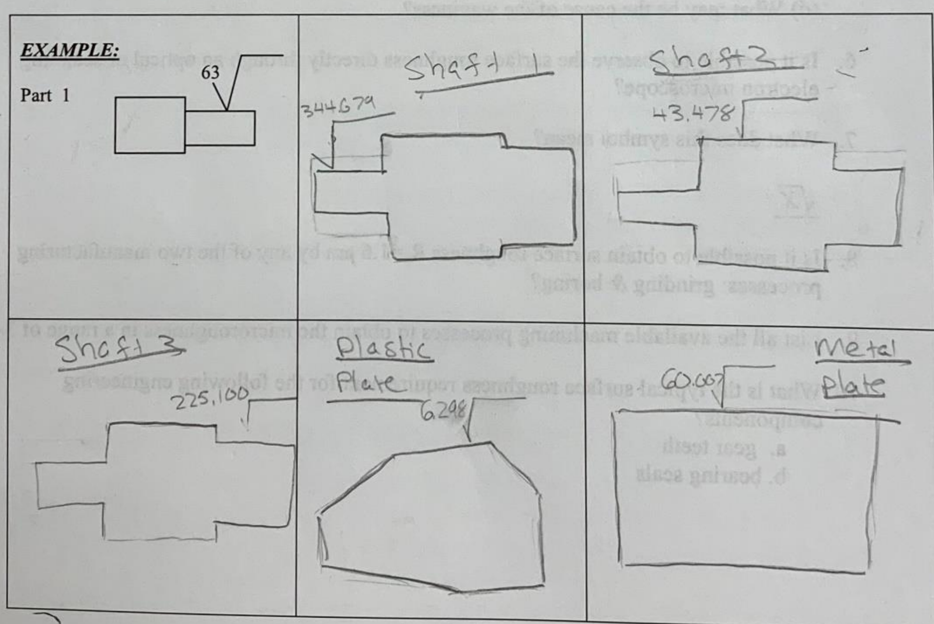
DATA SHEET FOR EXPERIMENT # 5

GROUP MEMBERS				GROUP LEADER	GROUP:
1	Sundeep Singh	5	Petros Apostolidis	Ertugrul Atlas	A2
2	Simerpreet Singh	6	Anmol Sethi	INSTRUCTOR'S APPROVAL:	
3	Theodore Nitro	7		DATE: 10/28/19	
4	Christopher Chia	8			

Table 5-2. SURFACE FINISHING

	Material or Specimen	Microfinish Comparator			Profilometer (mean absolute height) CLA		Surfometer (arithmetic average) Ra AA			Possible Machine Cutting Process
		µin	~~µm~~		µin Ra	~~µm~~ µin Ra	µin	~~µm~~		
1	Glass Shaft 1	500ST			344.679	407.790	218.133			Shape Turning
2	Shaft 2	63ST			43.478	62.627	40.667			Shape Turning
3	Bushing Shaft 3	250ST			225.100	265.731	166.667			Shape Turning
4	Block –3 Plastic Plate	32G			6.298	12.000	9.133			Ground
5	Block - 4 Metal Plate	500M			60.007	84.466	62.267			Milling

SUGGESTED SPECIMENS.
Make a sketch and specify your investigated surface.



Plastic Plate:
0.036
0.045
0.056
0.046 → Avg
(x200) = 9.133

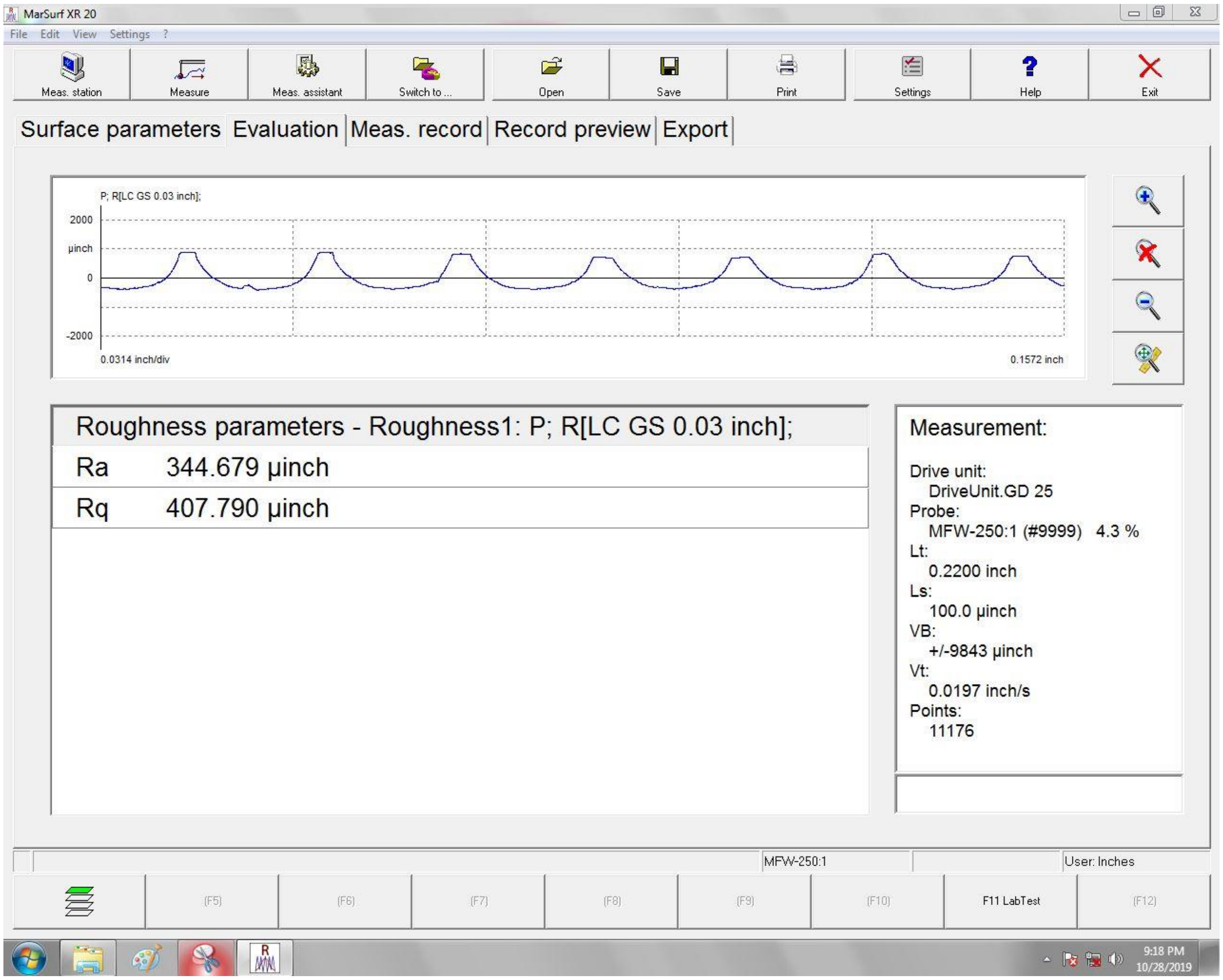
Metal Plate:
0.299
0.320
0.315
0.311 → Avg
(x200) = 62.267

Shaft 1:
1.073
1.101
1.098
1.091 → Avg.
(x200) = 218.133

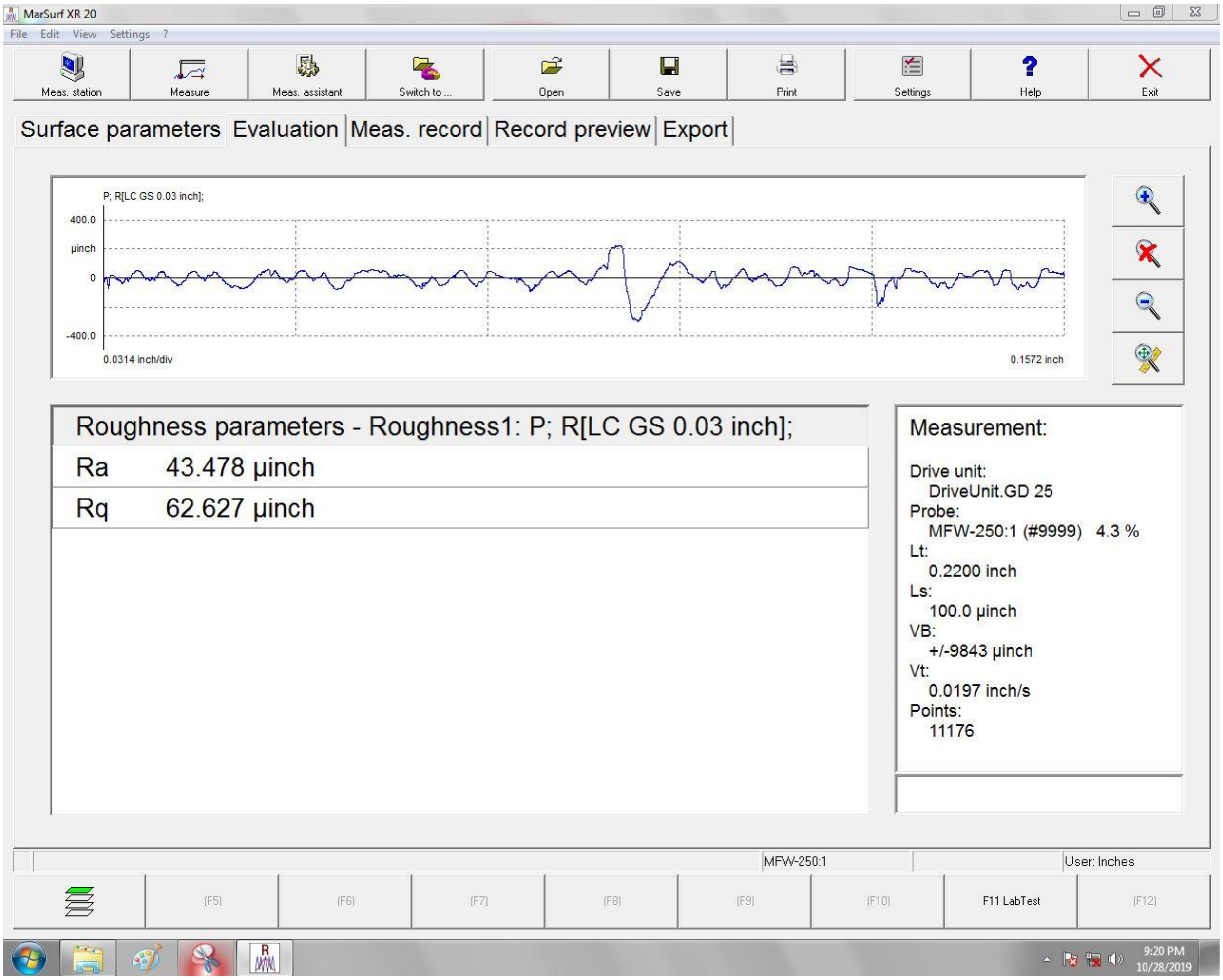
Shaft 2:
0.202
0.204
0.204
0.203 → Avg
(x200) = 40.667

Shaft 3:
0.829
0.848
0.823
0.833
(x200) = 166.667

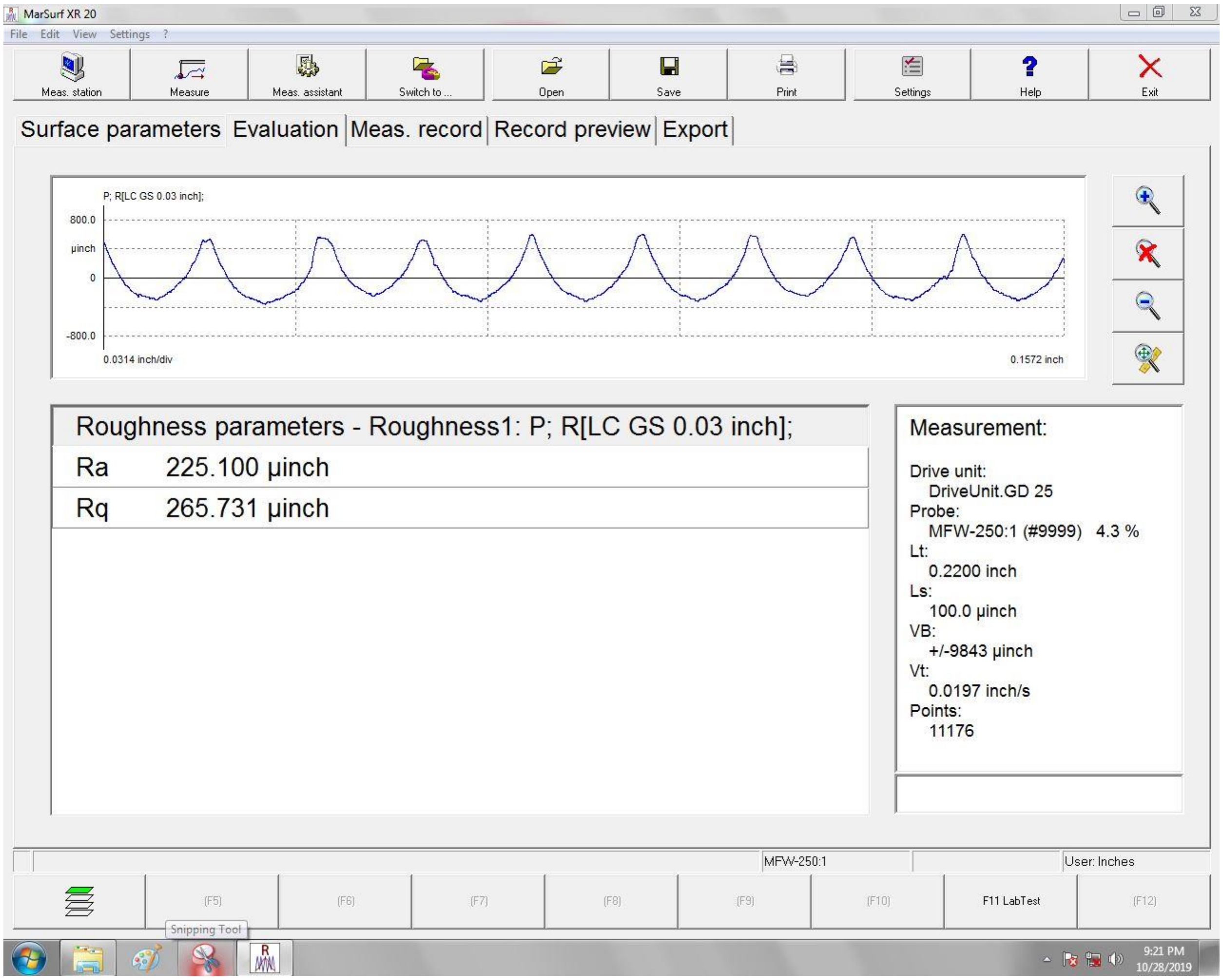
Shaft 1a


MarSurf XR 20
File Edit View Settings ?
Meas. station
Measure
Meas. assistant
Switch to ...
Open
Save
Print
Settings
Help
Exit
Surface parameters
Evaluation
Meas. record
Record preview
Export
P; R[LC GS 0.03 inch];
2000
µinch
0
-2000
0.0314 inch/div
0.1572 inch
Roughness parameters - Roughness1: P; R[LC GS 0.03 inch];
Ra 344.679 µinch
Rq 407.790 µinch
Measurement:
Drive unit:
DriveUnit.GD 25
Probe:
MFW-250:1 (#9999) 4.3 %
Lt:
0.2200 inch
Ls:
100.0 µinch
VB:
+/-9843 µinch
Vt:
0.0197 inch/s
Points:
11176
MFW-250:1
User: Inches
F11 LabTest
9:18 PM
10/28/2019

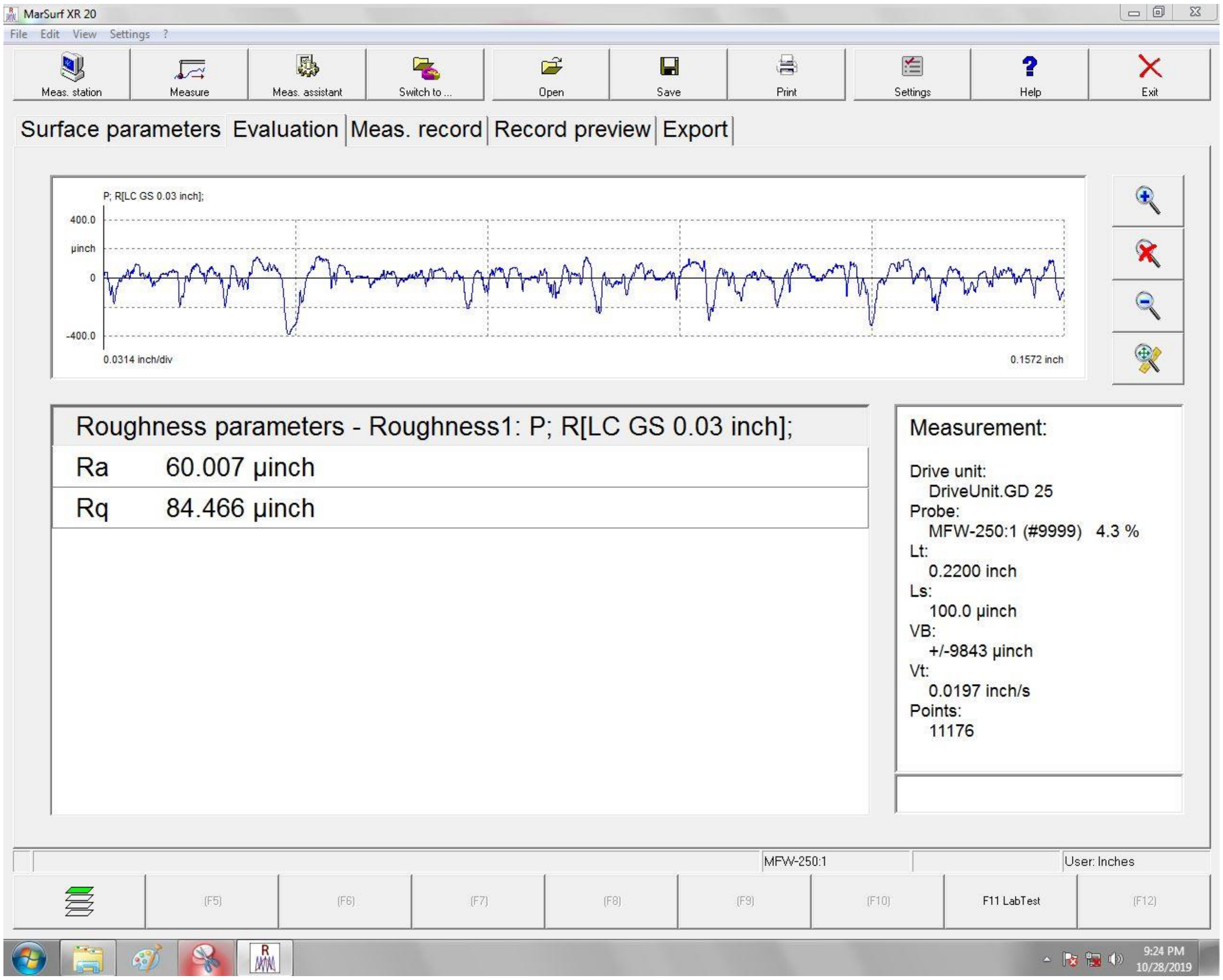
Shaft 1b


MarSurf XR 20
File Edit View Settings ?
Meas. station
Measure
Meas. assistant
Switch to ...
Open
Save
Print
Settings
Help
Exit
Surface parameters
Evaluation
Meas. record
Record preview
Export
P; R[LC GS 0.03 inch];
400.0
µinch
0
-400.0
0.0314 inch/div
0.1572 inch
Roughness parameters - Roughness1: P; R[LC GS 0.03 inch];
Ra 43.478 µinch
Rq 62.627 µinch
Measurement:
Drive unit:
DriveUnit.GD 25
Probe:
MFW-250:1 (#9999) 4.3 %
Lt:
0.2200 inch
Ls:
100.0 µinch
VB:
+/-9843 µinch
Vt:
0.0197 inch/s
Points:
11176
MFW-250:1
User: Inches
F11 LabTest
9:20 PM
10/28/2019

Shaft 1c


MarSurf XR 20
File Edit View Settings ?
Meas. station
Measure
Meas. assistant
Switch to ...
Open
Save
Print
Settings
Help
Exit
Surface parameters
Evaluation
Meas. record
Record preview
Export
P; R[LC GS 0.03 inch];
800.0
µinch
0
-800.0
0.0314 inch/div
0.1572 inch
Roughness parameters - Roughness1: P; R[LC GS 0.03 inch];
Ra 225.100 µinch
Rq 265.731 µinch
Measurement:
Drive unit:
DriveUnit.GD 25
Probe:
MFW-250:1 (#9999) 4.3 %
Lt:
0.2200 inch
Ls:
100.0 µinch
VB:
+/-9843 µinch
Vt:
0.0197 inch/s
Points:
11176
MFW-250:1
User: Inches
(F5)
(F6)
(F7)
(F8)
(F9)
(F10)
F11 LabTest
(F12)
Snipping Tool
9:21 PM
10/28/2019

Metal Plate


MarSurf XR 20
File Edit View Settings ?
Meas. station
Measure
Meas. assistant
Switch to ...
Open
Save
Print
Settings
Help
Exit
Surface parameters
Evaluation
Meas. record
Record preview
Export
P; R[LC GS 0.03 inch];
400.0
µinch
0
-400.0
0.0314 inch/div
0.1572 inch
Roughness parameters - Roughness1: P; R[LC GS 0.03 inch];
Ra 60.007 µinch
Rq 84.466 µinch
Measurement:
Drive unit:
DriveUnit.GD 25
Probe:
MFW-250:1 (#9999) 4.3 %
Lt:
0.2200 inch
Ls:
100.0 µinch
VB:
+/-9843 µinch
Vt:
0.0197 inch/s
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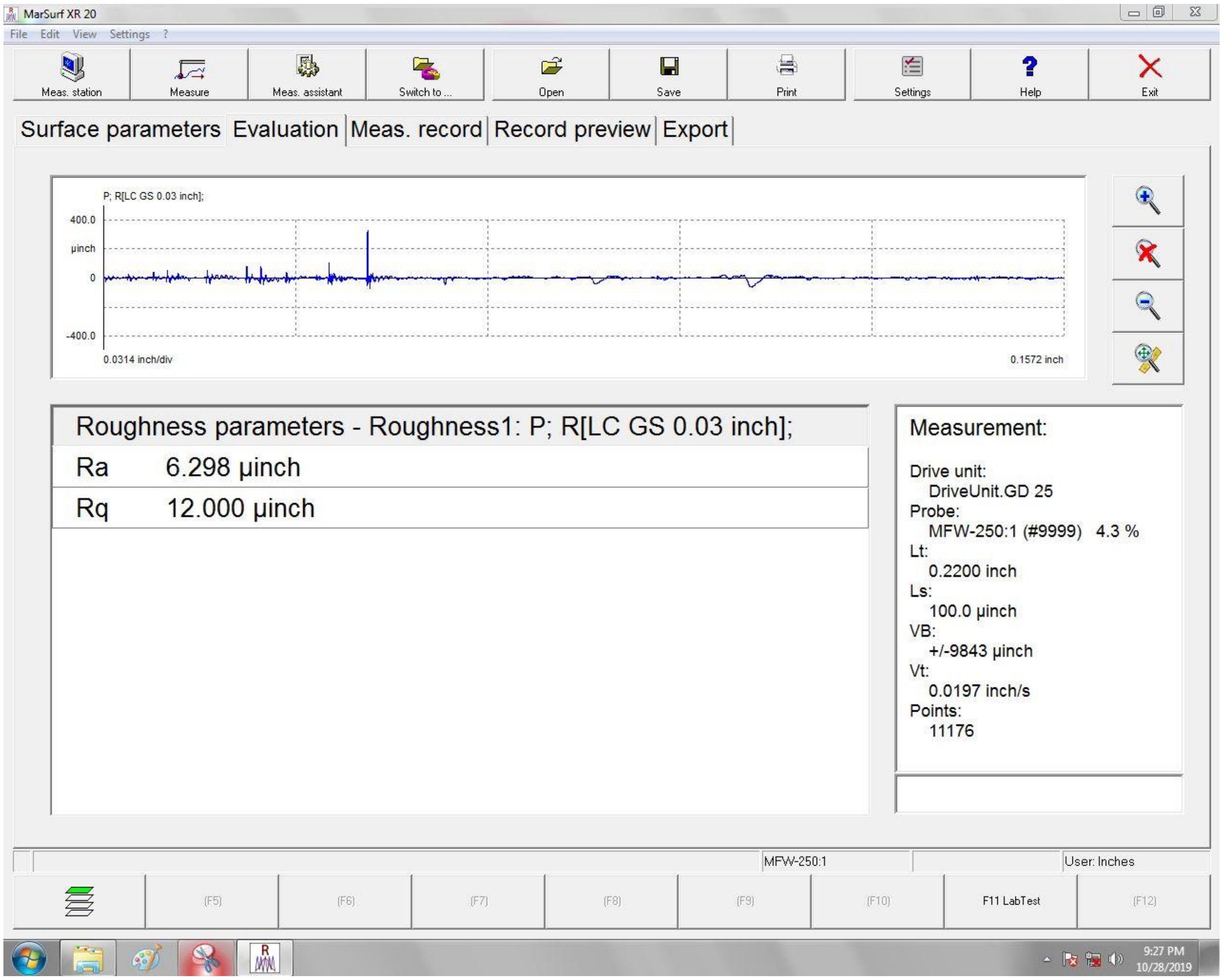
Plastic Plate



Results and Calculations

Surfometer:

$$Arithmetic\ Average\ (\mu in) = \frac{Result\ 1 + Result2 + Result3}{3} * 200$$

Discussion

The results calculated for this experiment were approved and signed by the teacher assistant. Additionally, the results calculated helped confirm the objectives of the lab. The objective of the lab was to learn different surface measuring tools and comparators. Additionally, some other objectives of the lab included studying variations in surface finish produced by different manufacturing processes and learning the standard symbols used to specify the surface roughness during surface measurements. The results retrieved from the Profilometer and the Surfometer were very different when taking precision into account. For example, the Ra value of Shaft 1a was 344.679 μin while the value given by the Surfometer of the same Shaft 1 was 218.133 μin. This is a total difference of 126.546 μin for the same exact shaft.

The main reason behind this are the accuracy and precisions of the machine. The profilometer is much more precise and accurate since it employs a mixture of hardware and computer software to find the average R values. On the other hand, the Surfometer is only hardware based and the students manually operated this machine to find three results and then find the average of those results. Furthermore, the Surfometer would fluctuate in its finding occasionally. Although the results for both the Profilometer and Surfometer may not be exactly the same, they generally follow the same trend. In both the Profilometer and Surfometer’s finding, plastic plate had the least roughness and the Shaft 1a had the most roughness.

Although the results in the machines did not line up, this was the intended purpose to show the dependence of accuracy on surface finishing. Overall, throughout the lab, the results in the data sheet help support the objectives listed above.

Conclusion

The purpose and objective of Experiment 5, Surface Topography, was to learn dependence of accuracy on surface finishing. Throughout experiment, the main objectives of this laboratory experiment were for students to study variations in surface finish produced by different manufacturing processes, learn the standard symbols used to specify the surface roughness during surface measurements, and learn different surface measuring tools and comparators. The objective of learning the symbols was accomplished first through the PowerPoint given by the teacher assistant and further supported by filling out the data sheet. From conducting the lab, students learned about different surface measuring tools, the Micro finish, the Profilometer, and the Surfometer. From the results found using the plastic plate and metal plate, it can be seen how much smoother the plastic plate is regardless of the fact that both of them feel smooth, showing that the accuracy of the plastic plate is much better. Hence, supporting the objective to learn dependence of accuracy on surface finishing. Overall, the objectives were accomplished and validated from the results.

Questions and Answers

1. What kind of commercial instruments are available for measuring and recording the surface finish?

    Some commercial instruments available for measuring and recording the surface finish are the profilometer, focus variation, interferometry, digital holography, confocal chromatic aberration, and confocal microscopy (DeRose).

2. Discuss the effects of grinding and turning on the endurance limit of steel. What is the reason of change in fatigue strength with various surfaces finishes?

    Grinding does not have any negative effects on the endurance limit of steel if it is done the correct way. On the other hand, since turning removes material from the steel, this may lead to a lower endurance limit of steel (Guo). The various different finishes required different methodology, for instance the amount of lubrication and friction vary from process to process and therefore, the various surface finishes can vary in fatigue strength (Guo).

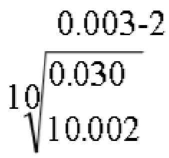
3. Explain the principle of measurement by light wave interference?

    Known as interferometry, it uses two light beams to form an interference pattern when the two beams superpose and because the wavelength of the visible light is short, small changes in the optical path between the two beams can be detected (Renishawplc).

4. Why is the micro finish comparator often used for specifying surface finish?

    The micro finish comparator is often used for specifying surface finish because it showcases decades of surface finish knowledge and if a certain product needs the appearance of a certain surface finish, it can be compared to the micro finish to compare.

5. A designer places the following surface finish specification symbol on a given surface:



a. Is the roughness width cut off consistent with the roughness width?

The roughness with cut off is not consistent with the roughness width since the roughness width cut off is only a small fraction of the roughness width, they should be closer together.

b. What processes would be needed to achieve the surface roughness specified?

To achieve the surface roughness of 10 micro inches, the electro-chemical, barrel finishing, electrolytic grinding, roller burnishing, grinding, honing, electro-polish, polishing, or lapping process can be used (R.Dubrovsky).

c. What would the roughness be in metric measurement?

The roughness in metric measurement would be 0.254 micro meters.

d. What may be the cause of the waviness?

The cause of the waviness could be repeating irregularities with spacing greater than roughness marks or results from machine deflections and vibrations (R.Dubrovsky).

6. Is it possible to observe the surface roughness directly through an optical or scanning electron microscope?

It is possible to observe the surface roughness through an optical or scanning electron microscope, but it may not be the most precise or accurate representation of the surface roughness.

7. What does this symbol mean?

$\underline{\sqrt{X}}$

This symbol stands for the lay angular in both directions to line representing the surface to which symbol is applied (R.Dubrovsky).

8. Is it possible to obtain surface roughness Ra=1.6 μm by any of the two manufacturing processes: grinding & boring?

   It is very plausible to obtain surface roughness Ra=1.6 μm by boring since it falls under the "Average Application" range. On the other hand, for grinding, Ra=1.6 μm only falls under the "Less Frequent Application" range, meaning it is not as frequently occurring as it is for boring (R.Dubrovsky).

9. List all the available machining processes to obtain the microroughness in a range of 3-5 μm.

   - Snapping
   - Sawing
   - Planing
   - Shaping
   - Drilling
   - Chemical Milling
   - Elect. Discharge Mach.
   - Milling
   - Broaching
   - Reaming
   - Electron Beam

- Laser
- Electro-chemical
- Boring-turning
- Grinding
- Forging
- Perm Mold Casting
- Investment Casting
- Extruding
- Cold Rolling
- Drawing (R.Dubrovsky)

10. What is the typical surface roughness requirement for the following engineering components?

    a. Gear teeth

    The typical surface roughness requirement for gear teeth are less than 4 micro inches thanks to flank finishing. This flank finishing helps to reduce surface distress failures which helps extend the life of the gear teeth (Michaud).

    b. Bearing seals

    The surface roughness plays a large role in the lifespan of bearing seals due to the fact that if the roughness is too low, the seal will not retain lubrication and it the roughness it too high, the seal will wear faster due to more friction. The typical surface roughness requirement for bearing seals is from 4 to 12 micro inches (Surface Roughness).

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