ME 312 PROJECT

Surface Roughness Analysis in Turning and Milling

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Plan of Presentation

- Introduction
- Literature Review
- Numerical Formulation
- Experimental Details
- Conclusions
- Images of experimental work
- Video of experiment

Introduction

- In this project, we will be conducting a comprehensive analysis of surface roughness profiles resulting from milling and turning operations, each performed at varying machining parameters.
- Milling and turning operations are pivotal in the realm of metalworking, with many components necessitating these processes during their manufacturing journey.
- This necessity arises from factors such as part design specifications, cost-effectiveness considerations, and the pursuit of high-quality surface finishes.
- Now, let's delve into the fundamental factors that exert influence on surface finish quality in both milling and turning operations:
    - **Tool Geometry**
    - **RPM (Revolutions Per Minute)**
    - **Feed Rate**
    - **Depth of Cut**

Literature Review

Milling

- Milling is a metal cutting operation characterized by the removal of excess material from a workpiece through the use of a rotating multipoint cutting tool called a milling cutter.

- The primary motion in milling is achieved by the axial rotation of the milling head, while the workpiece moves perpendicular to the cutter's axis, resulting in the feeding or auxiliary motion.

Milling Machine

- A milling machine is a power-driven machine tool designed for shaping workpieces. It consists of a movable table on which the workpiece is mounted, and various shapes are machined by moving the workpiece beneath a rotating cutter with serrated edges.

- The key components of a milling machine include a motor-driven spindle that holds and rotates the milling cutter and a reciprocating, adjustable worktable that supports the workpiece and facilitates its movement.

Literature Review

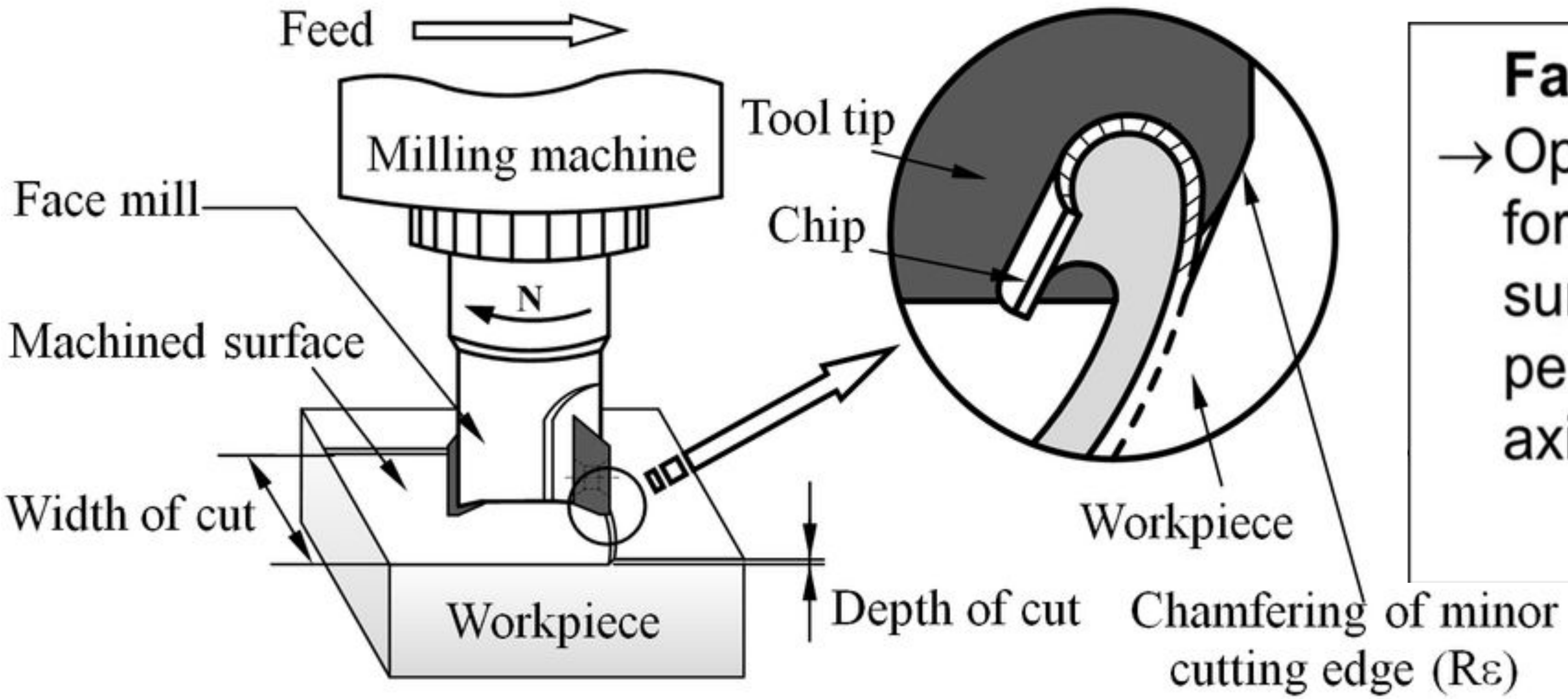
- Milling machines are categorized primarily as either vertical or horizontal in their configuration.

- Within the realm of milling methods, our focus has been on the face milling operation.

- Most milling machines have self-contained electric drive motors, coolant systems, variable spindle speeds, and power- operated table feeds.

HORIZONTAL MILLING MACHINE	VERTICAL MILLING MACHINE
Spindle is horizontal & parallel to the worktable.	Spindle is vertical & perpendicular to the worktable.
Cutter cannot be moved up & down.	Cutter can be moved up & down.
Cutter is mounted on the arbor.	Cutter is directly mounted on the spindle.
Spindle cannot be tilted.	Spindle can be tilted for angular cutting.
Operations such as plain milling, gear cutting, form milling, straddle milling, gang milling etc., can be performed.	Operations such as slot milling, T-slot milling, angular milling, flat milling etc., can be performed and also drilling, boring and reaming can be carried out.

Literature Review



Face Milling:

→ Operation carried out for producing a flat surface, which is perpendicular to the axis of rotating cutter.

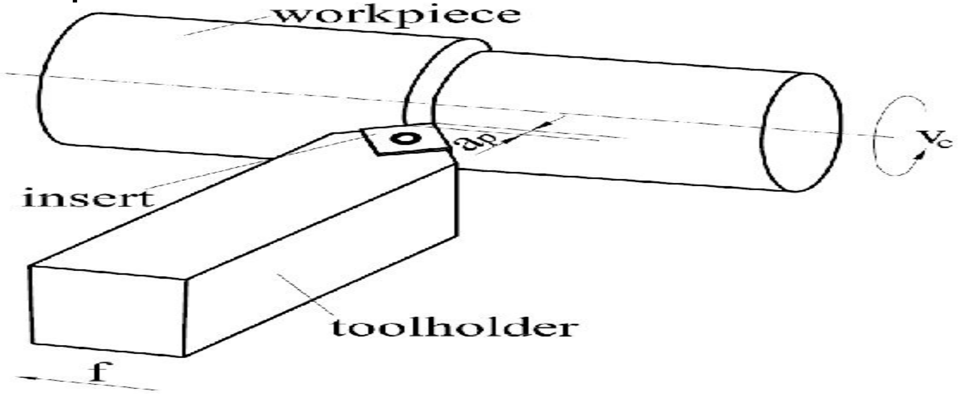
Literature Review

Turning

- Turning, on the other hand, is a metal cutting process where excess material is removed from a workpiece by rotating the workpiece itself while a single-point cutting tool, often in the form of a lathe tool or insert, engages with the workpiece's surface.

Turning Machine (Lathe)

- A turning machine, commonly known as a lathe, is a power-operated machine tool used for shaping workpieces during turning operations. In a lathe, the workpiece is securely clamped and rotated, and the cutting tool is brought into contact with the rotating workpiece to remove material and create the desired shape.
- The main components of a lathe include a motor-driven spindle that rotates the workpiece and a tool holder that holds and guides the cutting tool as it engages with the workpiece's surface.



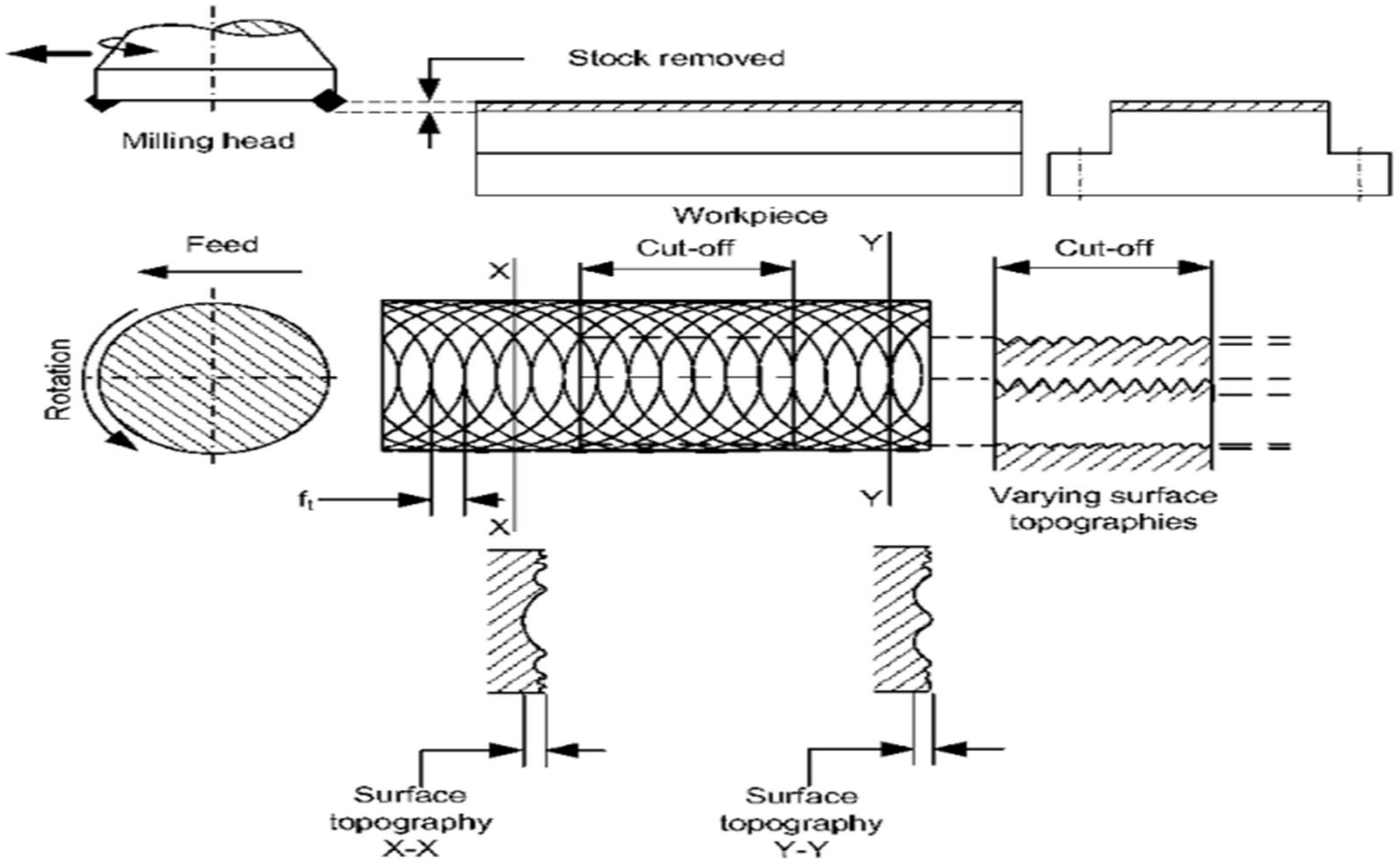
Literature Review

- In both milling and turning operations, precise control of tool movements, workpiece positioning, and cutting parameters is critical to achieving accurate and desired shapes and surface finishes. These machining processes are foundational in metalworking and find extensive use in various industries for manufacturing components with specific shapes and dimensions.

SURFACE ROUGHNESS

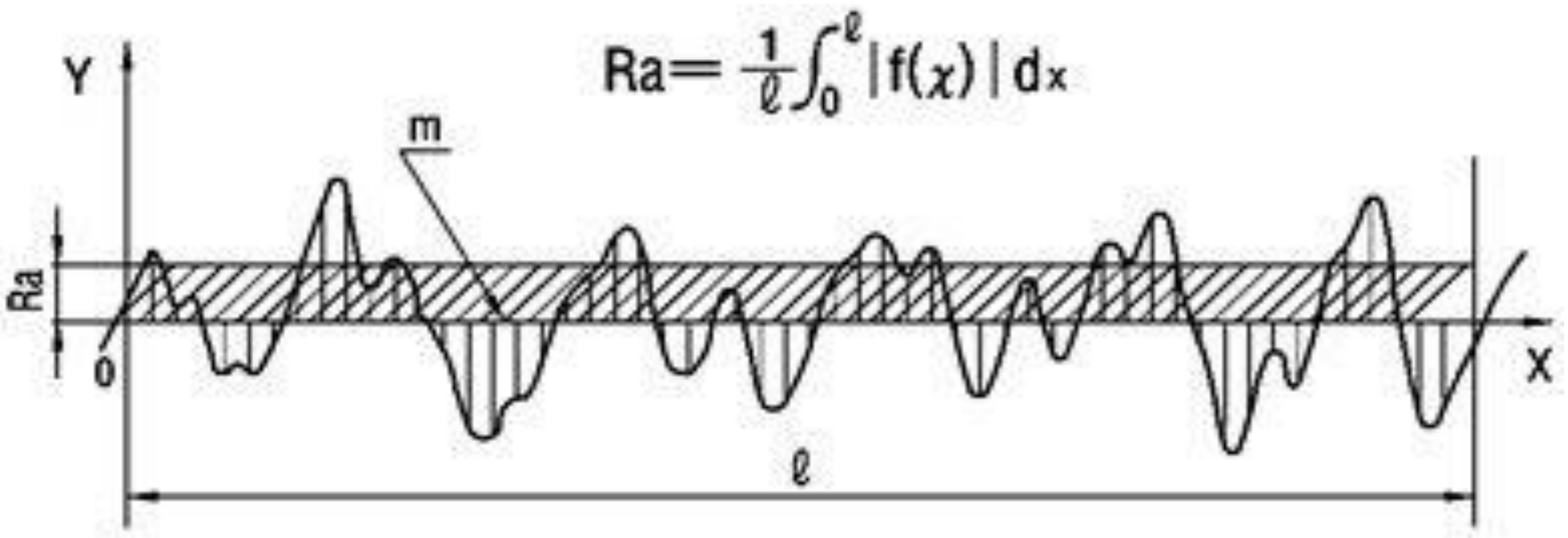
- Surface roughness is an integral component of surface texture, and it plays a pivotal role in determining how an object interacts with its surroundings.
- Roughness serves as a valuable indicator of a mechanical component's performance, as surface irregularities can serve as initiation points for cracks or corrosion
- In the field of tribology, it's observed that rough surfaces tend to experience accelerated wear and may exhibit higher friction coefficients compared to smoother surfaces. However, in certain applications, intentionally introducing roughness is desirable to enhance adhesion for cosmetic finish coatings like painting, powder coating, or plating.
- Due to the inherent kinematics of the machining process, face milling can yield varying roughness values contingent on measurement location and direction. Consequently, the roughness profile can exhibit significant changes based on these factors.

Literature Review



This phenomenon is visually represented in the accompanying figure, where profile sections in the X-X and Y-Y directions distinctly deviate from the original profiles in the feed direction.

Numerical Formulation



EXPERIMENTAL DETAILS

- Apparatus required:
  1) Milling Machine
  2) Cast Iron Workpiece (Cube 30X30)
  3) Surface Roughness Meter
  4) Vernier Caliper
  5) High Precision non-contact Computerized Surface Profilometer

- Procedure :

  - Vise is aligned and work piece is secured in the vise.
  - We have divided our experiment in three parts measuring surface roughness in each part by changing a parameter while keeping other constant.

First part: we calculate the surface roughness by changing the **Feed rate with constant RPM.**

Second part: we calculate the surface roughness by **changing the RPM with constant Feed rate.**

Third part: we calculate the surface roughness by **changing the Depth of cut.**

OBSERVATION

Surface roughness measurement in Turning Operation

- **Varying Feed**

Sr.No.	RPM	Feed (mm/min)	Depth (mm)	Ra (µm)	Rmax (µm)
1.	288	0.75	0.2	3.69	14.58
2.	288	1	0.2	3.86	15.39
3.	288	1.25	0.2	4.74	18.76
4.	288	1.4	0.2	4.89	19.43

- **Varying RPM**

Sr.No.	RPM	Feed (mm/min)	Depth (mm)	Ra (µm)	Rmax (µm)
1.	145	1	0.2	3.57	14.21
2.	288	1	0.2	4.62	18.29
3.	384	1	0.2	3.87	15.34
4.	598	1	0.2	4.48	17.77

Varying DEPTH OF CUT

Sr.No.	RPM	Feed (mm/min)	Depth (mm)	Ra (µm)	Rmax (µm)
1.	384	0.75	0.1	4.53	18.07
2.	384	0.75	0.2	4.65	18.51
3.	384	0.75	0.3	3.97	15.74
4.	384	0.75	0.5	4.54	18.02

OBSERVATION

Surface roughness measurement in milling operation

Varying FEED

Sr.No.	RPM	Feed (mm/min)	Depth (mm)	Ra (µm)	Rmax (µm)
1.	288	0.75	0.2	3.57	14.17
2.	288	1	0.2	3.84	15.28
3.	288	1.25	0.2	4.75	18.89
4.	288	1.4	0.2	4.87	19.41

Varying RPM

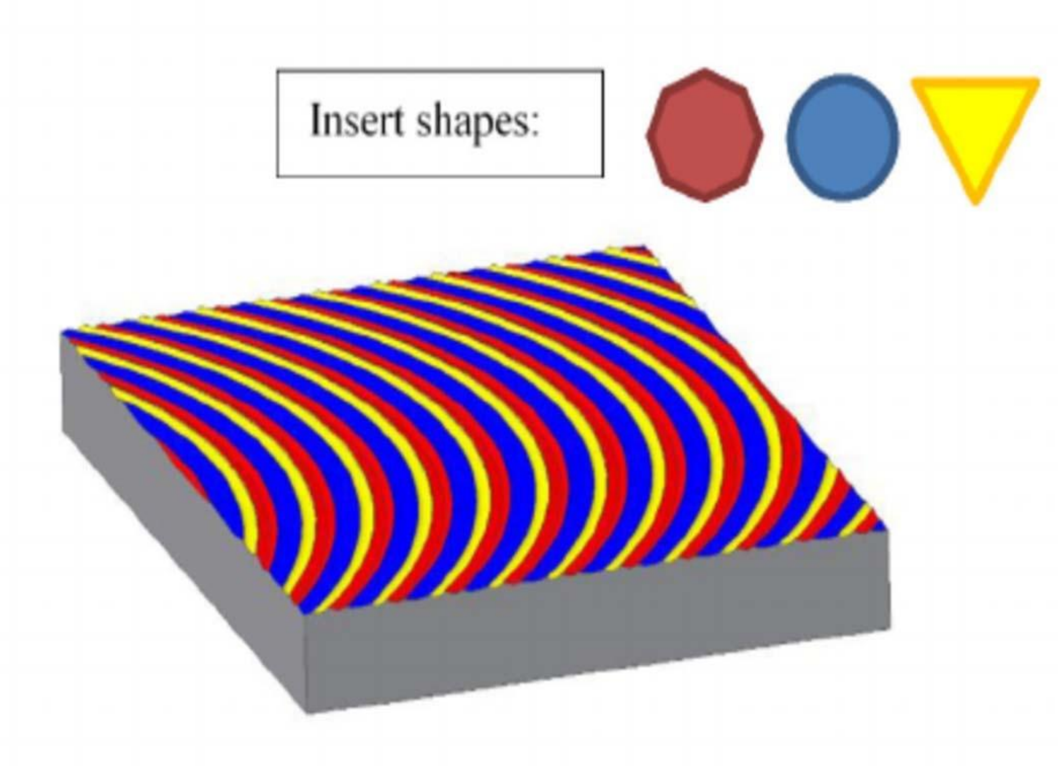
Sr.No.	RPM	Feed (mm/min)	Depth (mm)	Ra (µm)	Rmax (µm)
1.	145	1	0.2	3.52	13.91
2.	288	1	0.2	4.61	18.35
3.	384	1	0.2	3.94	15.64
4.	598	1	0.2	4.49	17.82

Varying DEPTH OF CUT

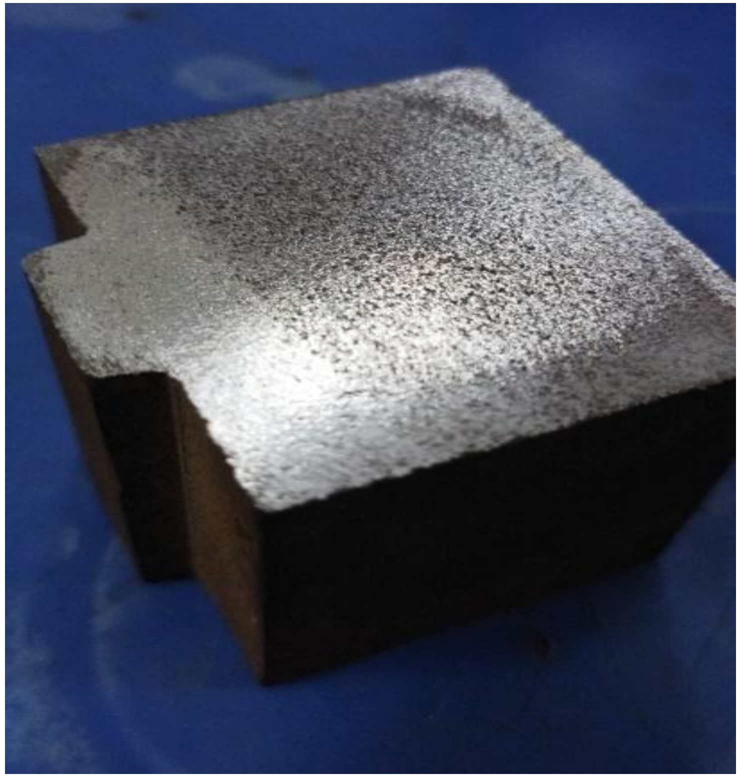
Sr.No.	RPM	Feed (mm/min)	Depth (mm)	Ra (µm)	Rmax (µm)
1.	384	0.75	0.1	4.42	17.54
2.	384	0.75	0.2	4.47	17.76
3.	384	0.75	0.3	3.96	15.72
4.	384	0.75	0.4	4.51	17.93

OBSERVATION

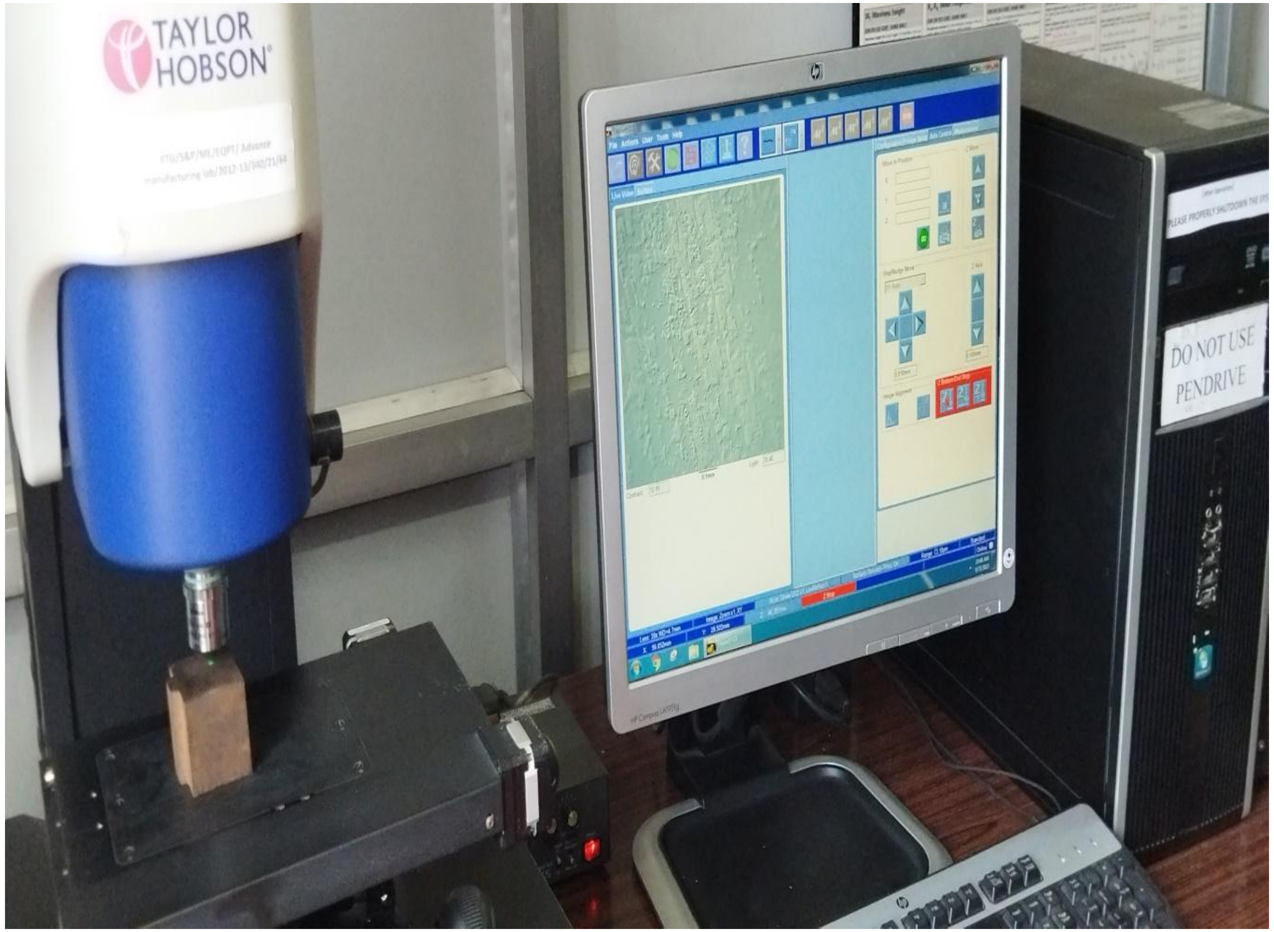
Theoretical surface profile

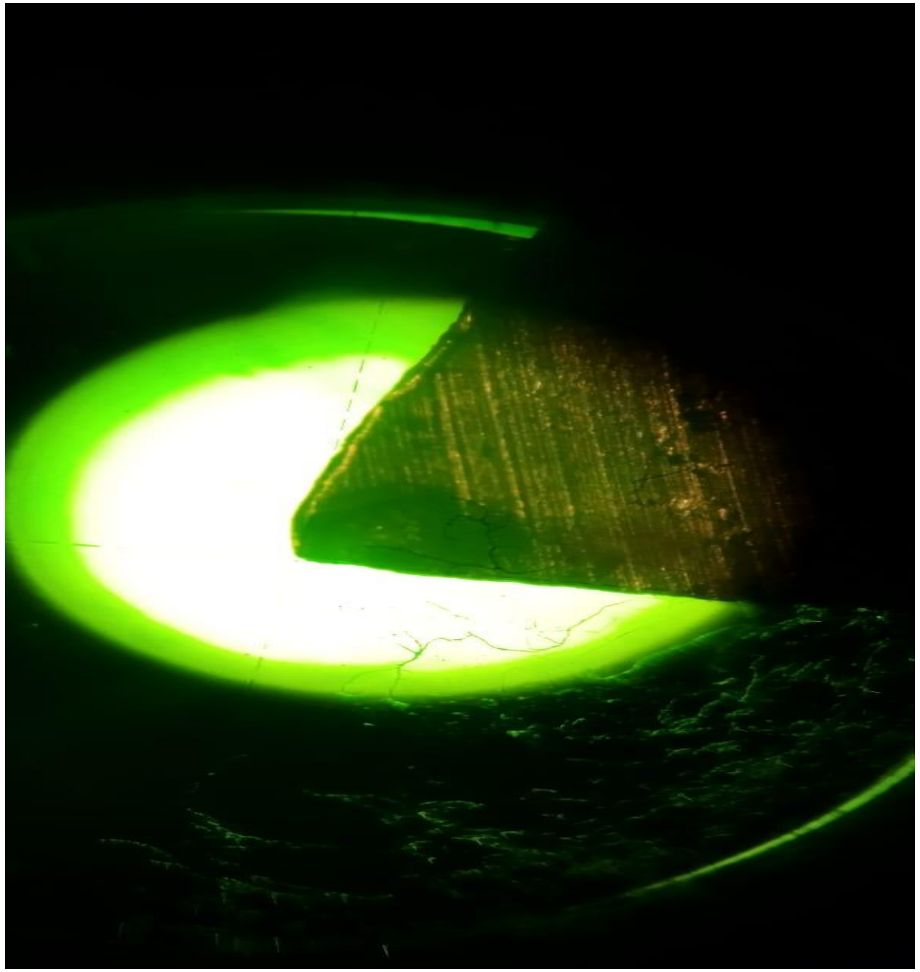


Experimental surface profile



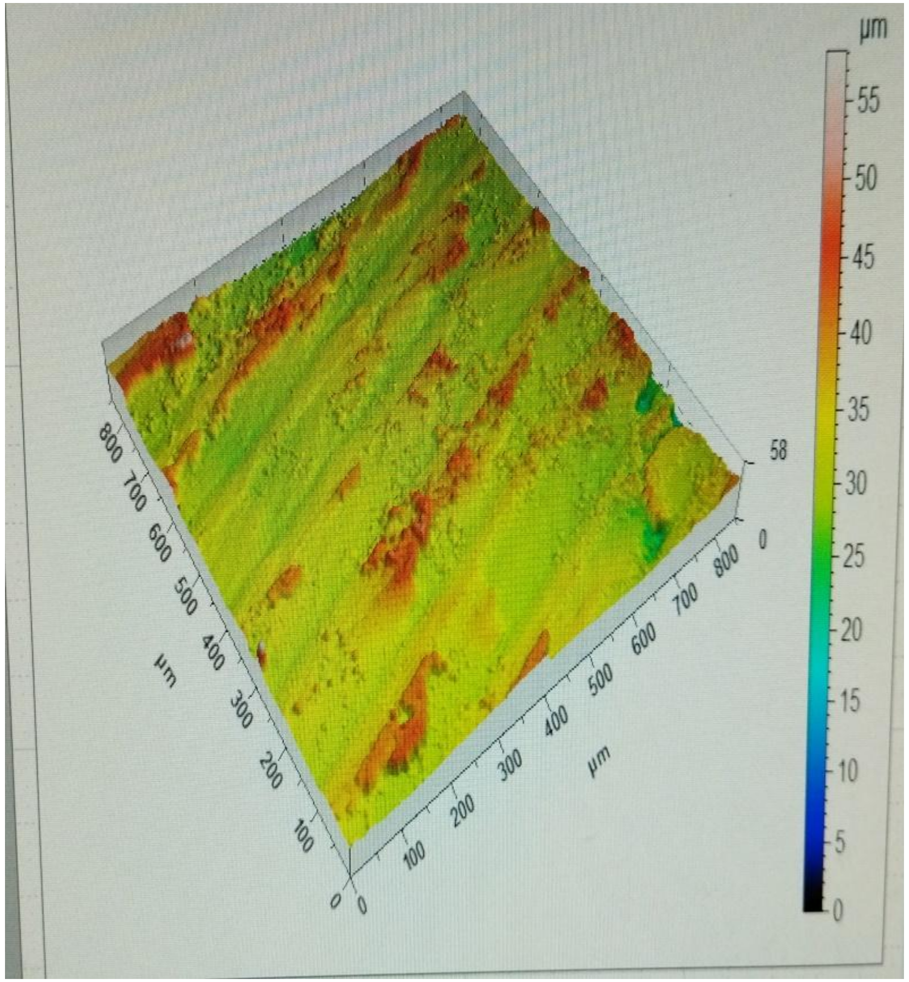
SNAPSHOTS OF EXPERIMENTAL WORK

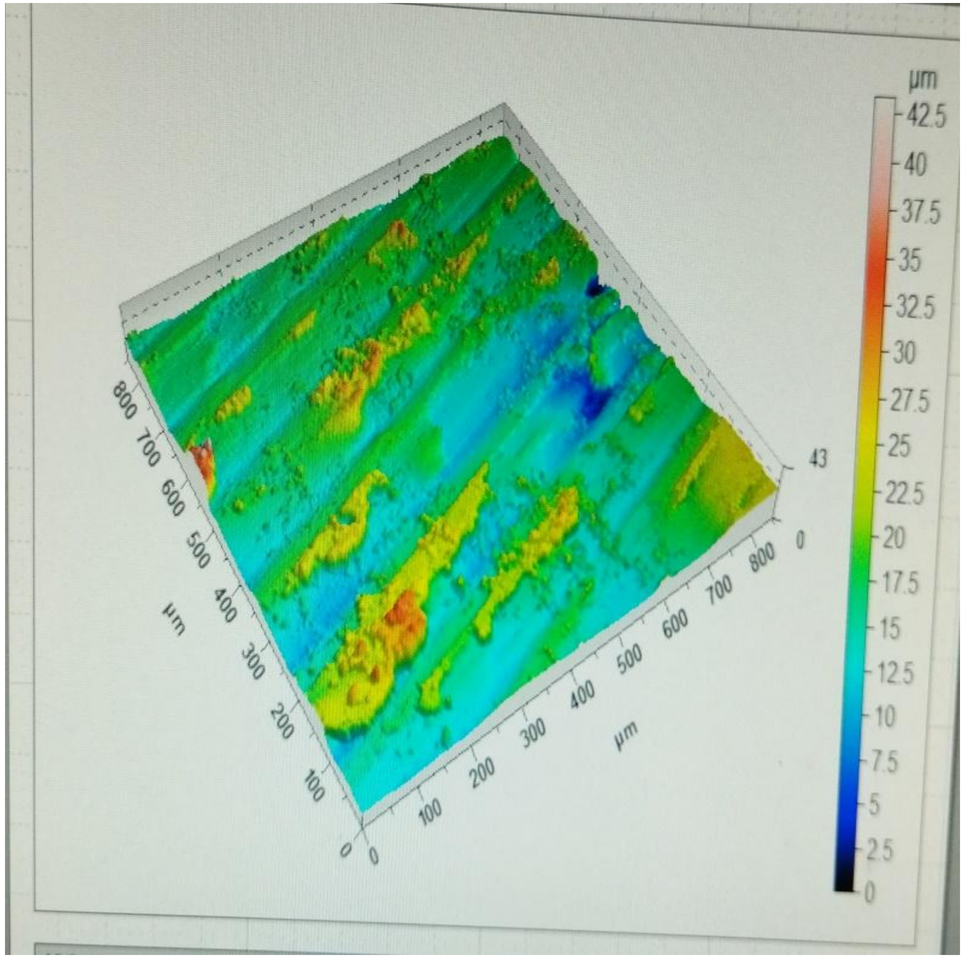




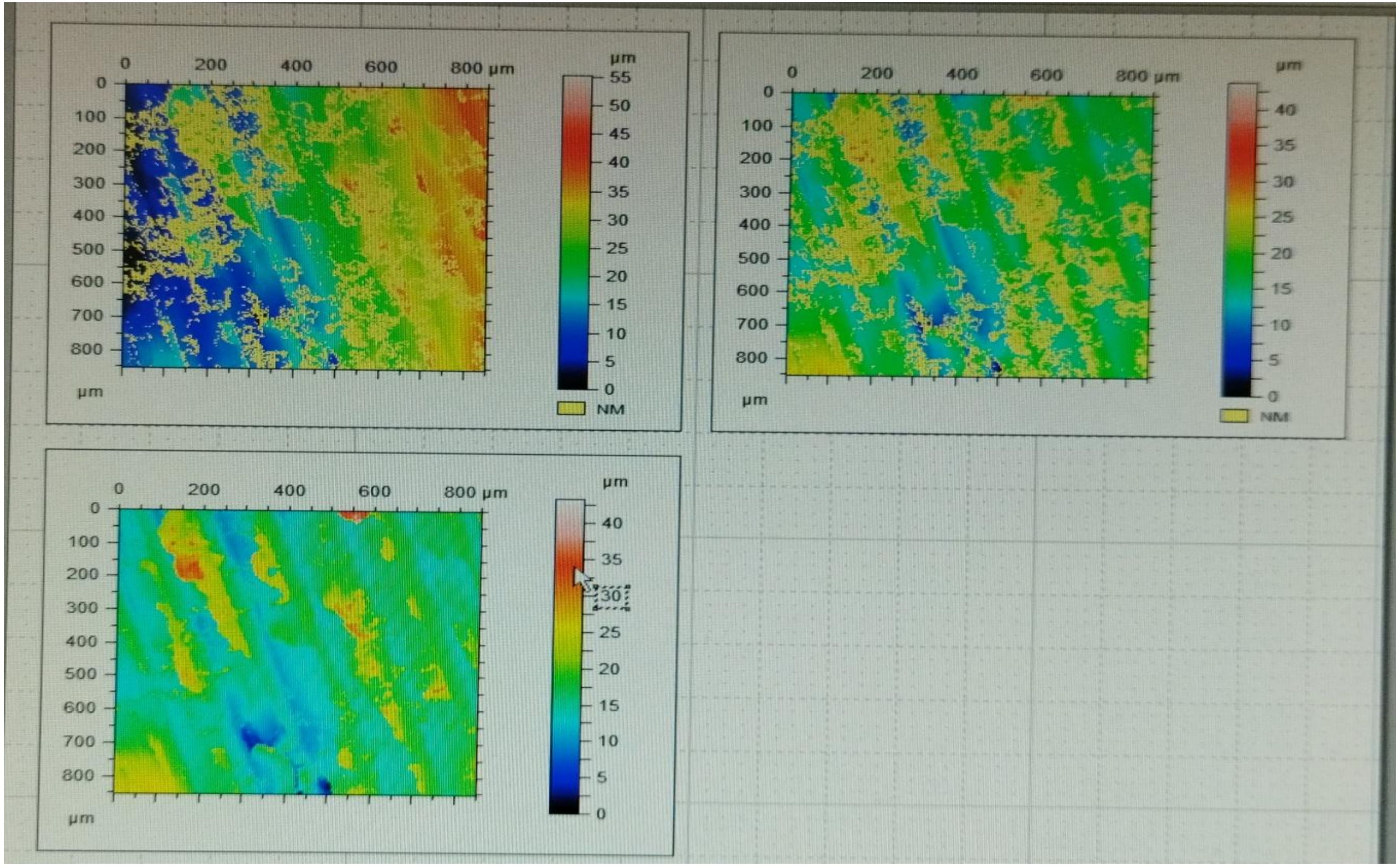
OBSERVATION

Microscopic view of surface roughness using surface profilometer

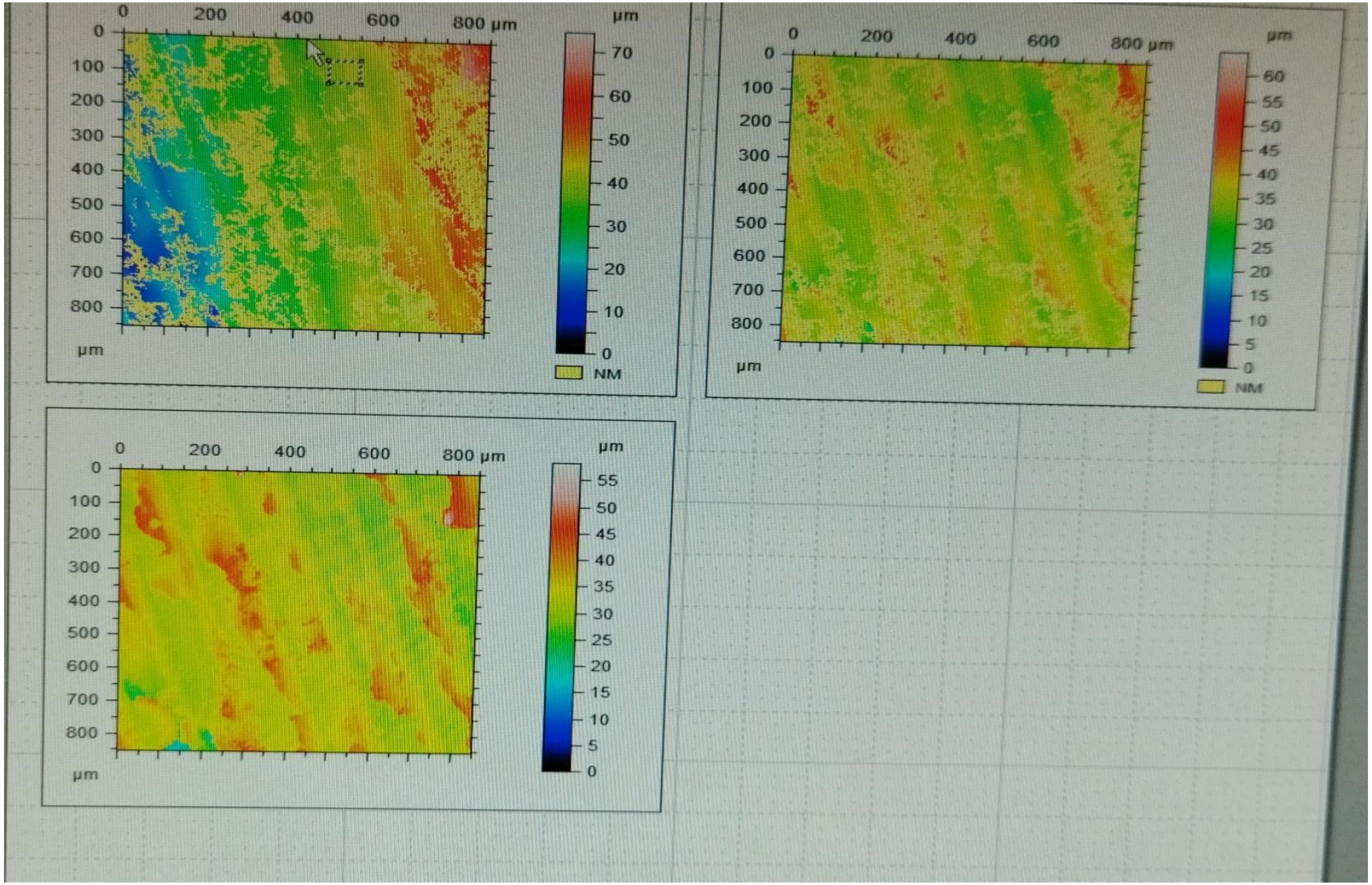




Microscopic view of surface roughness using surface profilometer

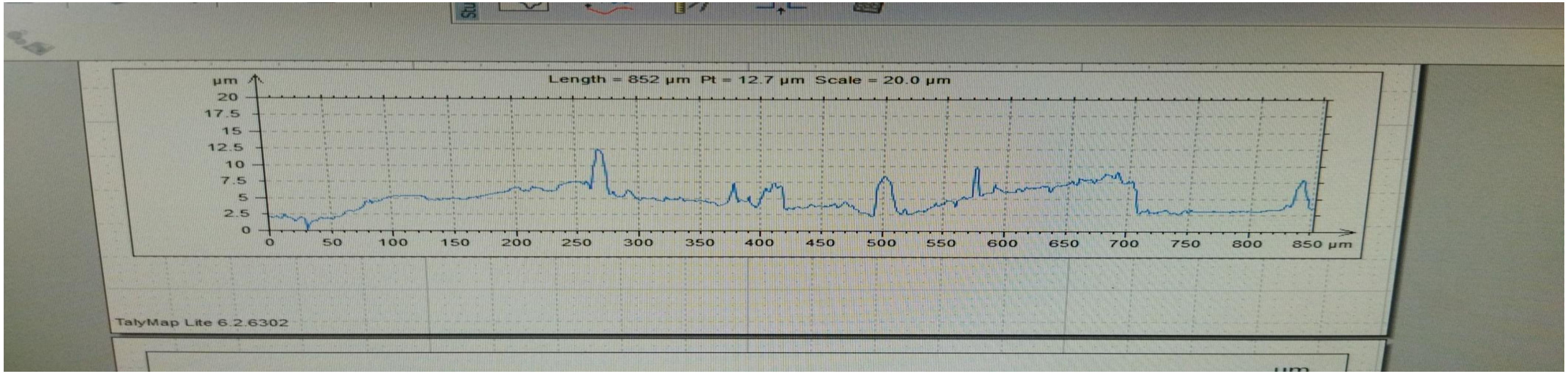


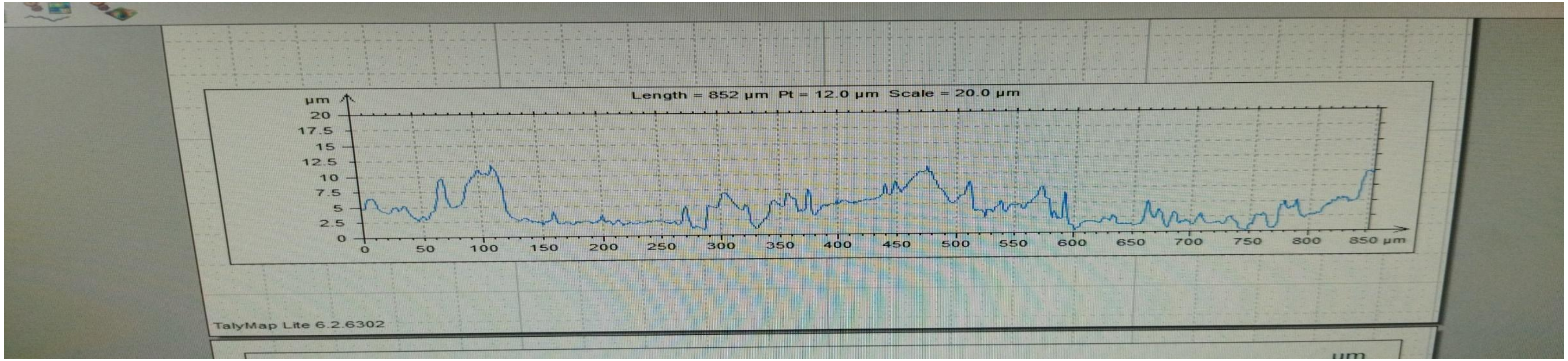
Microscopic view of surface roughness using surface profilometer



OBSERVATION

- **Graphs obtained by Surface Profilometer at two different location**

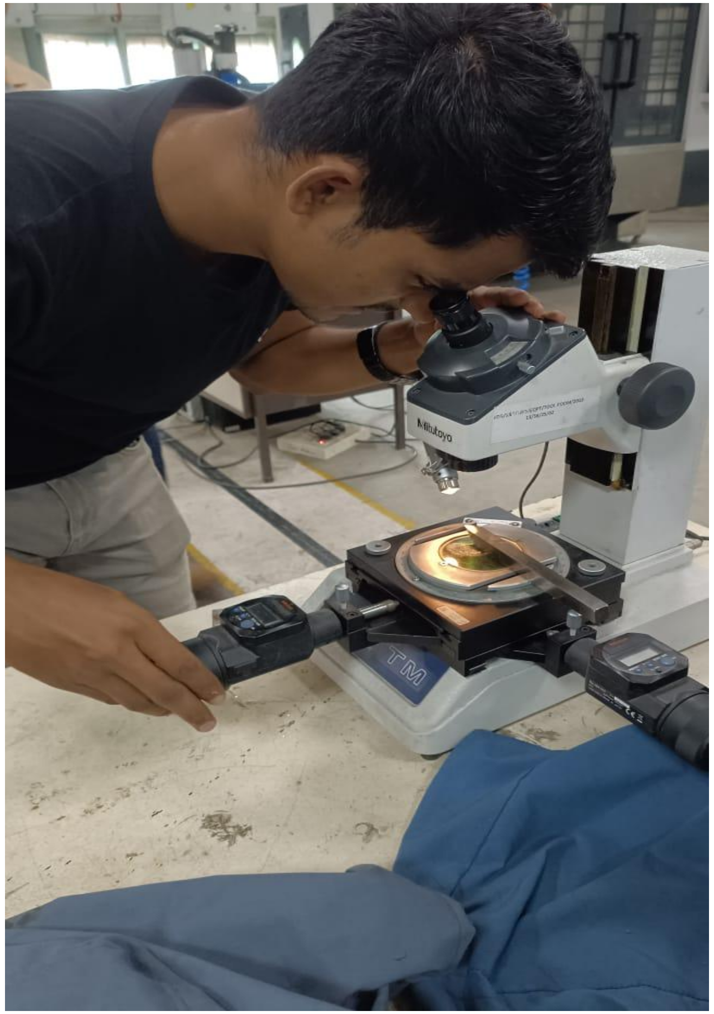




Conclusion

By observing readings We have arrived at the conclusion that

- Experiment backs the theoretical relation of $Ra=Rmax/4$ to a great extent .
- We observe a INCREASE in Ra and Rmax on increasing depth of cut while keeping feed and RPM constant.
- On increasing RPM for constant feed and depth Ra and Rmax DECREASES.
- Again there is an INCREASE in Ra and Rmax on increasing feed at constant RPM and depth of cut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