ME409

Intelligent Manufacturing Processes Lab-6

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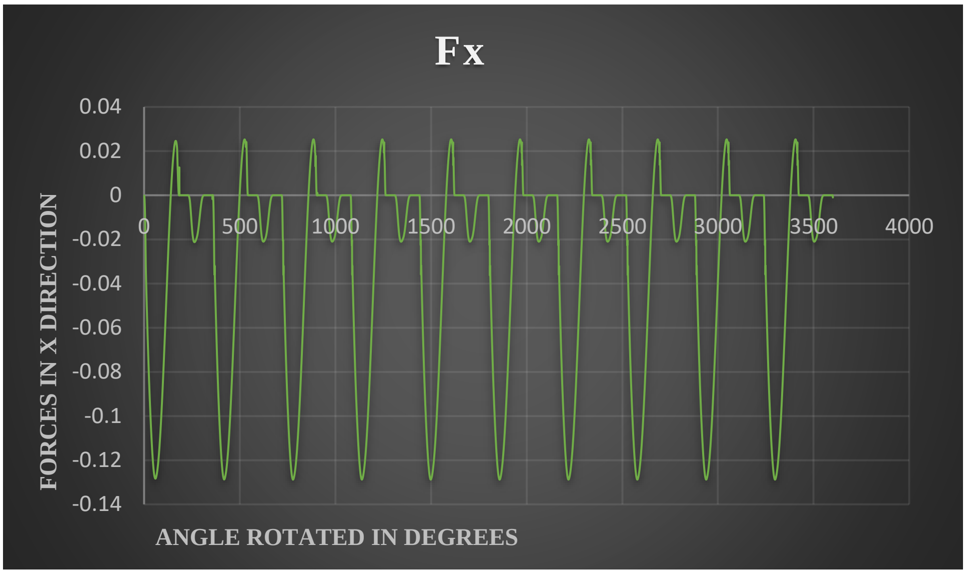
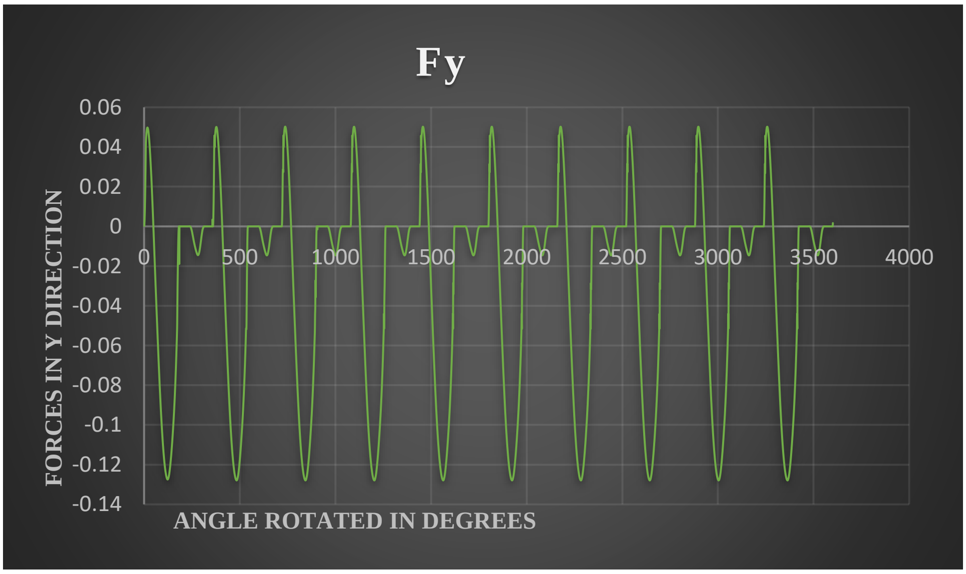
Micro-End milling Simulation: Part II

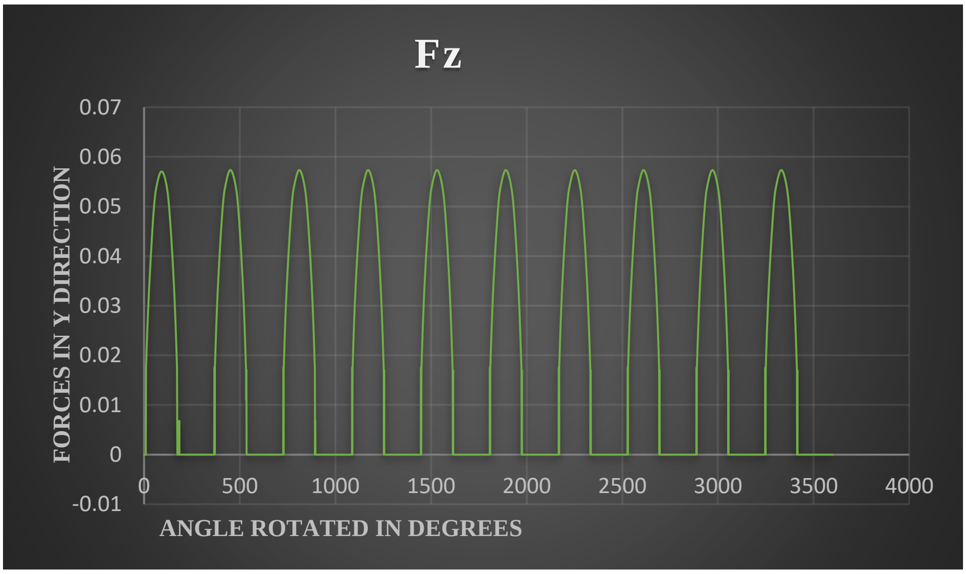
B. There are three phases in microstructure of in microstructure of ductile iron, these are graphite, ferrite, and pearl, they exists in the form of nodules. The grains consist of graphite phases embedded inside the ferrite phases and dispersed in a pearlite matrix. The microstructure is defined by the number of grains, the centre C of each grain, and the radius R1 and R2 of the graphite and ferrite phases in the grain. However, there will be other phases other than primary phase and we will take 0 as microstructure value for single phase.

C. Data points denoted by Asi need to be collected for the micro endmill along the length of the tool along the helix. We will take zero as height of each profile which would be measured at regular interval.

D. **1.** Because of the up and down milling, each time the edge enters, it is subjected to a shock load, as shown in the graphs. Because it is a slotted profile, both impacts are visible. Amount of forces is greater in up milling than in down milling.


Fx
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
-0.14
0
500
1000
1500
2000
2500
3000
3500
4000
FORCES IN X DIRECTION
ANGLE ROTATED IN DEGREES


Fy
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
-0.14
0
500
1000
1500
2000
2500
3000
3500
4000
FORCES IN Y DIRECTION
ANGLE ROTATED IN DEGREES


Fz
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0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
0
500
1000
1500
2000
2500
3000
3500
4000
FORCES IN Y DIRECTION
ANGLE ROTATED IN DEGREES

2. Average peak-to-valley forces for 10 revolutions –

Took average of force values achieved in output file-

In x direction; Fx_avg = 0.154068

In y direction; Fy_avg = 0.178151

such results are achieved because amount of forces is greater in up milling than in down milling.

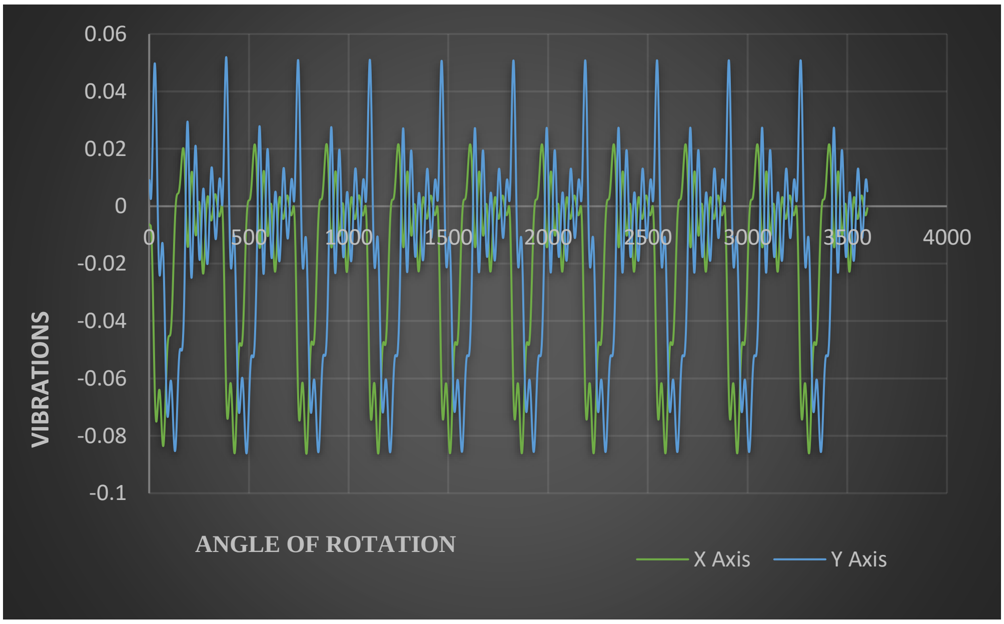
3. Average tool Deflection over 10 revolutions –

In X Direction; Average vibration - 0.00675

In Y Direction; Average vibration - 0.002805

The reason for the differences in magnitude in vibration is that In Down milling tool due to chip thinning effect vibration increases. This decrease in chip thickness leads to stability and high vibrations.

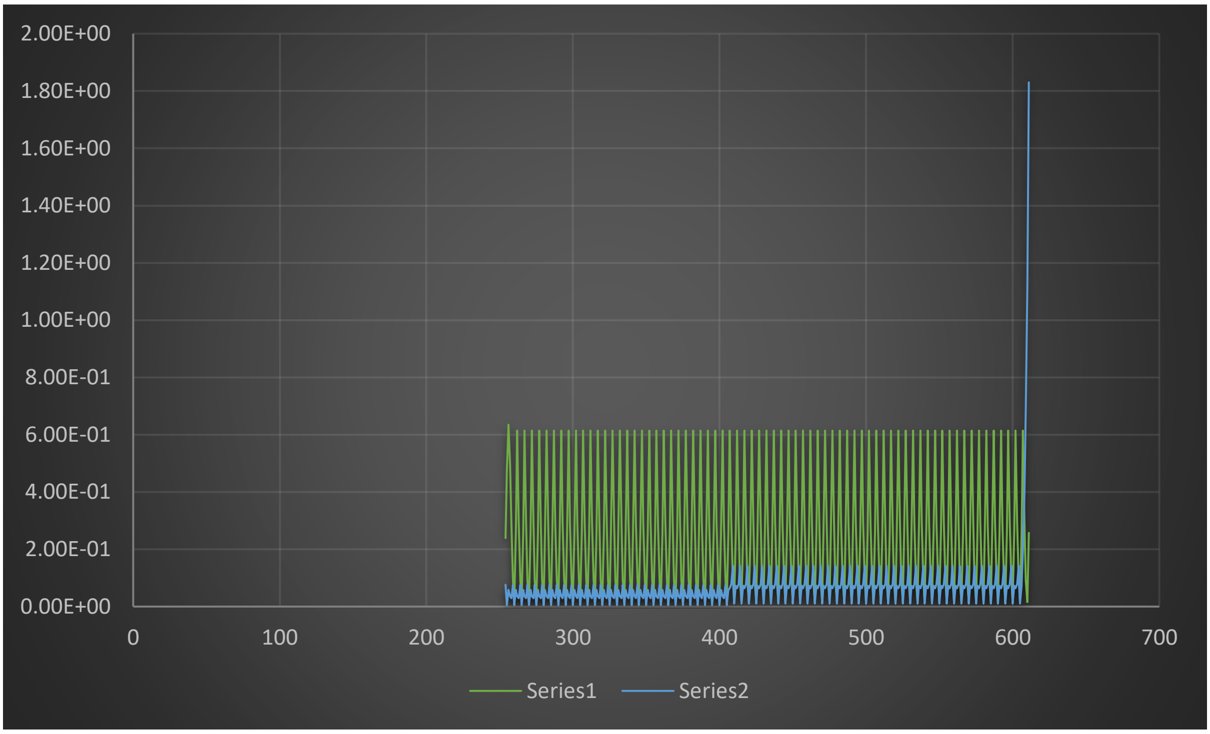
6. Plots of X and Y Vibrations of the tool over ten revolutions



Green Line – X Axis Vibrations

Blue Line - Y axis Vibrations

5. Variation of surface profile along the center of slot along the scan 25 microns away from one of the edges.

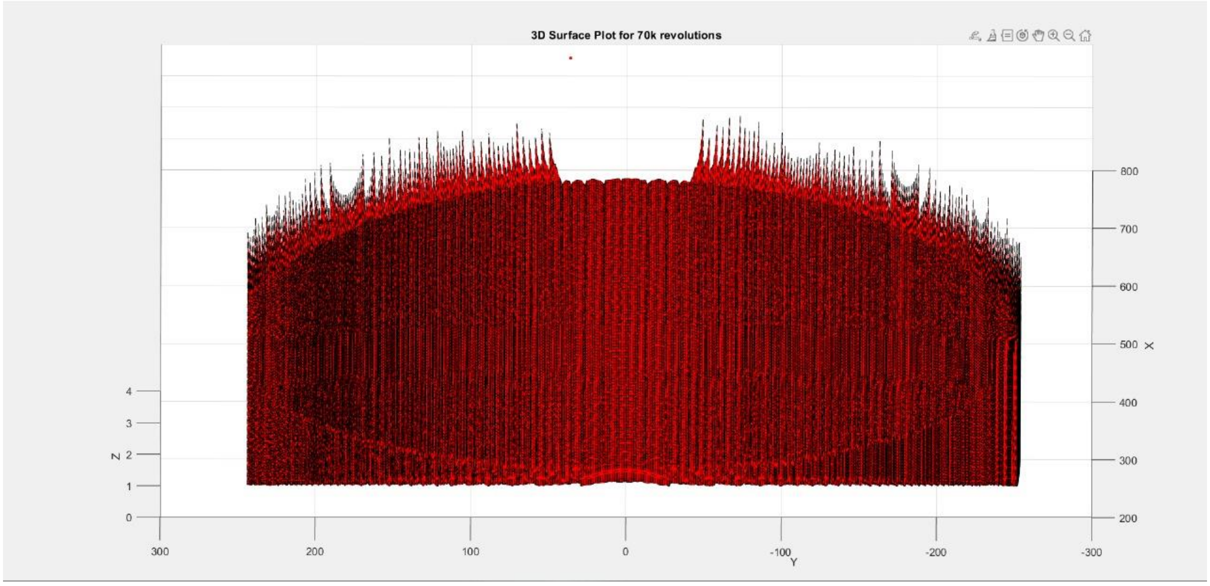


Green line – Cut profile at Centerline

Blue Line – Cut profile at 25 Microns from the edge

Explanation can be given; milling cutter's shape is the reason behind this. Central part of the cutter, have a lower chip load which results in less effective cutting action, whereas the cutting edges on the cutter's outer portions contact with the workpiece more effectively results in more cutting action.

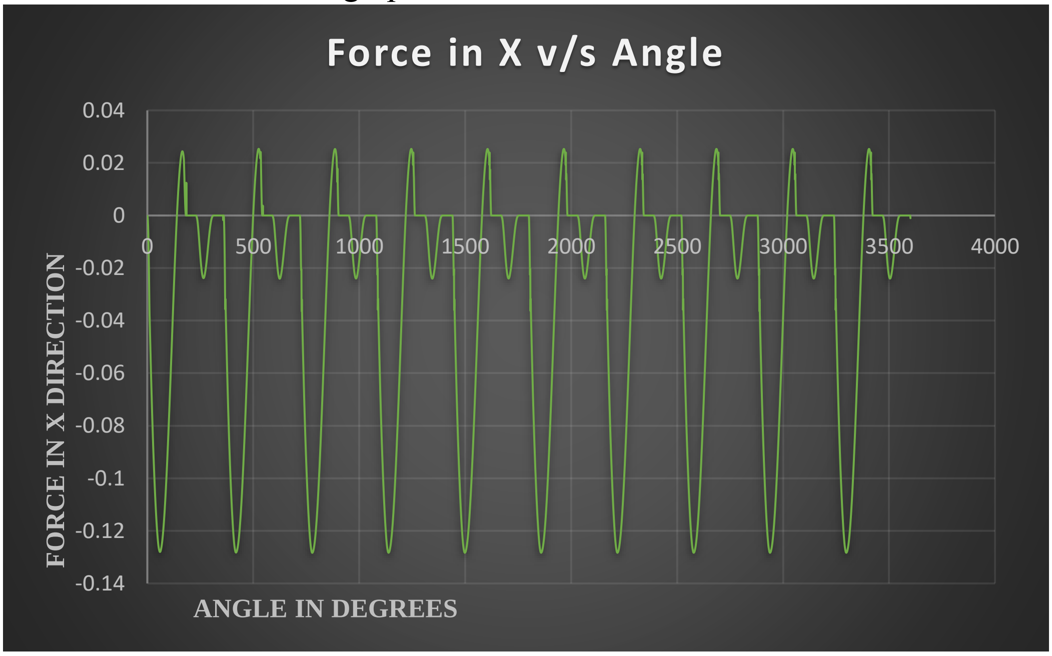
4.

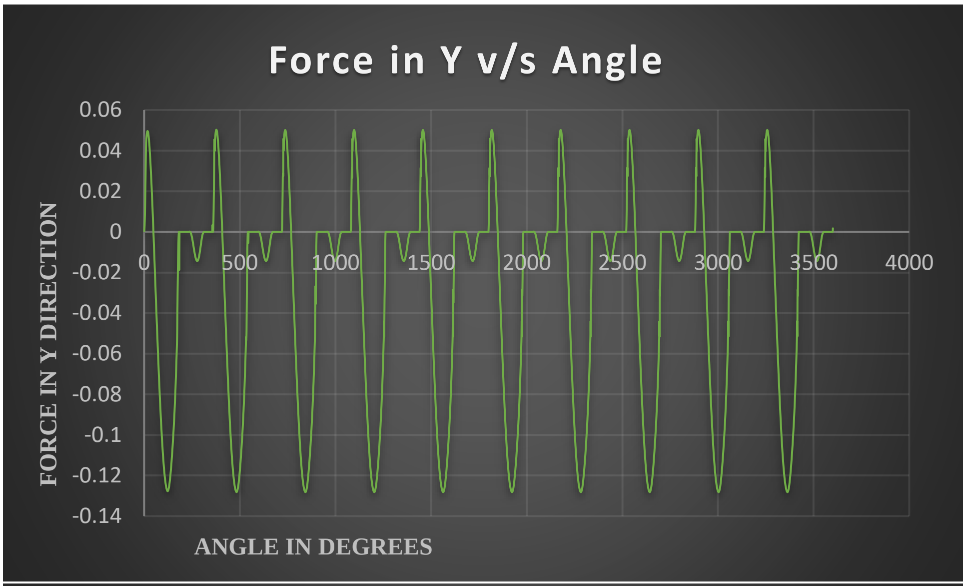


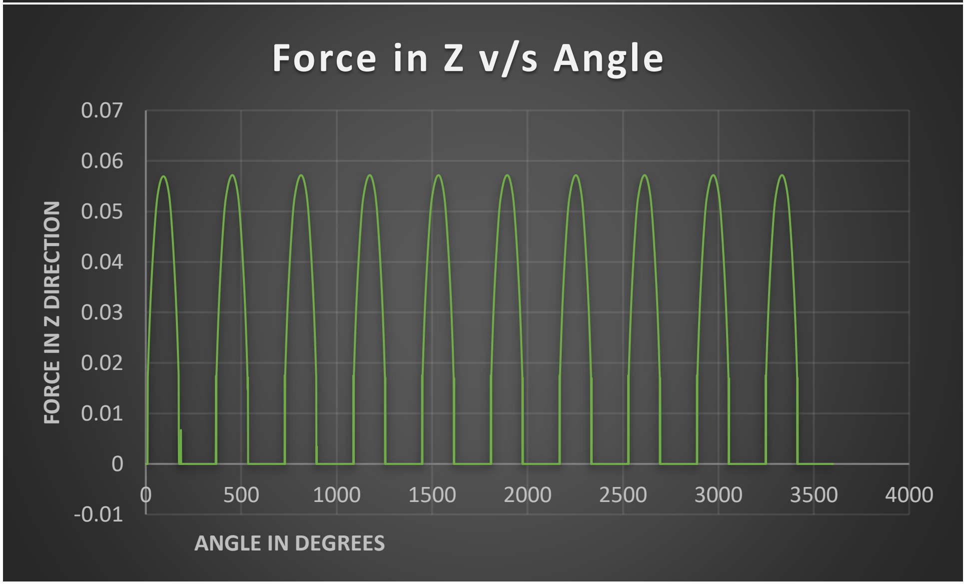
3D Surface plot of machined surface, top view

E. So, now we are changing the value of rpm to 140000;

- The methods to find the graphs will remain same as earlier.







2. Average peak-to-valley forces for 10 revolutions –

Took average of force values achieved in output file-

In x direction; Fx_avg = 0.153638

In y direction; Fy_avg = 0.178322

3. Average tool Deflection over 10 revolutions –

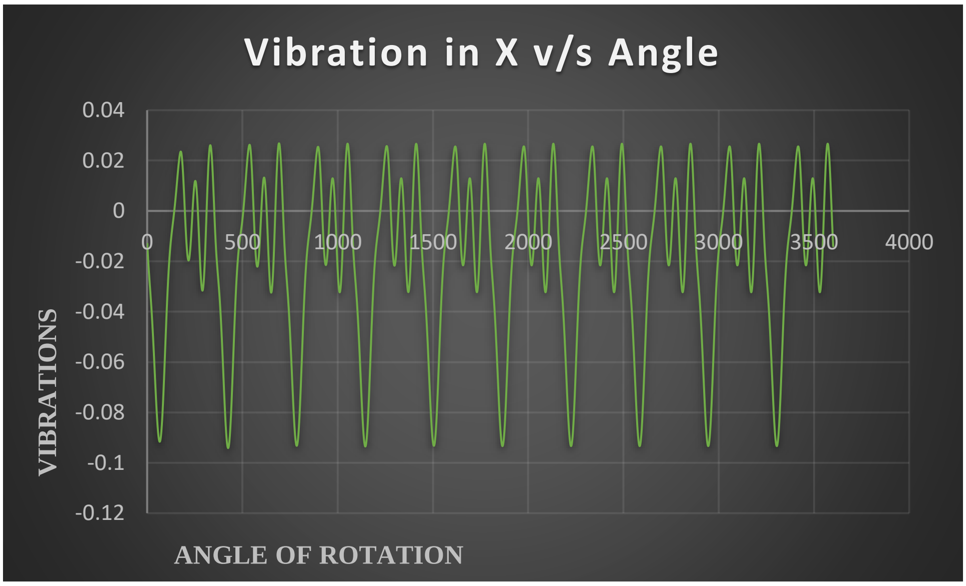
In X Direction; Average vibration - 0.02173

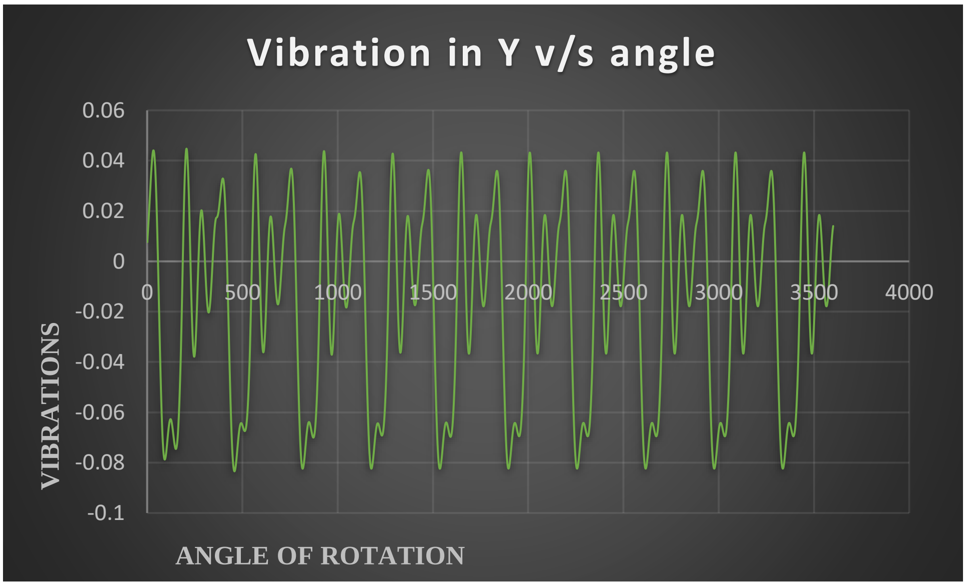
In Y Direction; Average vibration - 0.0015821

The reason for the differences in magnitude in vibration is same as explained earlier.

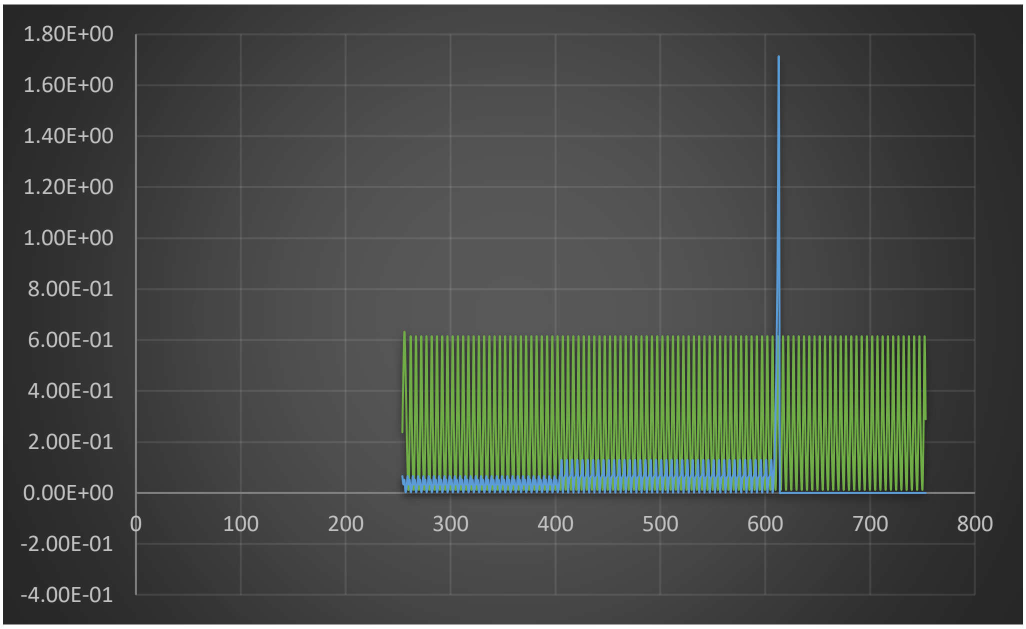
Average cutting forces are still the same as earlier, higher RPM results in higher vibrations.

6. Plots of X and Y Vibrations of the tool over ten revolutions.





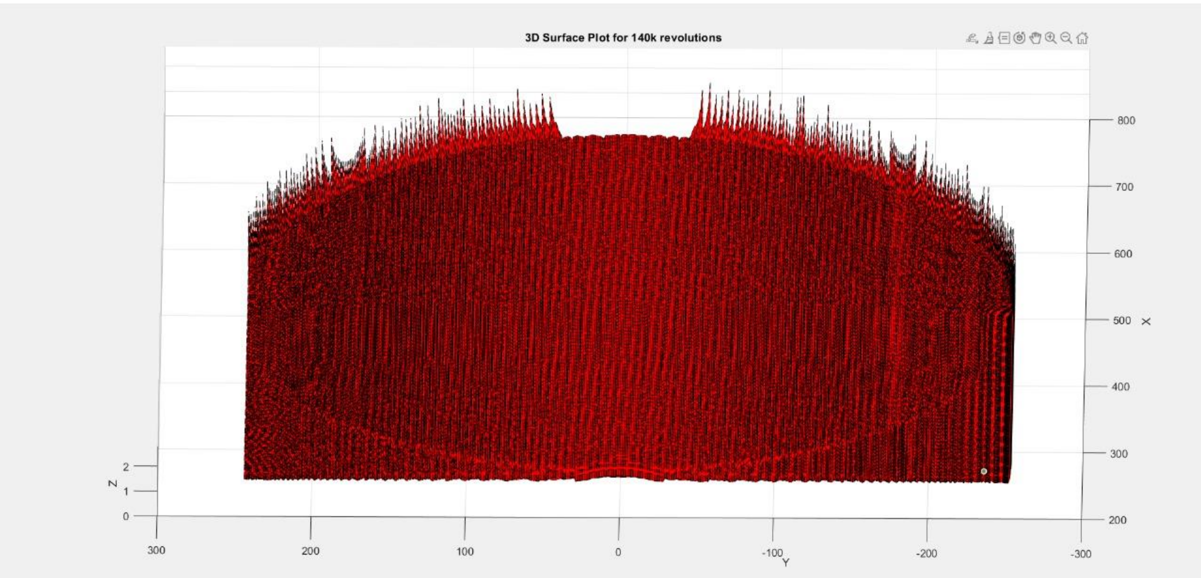
5. Variation of surface profile along the center of slot along the scan 25 microns away from one of the edges.



Green line – Cut profile at Centerline

Blue Line – Cut profile at 25 Microns from the edge

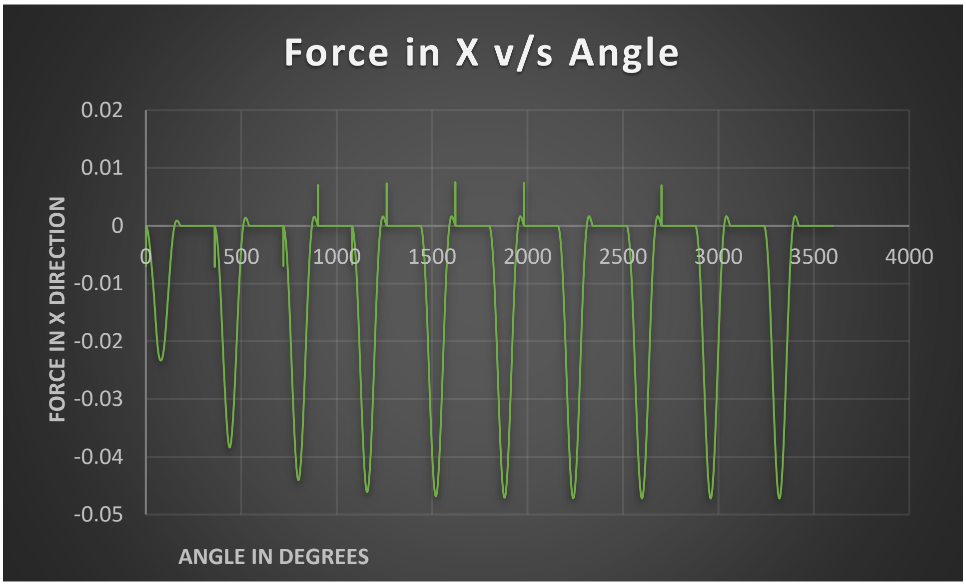
4.

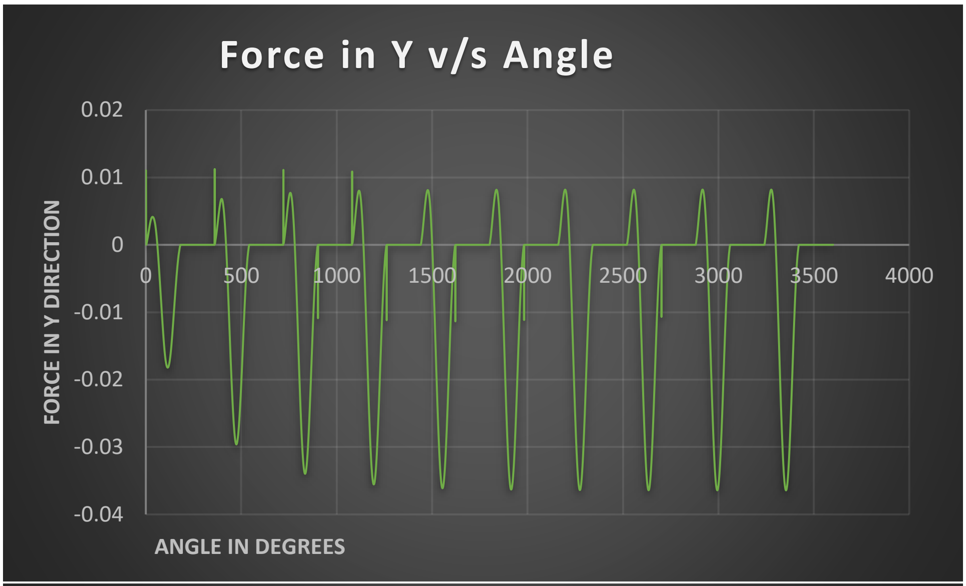


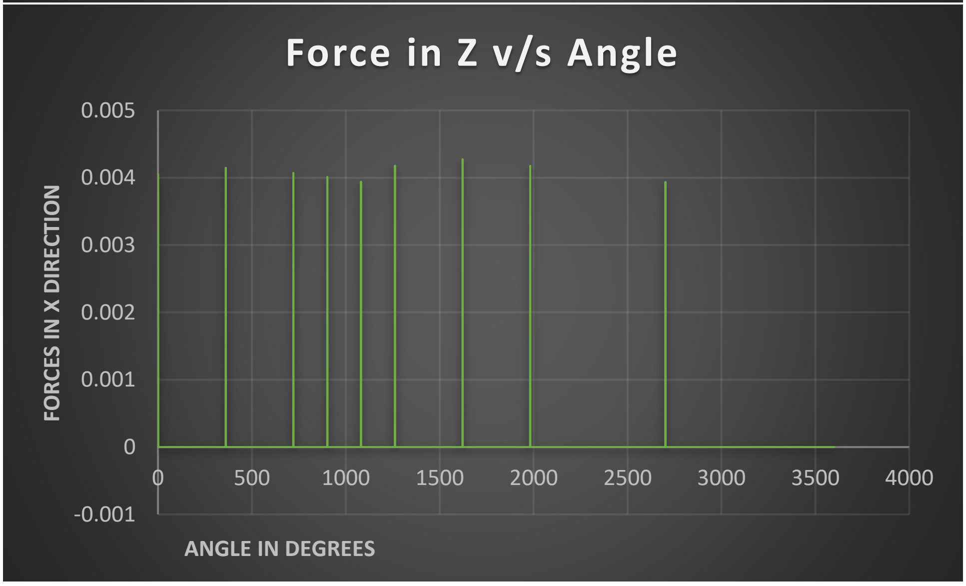
3D Surface plot of machined surface, top view

F. Now we will use 0.25 microns Feed per tooth.

- Forces can be find with the same methods as earlier;







2. Average peak-to-valley forces for 10 revolutions –

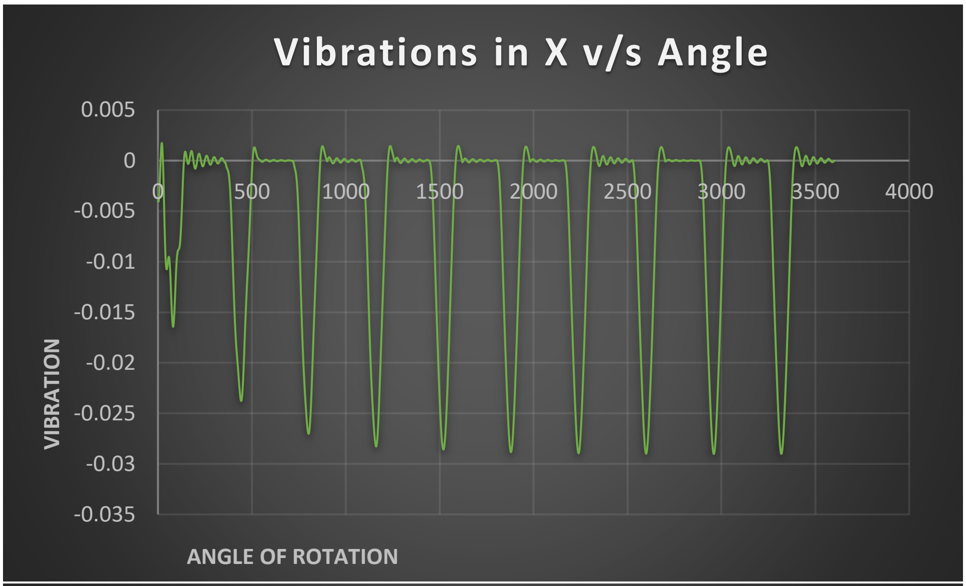
- Took average of force values achieved in output file-

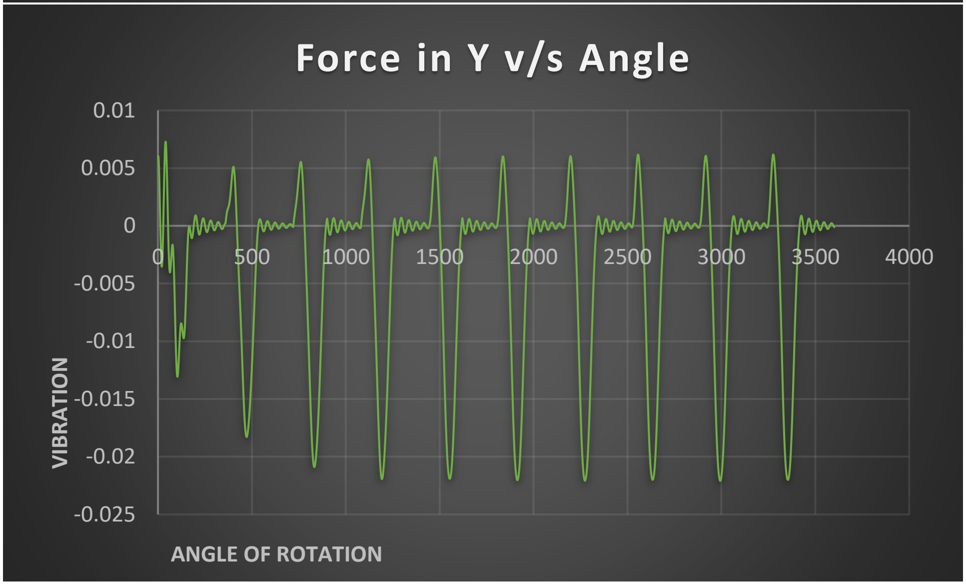
- In x direction; Fx_avg = 0.054198
- In y direction; Fy_avg = 0.044596

3. Average tool Deflection over 10 revolutions –

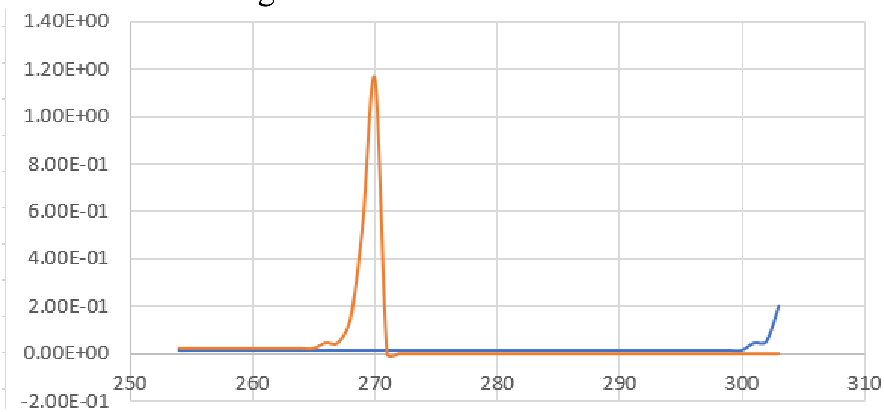
- In X Direction; Average vibration - 0.001735
- In Y Direction; Average vibration - 0.0035

6. Plots of X and Y Vibrations of the tool over ten revolutions.





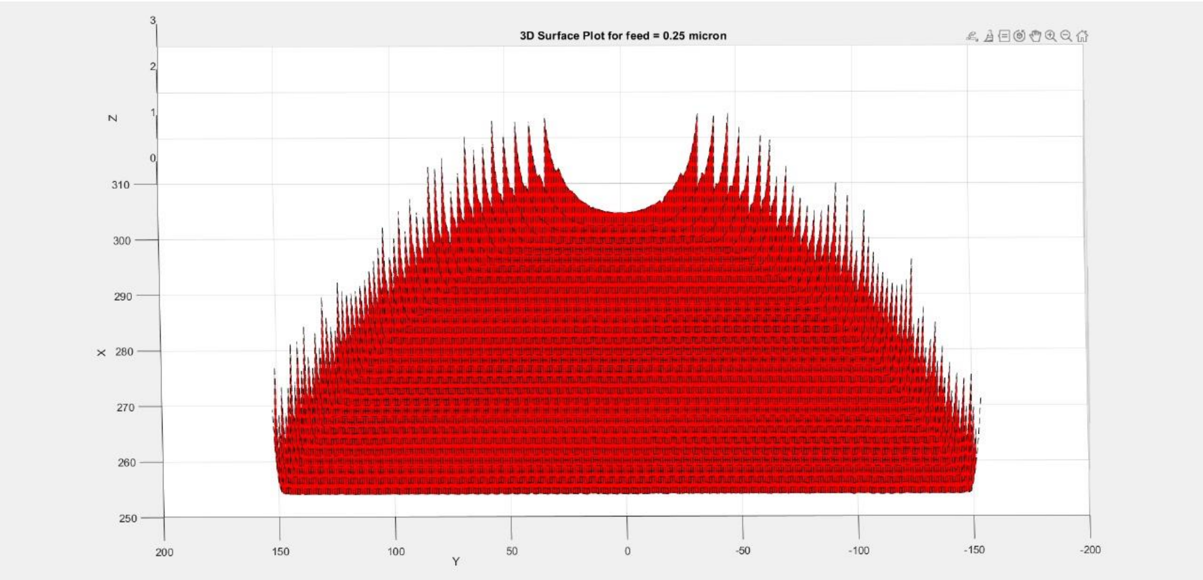
5. Variation of surface profile along the center of slot along the scan 25 microns away from one of the edges



Blue line – Cut profile at Centerline

Orange Line – Cut profile at 25 Microns from the edge

4.

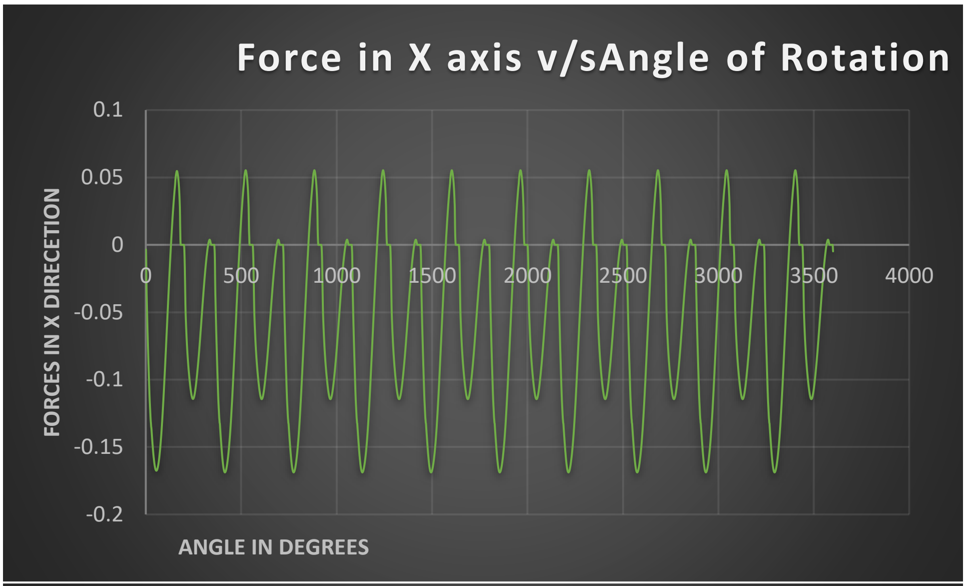


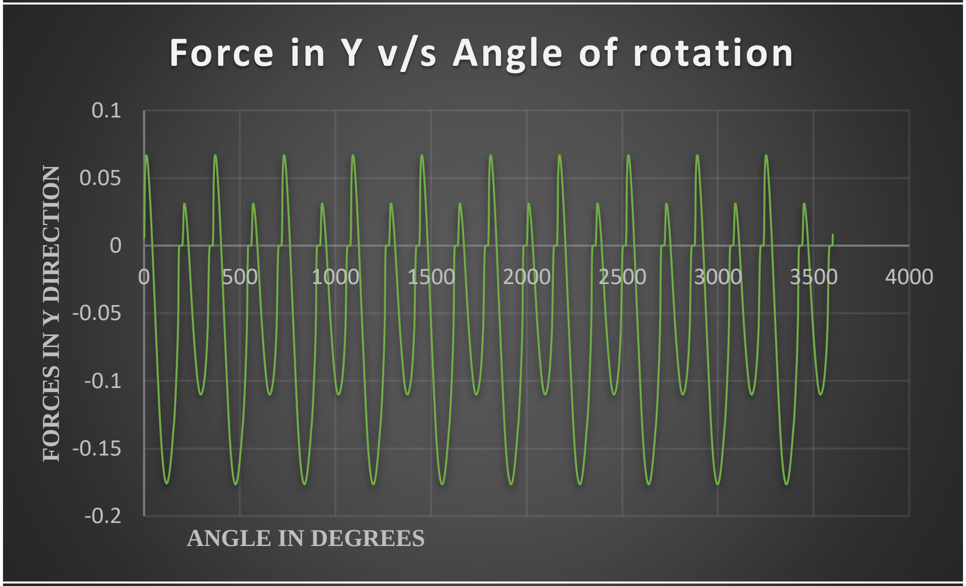
3D Surface plot of machined surface, top view;

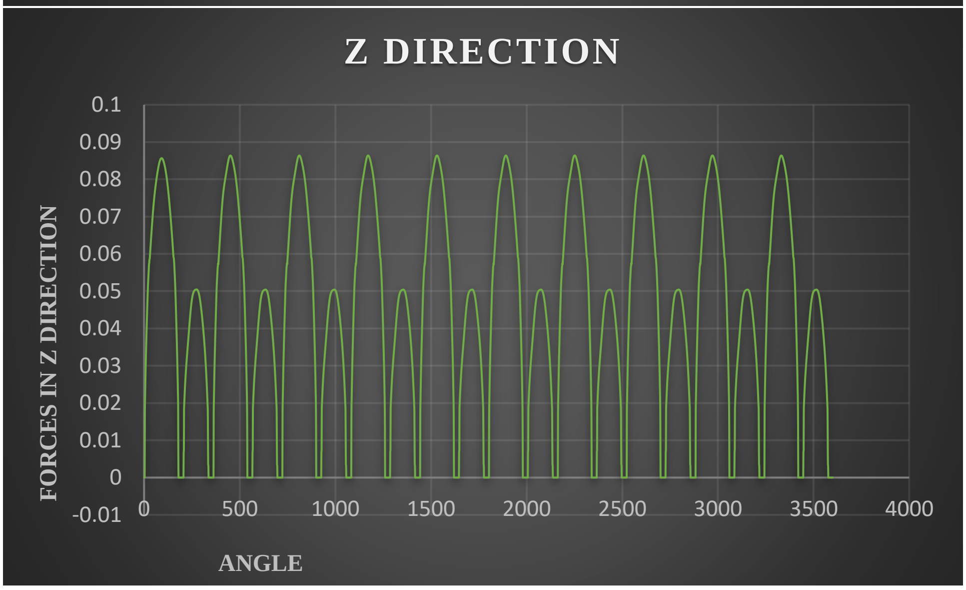
average forces are lower in this case as compared to High FPT.

F. So, now we are keeping the Feed per tooth = 6 Microns

The methods to find the graphs 0f forces will remain same as earlier







2. Average peak-to-valley forces for 10 revolutions –

- Took average of force values achieved in output file-

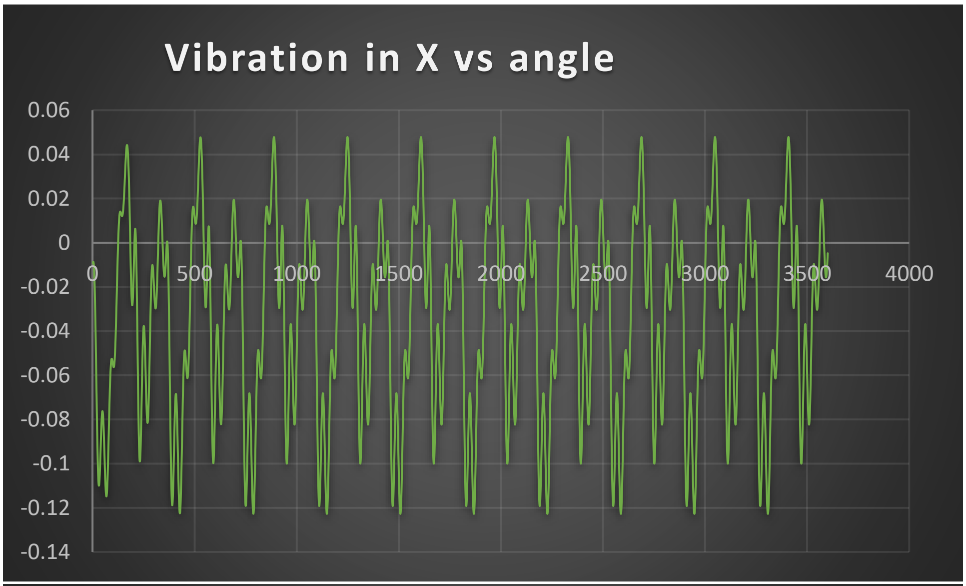
- In x direction; Fx_avg = 0.224131
- In y direction; Fy_avg = 0.243405

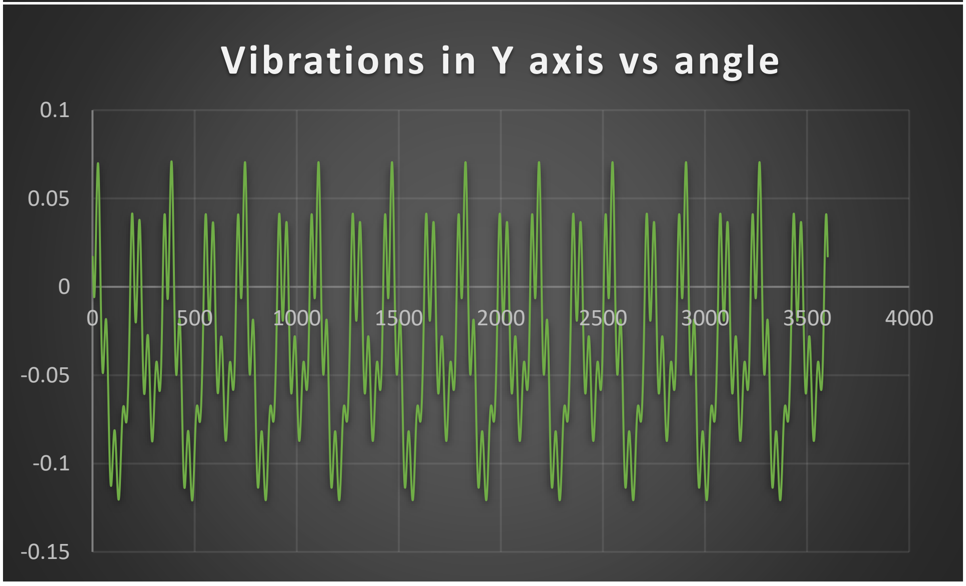
  REASON ALREADY EXPLAINED

3. Average tool Deflection over 10 revolutions –

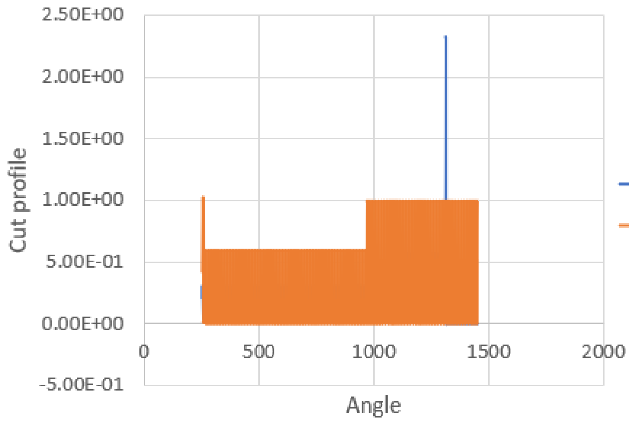
- In X Direction; Average vibration - 0.01271
- In Y Direction; Average vibration - 0.00588

6. Plots of X and Y Vibrations of the tool over ten revolutions;





5. Variation of surface profile along the center of slot along the scan 25 microns away



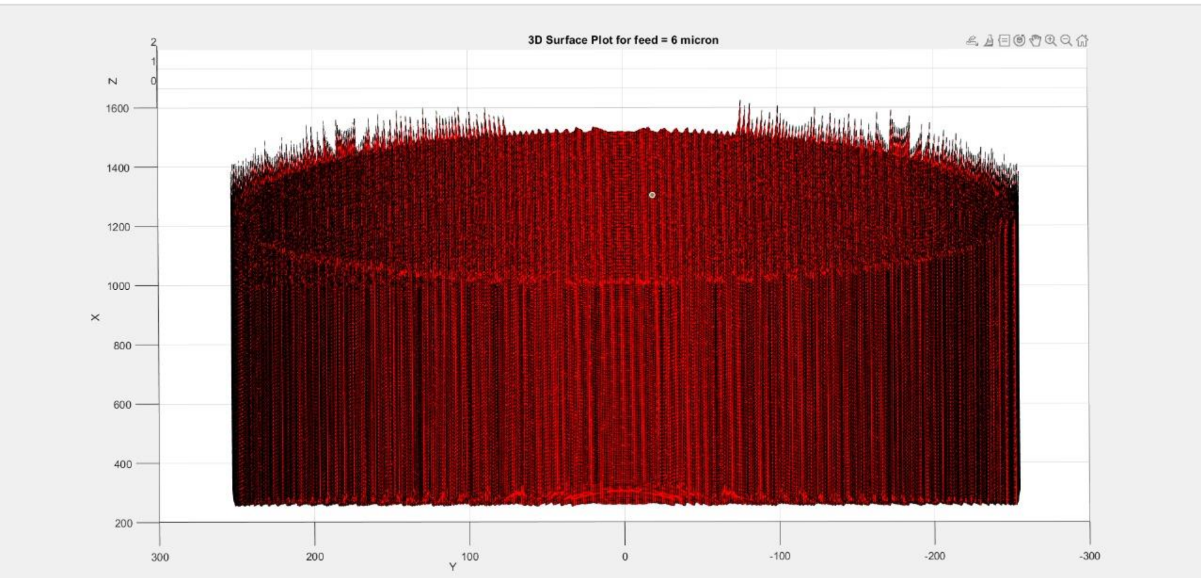
from one of the edges

Blue line – Cut profile at Centerline

Orange Line – Cut profile at 25 Microns from the edge

4. 3D Surface plot of machined surface, top view;

average forces are lower in this case as compared to High FPT.



The 0.5 microns feed case results in an incredibly smooth surface. Less than 1% of the centre axis's length varies on each side. However, strong cutting forces, vibrations, and surface roughness can be seen when the thickness is 6 microns.