Department of Mechanical & Mechatronics Engineering

ME 548 Project 2: Simulation and Measurement of End Milling Forces

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Figures and Tables

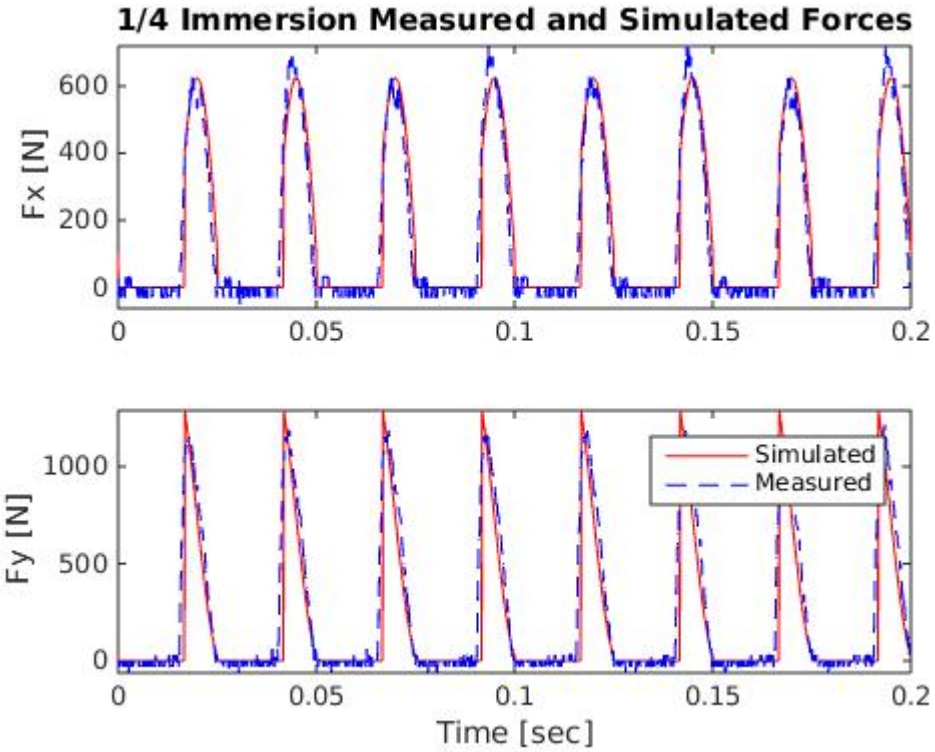

Figure 1: Quarter Immersion with Measured and Simulated Forces

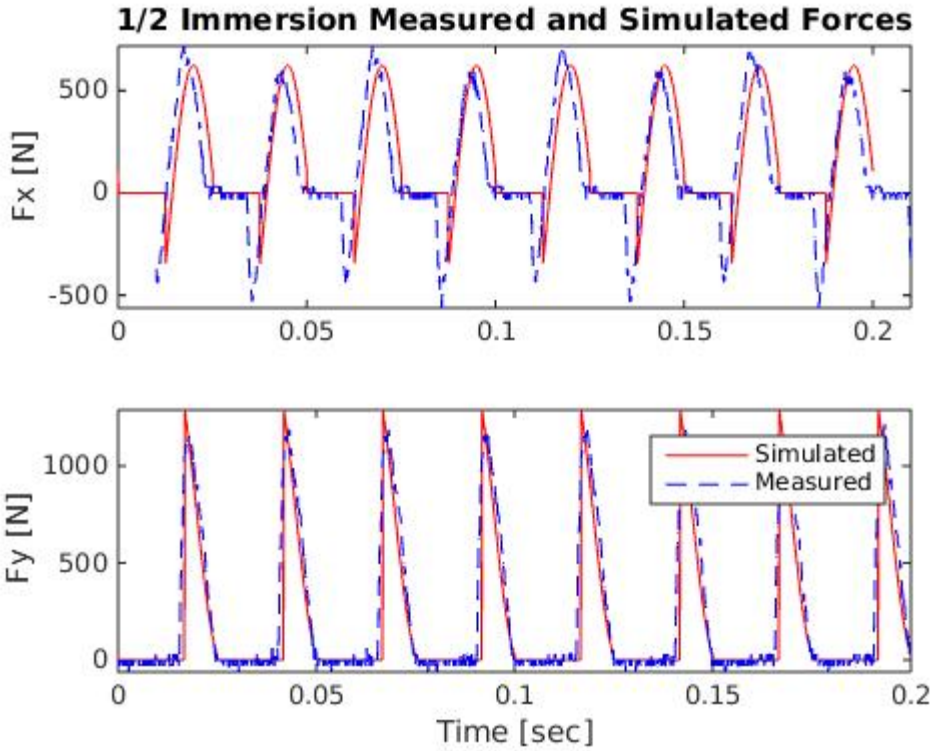

Figure 2: Half Immersion Measured and Simulated Forces

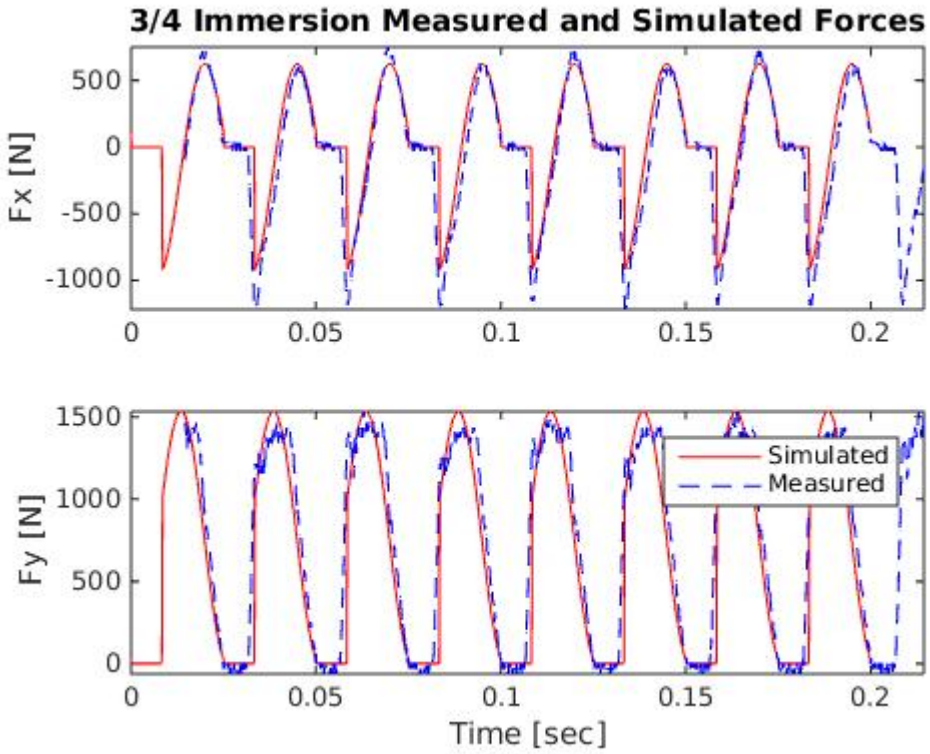

Figure 3: Three Quarter Immersion Measured and Simulated Forces

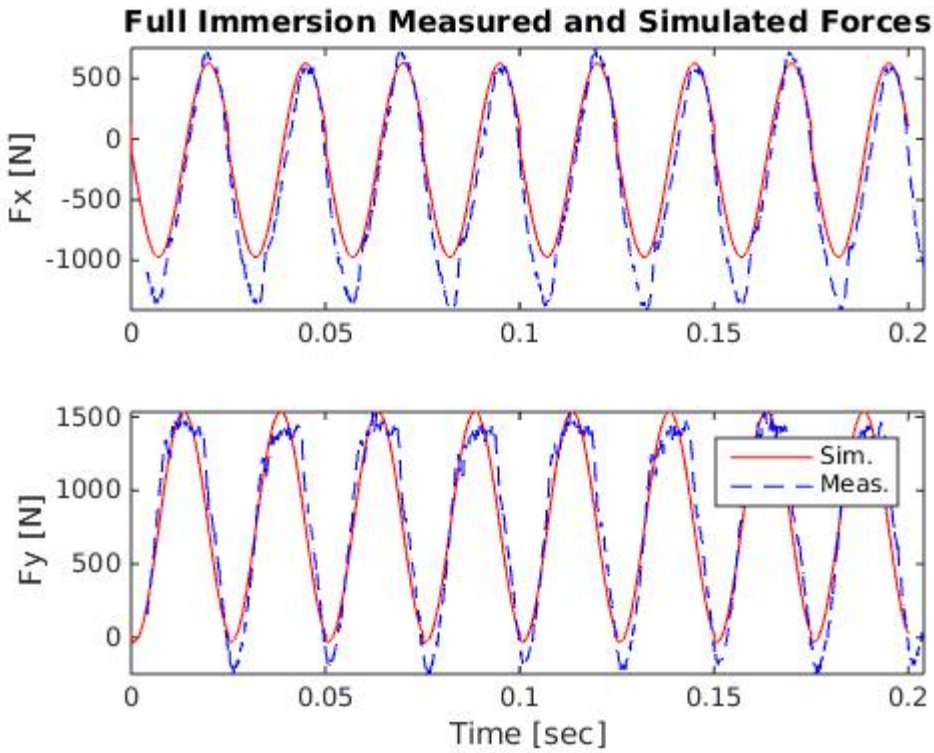

Figure 4: Full Immersion Measured and Simulated Forces

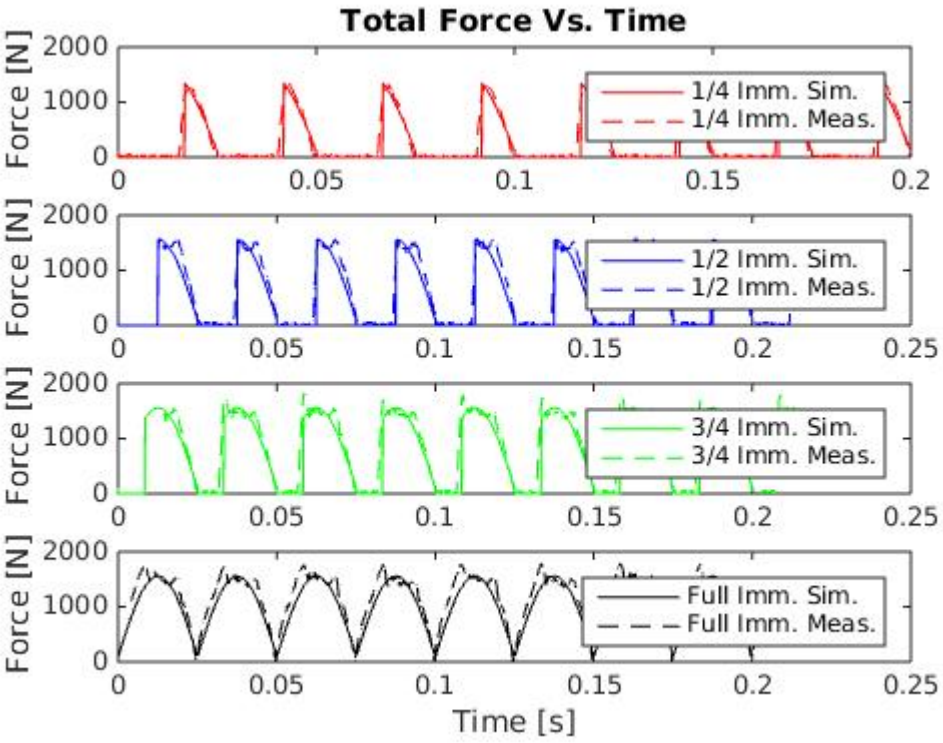

Figure 5: Total Forces for all Immersions with Time

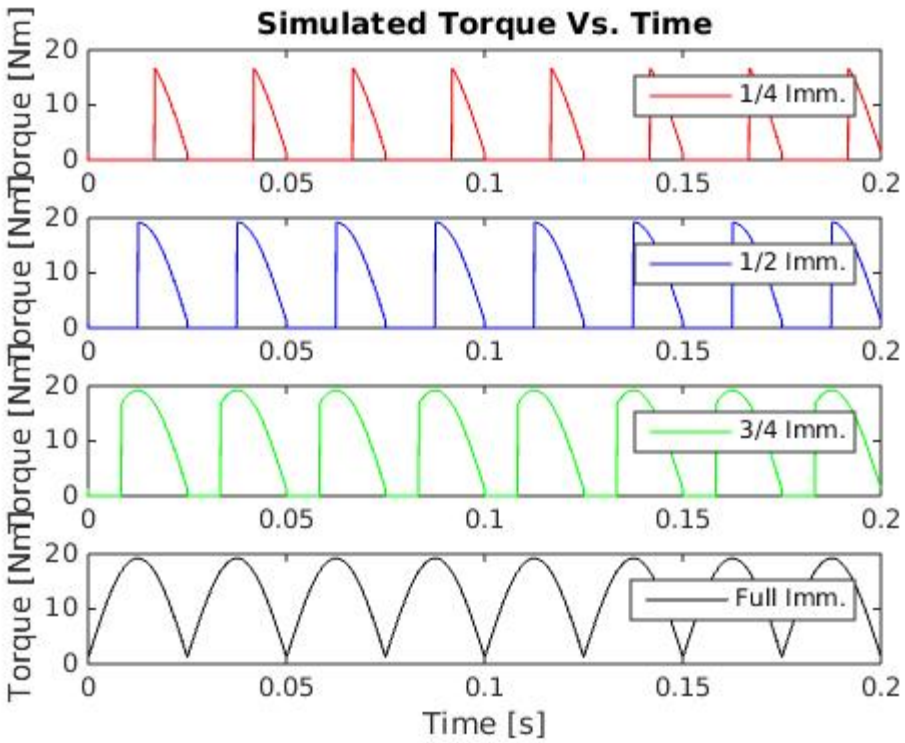

Figure 6: Simulated Torques for all Immersions with Time

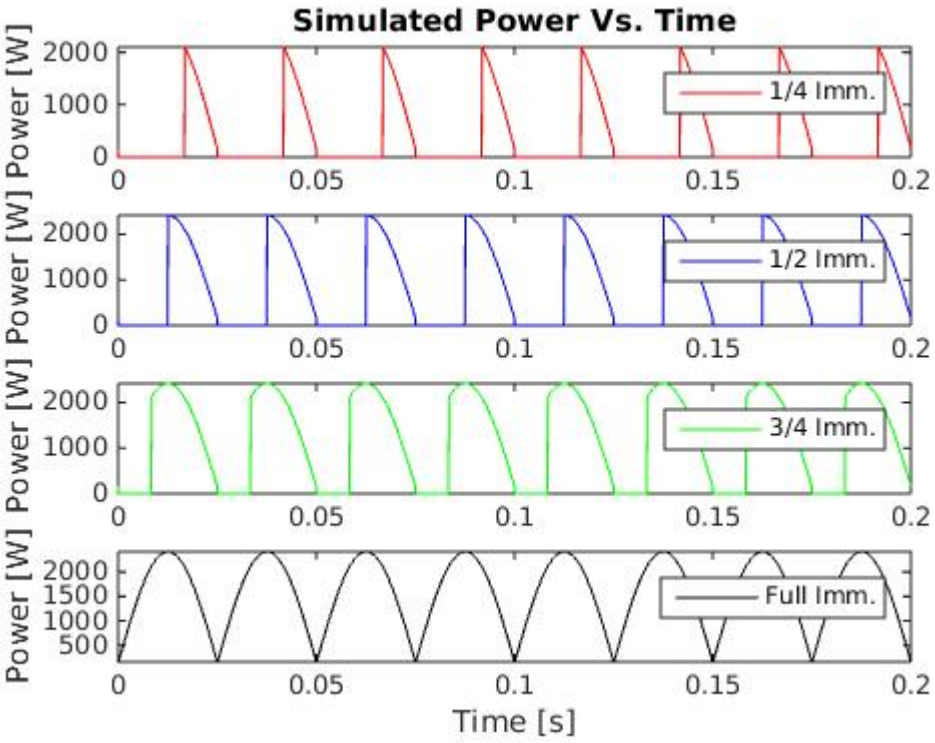

Figure 7: Simulated Power for All Immersions with Time

Comparing Simulated and Measured Data

Quarter Immersion:

- Figure 1 is the graph for Fx and Fy of the quarter immersion simulation
- Simulated and measured are almost the same with some variation in the measured
- This could be caused by vibration of the workpiece during measurement of the dynamometer
- Figure 5 is the graph of total force for all the immersions
- Looking at the quarter immersion total force, simulated and measured are very close to each other
- Torque and power respectively for quarter immersion are given in figure 6 and figure 7

Half Immersion:

- Figure 2 is the graph of Fx and Fy of the half immersion simulation
- Note that the Fx is slightly more distorted when compared to the quarter immersion
- This could be caused by the higher forces on the dynamometer and increased vibrations
- The Fy graph looks quite accurate
- The total force for half immersion in figure 5 is noted to be slightly shifted when compared to the quarter immersion
- Torque and power respectively for half immersion are given in figure 6 and figure 7

Three Quarter Immersion:

- Figure 3 is the graph of Fx and Fy of the three quarter immersion simulation

- The simulated and measured line up pretty well as shown in the graphs
- The total force for three quarter in figure 5 is noted to be slightly more shifted when compared the the half immersion and even more when compared to the quarter immersion
- Torque and power respectively for half immersion are given in figure 6 and figure 7

Full Immersion:

- Figure 4 is the graph of Fx and Fy of the full immersion simulation
- Simulation and measured are pretty close to eacher
- The total force for full immersion in figure 5 is noted to be slightly more shifted when compared to the three quarter immersion
- Torque and power are shown respectively for full immersion in figure and figure 7

In general the plots are fairly accurate when if tool wear and measurement/vibrational noise are considered.

Comparing the Four Test Cases:

- Similar Fy profiles
- Changing Fx profiles from case to case but can be explained by how the tool hits the workpiece
- Total force (figure 5) shows an expanding profile from quarter to full immersion where the full immersion is a sinusoidal wave
- As expected, torque shows a similar profile to total force (multiplied by the angular speed which is a constant)
- Power also has the same profile has torque and total force again because of multiplying in just constants
    - Note that all the immersions have the about the same peak power