RIYA Week 9 Presentation

Comparison of Experimental Results with Simulation Results - Part 3

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Tasks Accomplished

- Tuning the **damping coefficient** in order to match the motion transmissibility peaks obtained in simulation as well as experiment
- Simulated the dynamics of the two-spring stack for different values of **Coulomb friction** and compared the simulation and experimental results
- Simulated the dynamics of the two-spring stack for different **mixed damping conditions** and compared the simulation and experimental results
- Performed simulations for the conditions in **Experiment 2** (using the spring and damping parameters obtained in Experiment 1), and compared the results.

Tuning the Damping Coefficient

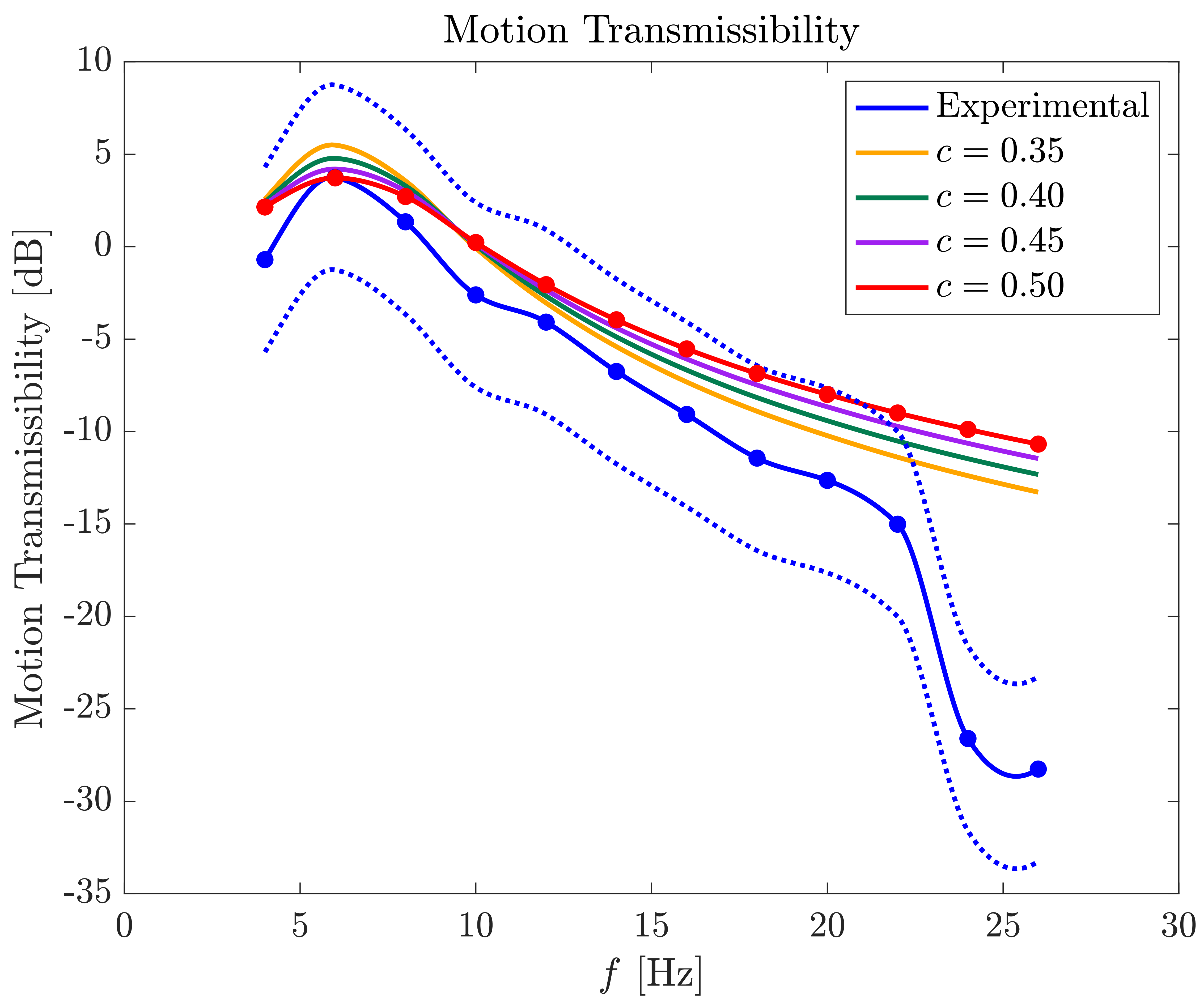

Figure - Motion Transmissibility Curves for different values of c

- Peaks match at $c \approx 0.5$ Ns/mm
- As the value of c increases, the value of Motion Transmissibility
    - Increases in the high frequency region (15-25 Hz)
    - Decreases in the low frequency region (4-10 Hz)

Simulation with Coulomb Friction

PARAMETERS -

- $h_1/\tau = h_2/\tau = 1.41$
- $E = 210$ GPa
- $m = 11.2$ kg
- $\mu = 0.04$ (Magnitude of Coulomb Friction = $\mu m g$)
- $x_{base}(t) = 0.25\sin(2\pi f t)$ (in mm)

f is the frequency of the base excitation, which is varied from **4 Hz to 26 Hz** at intervals of **2 Hz**

Case 1 - $f = 4$ Hz

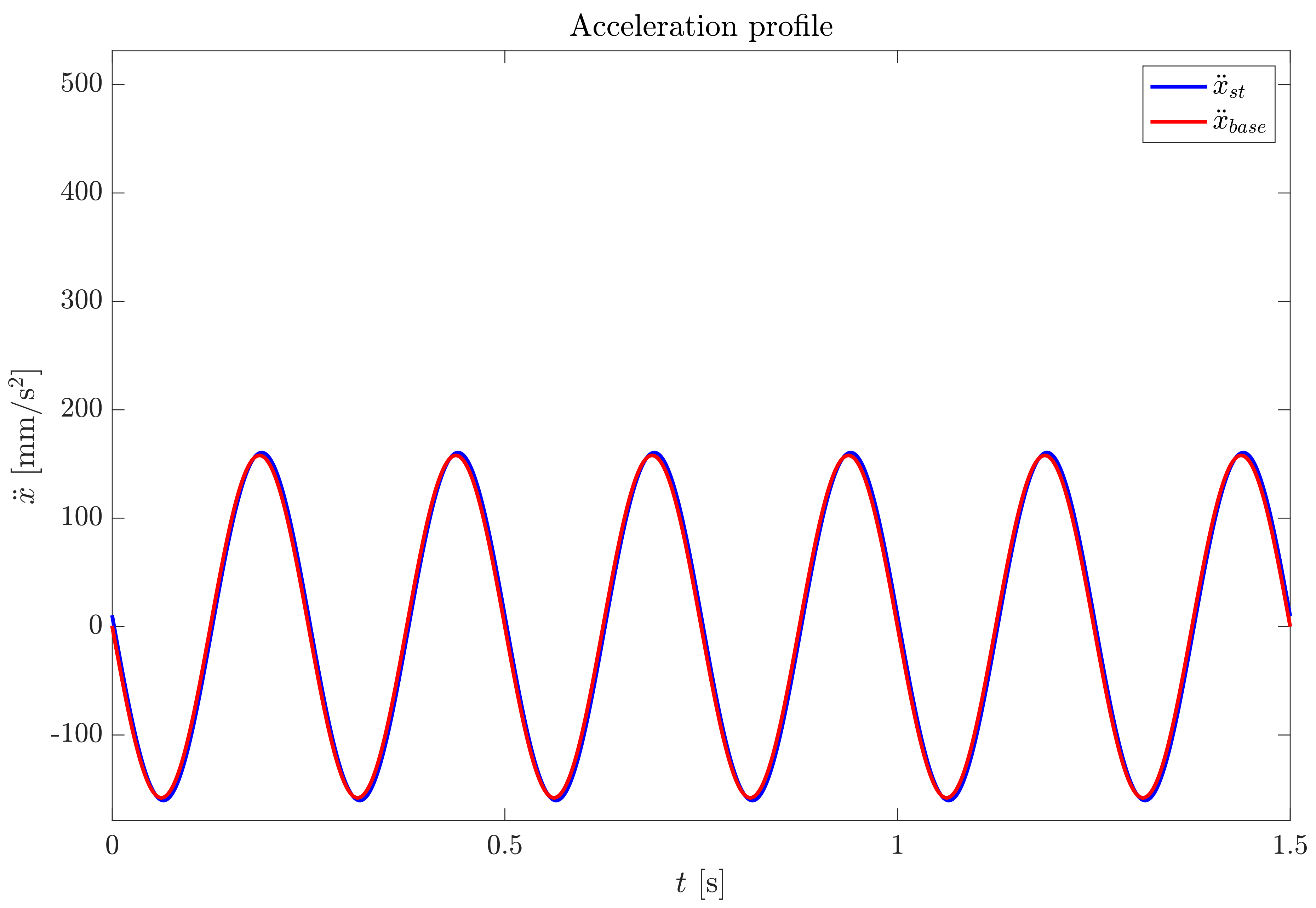

Figure - Simulation result for $f = 4$ Hz

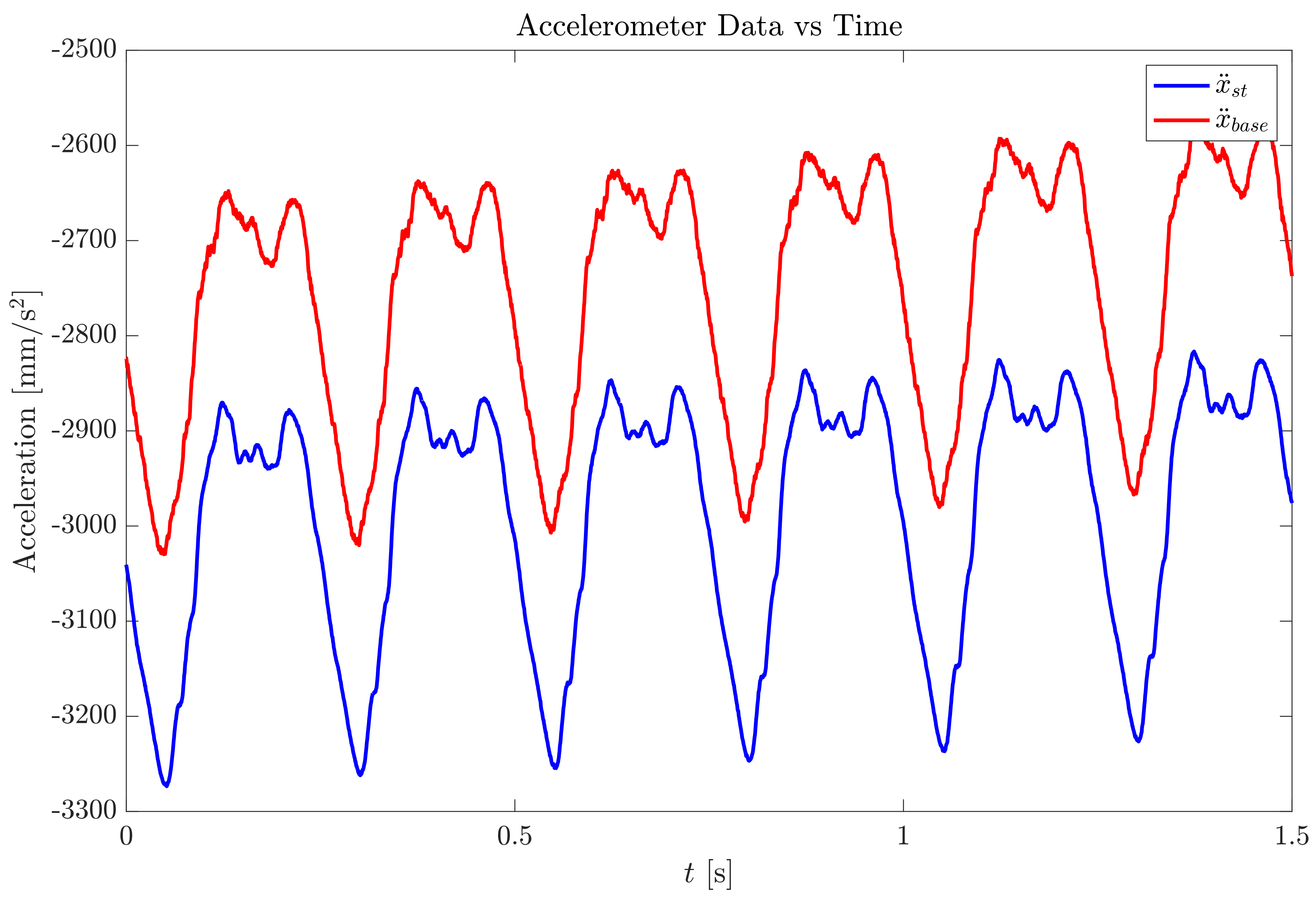

Figure - Experiment result for $f = 4$ Hz

Case 2 - $f = 6$ Hz

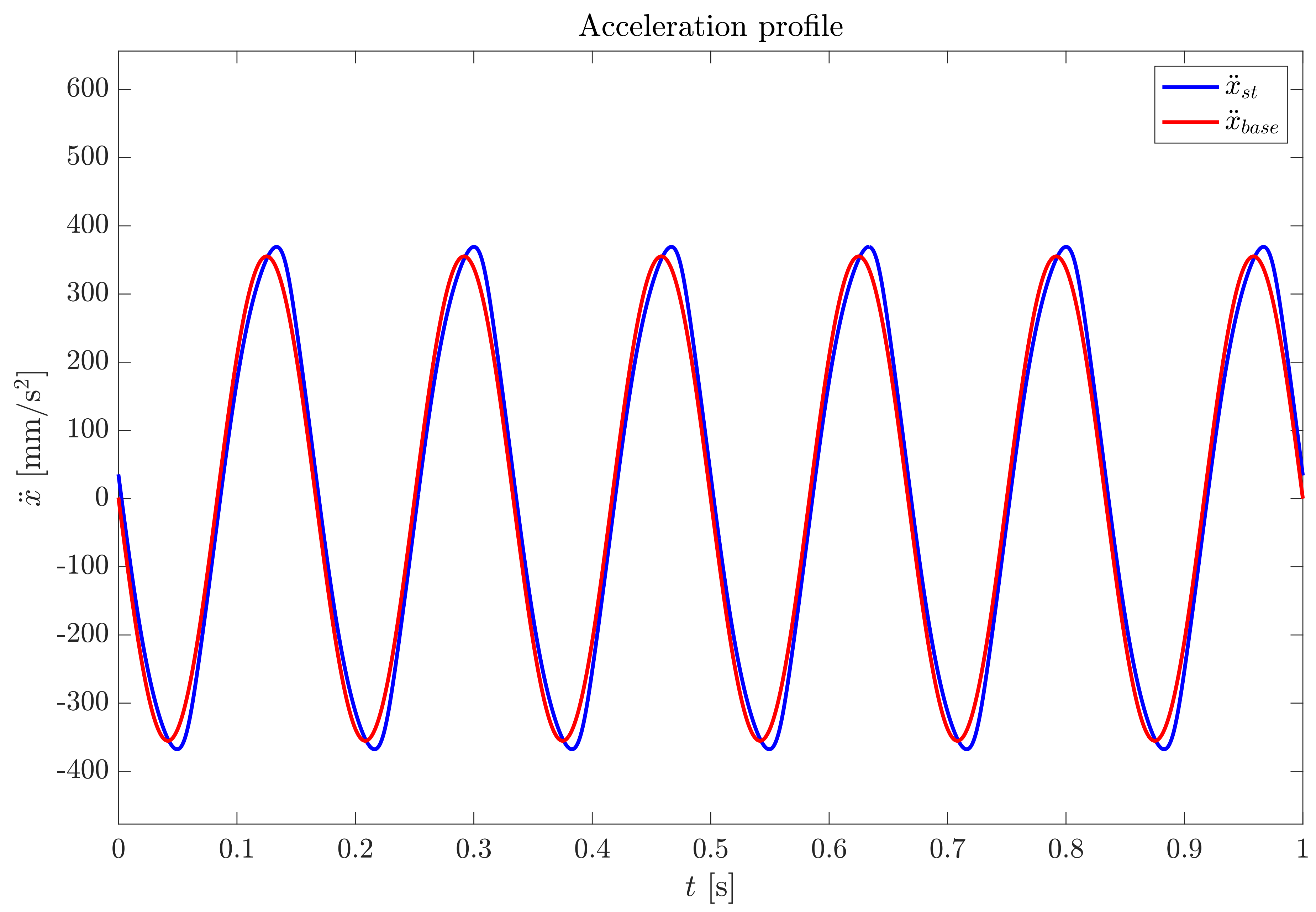

Figure - Simulation result for $f = 6$ Hz

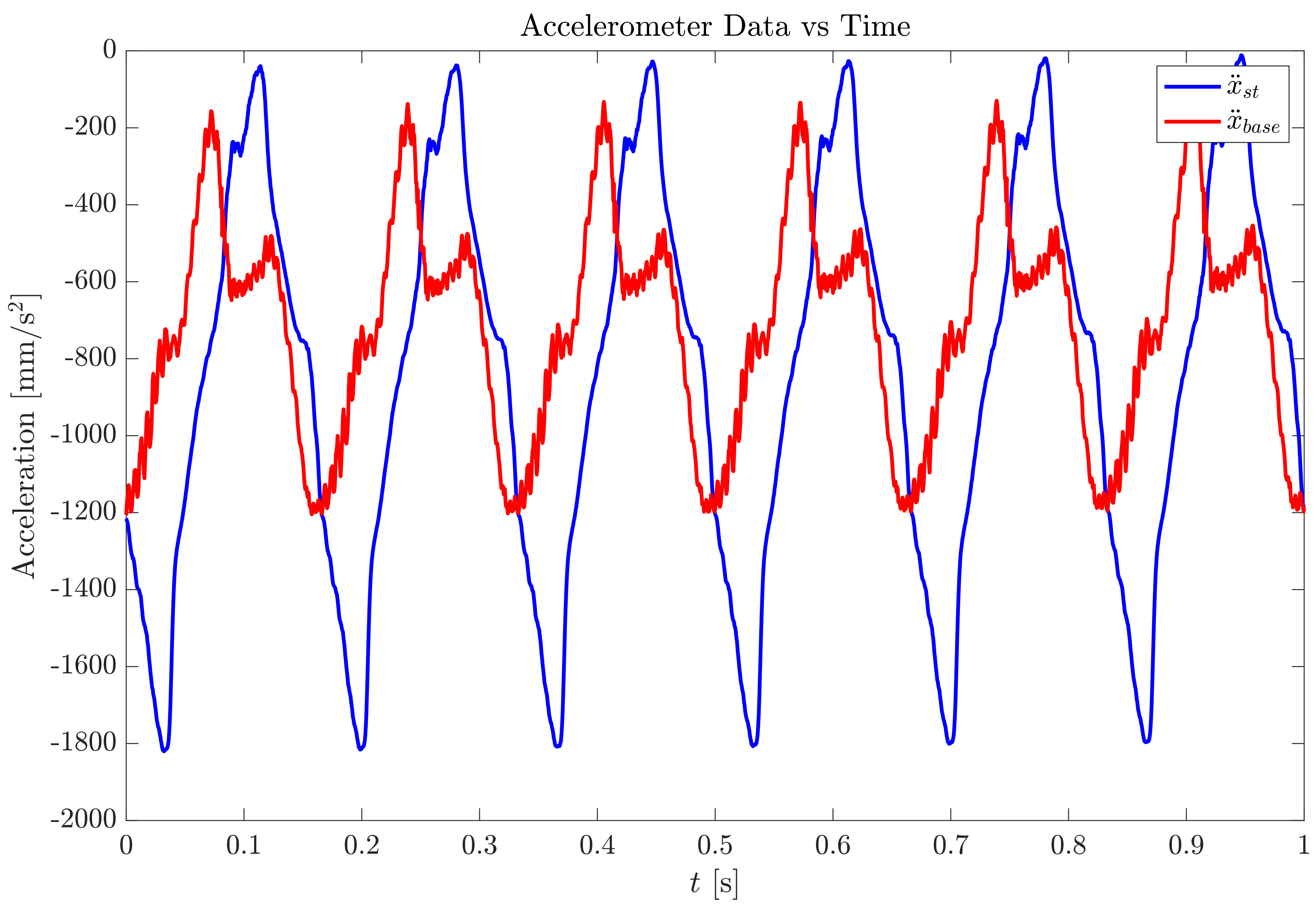

Figure - Experiment result for $f = 6$ Hz

Case 3 - $f = 8$ Hz

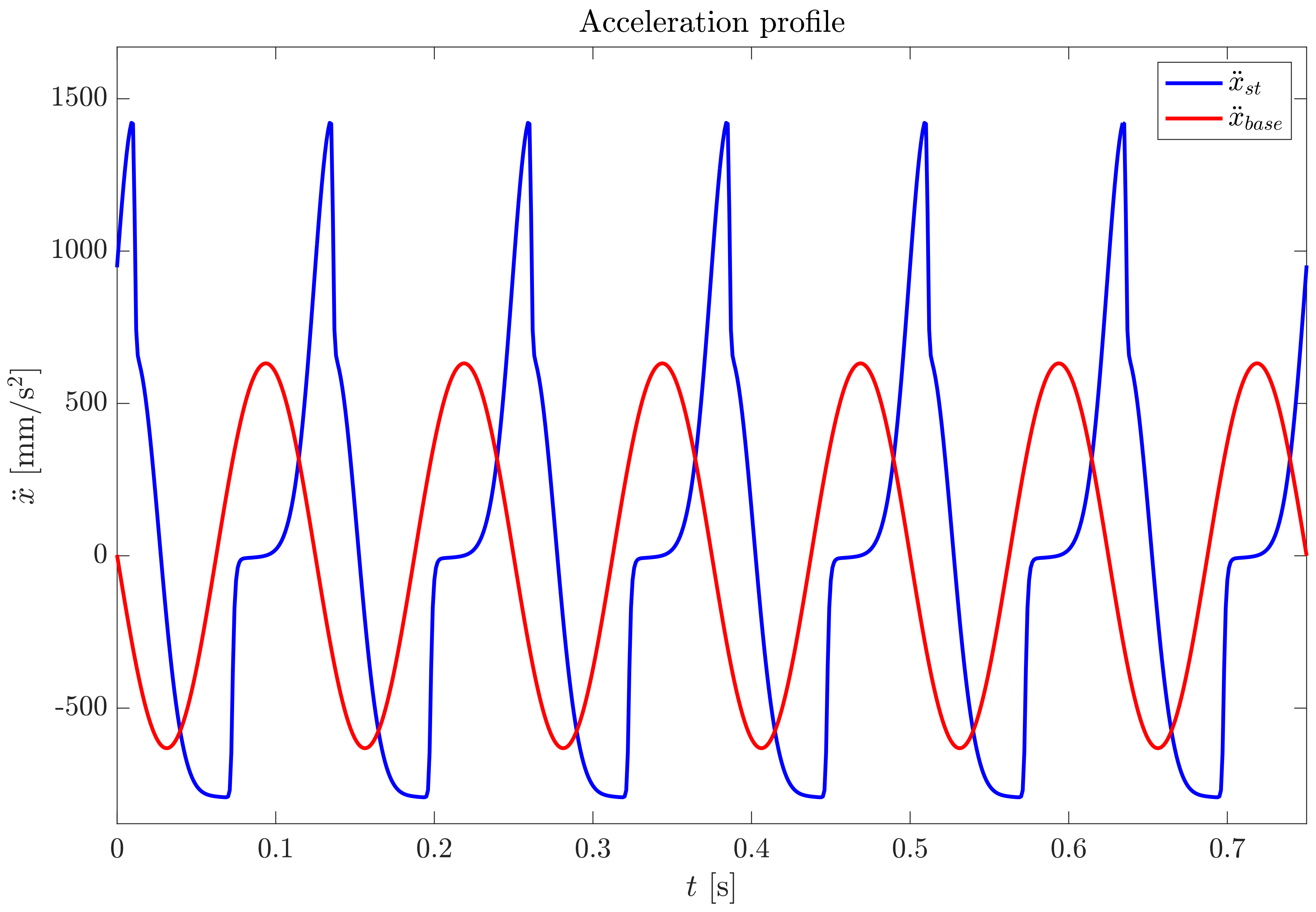

Figure - Simulation result for $f = 8$ Hz

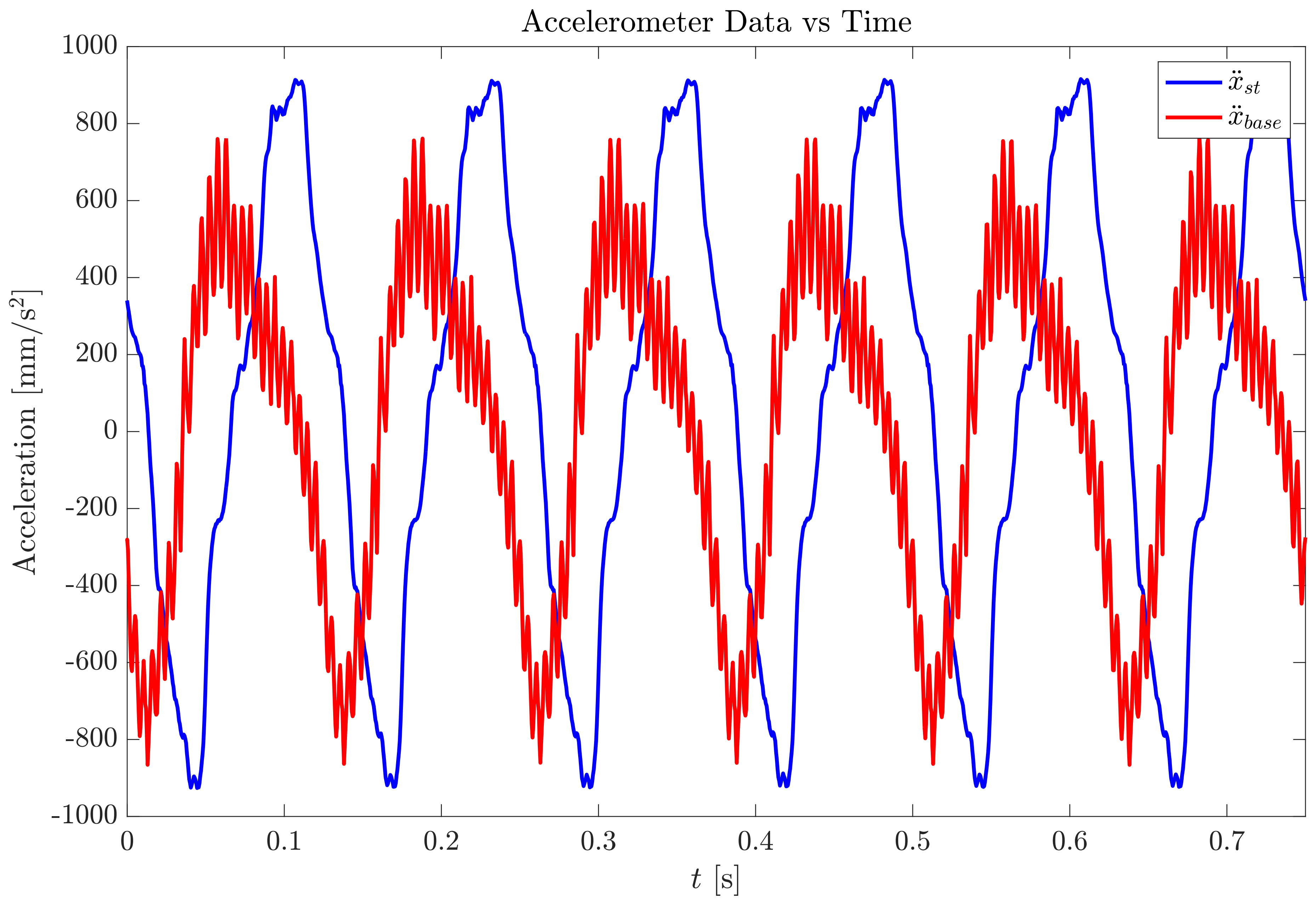

Figure - Experiment result for $f = 8$ Hz

Case 4 - $f = 10$ Hz

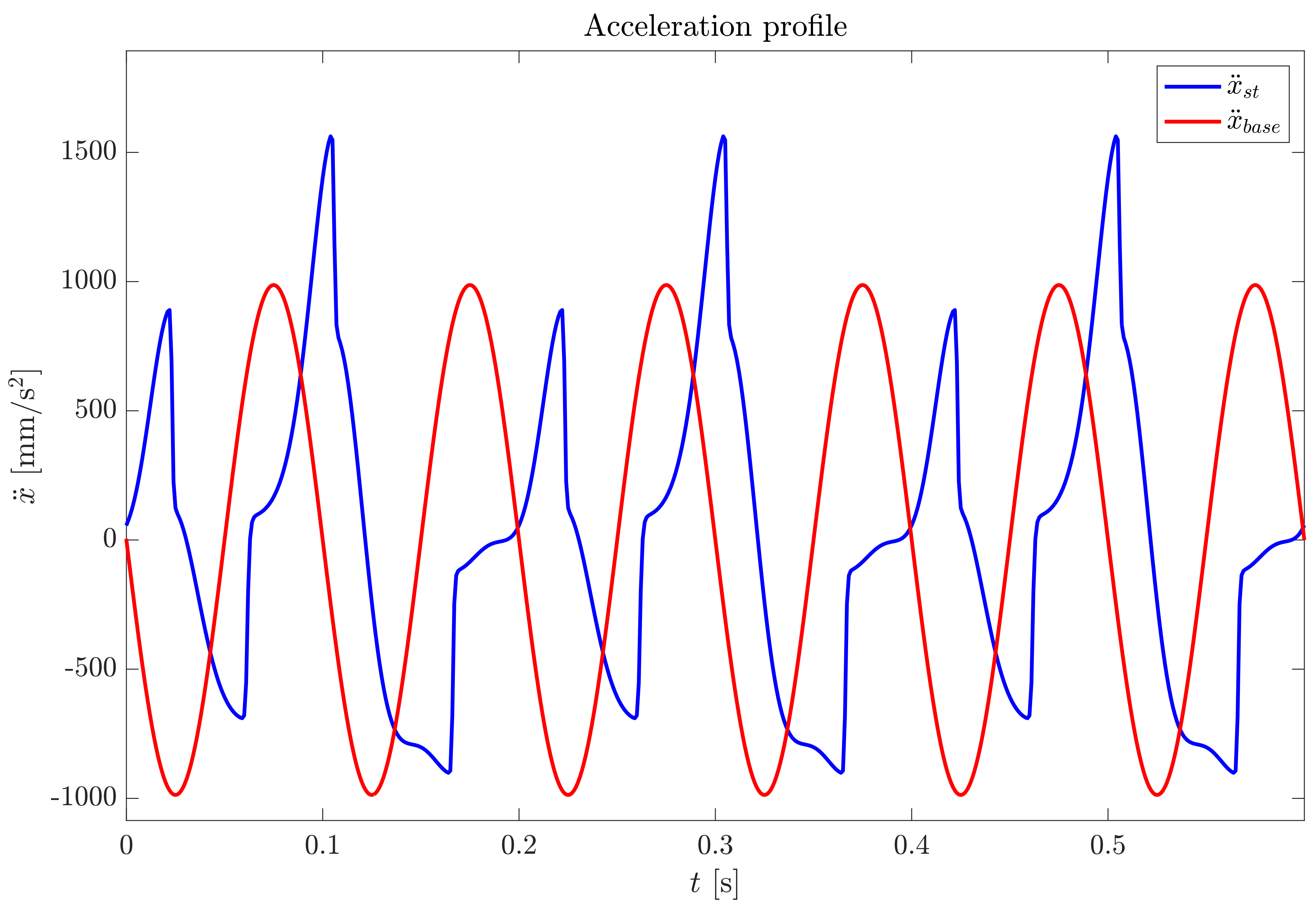

Figure - Simulation result for $f = 10$ Hz

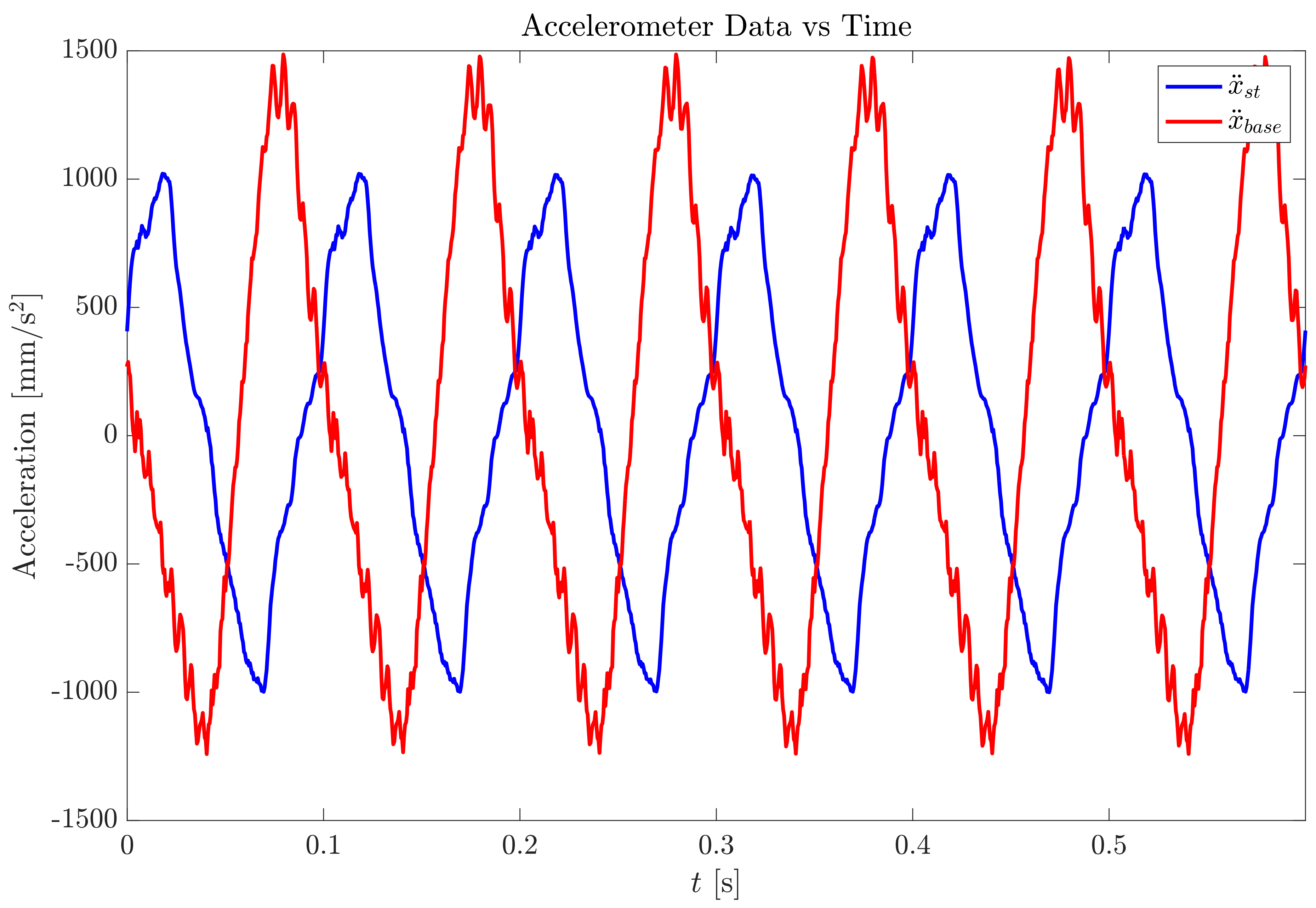

Figure - Experiment result for $f = 10$ Hz

Case 5 - $f = 12$ Hz

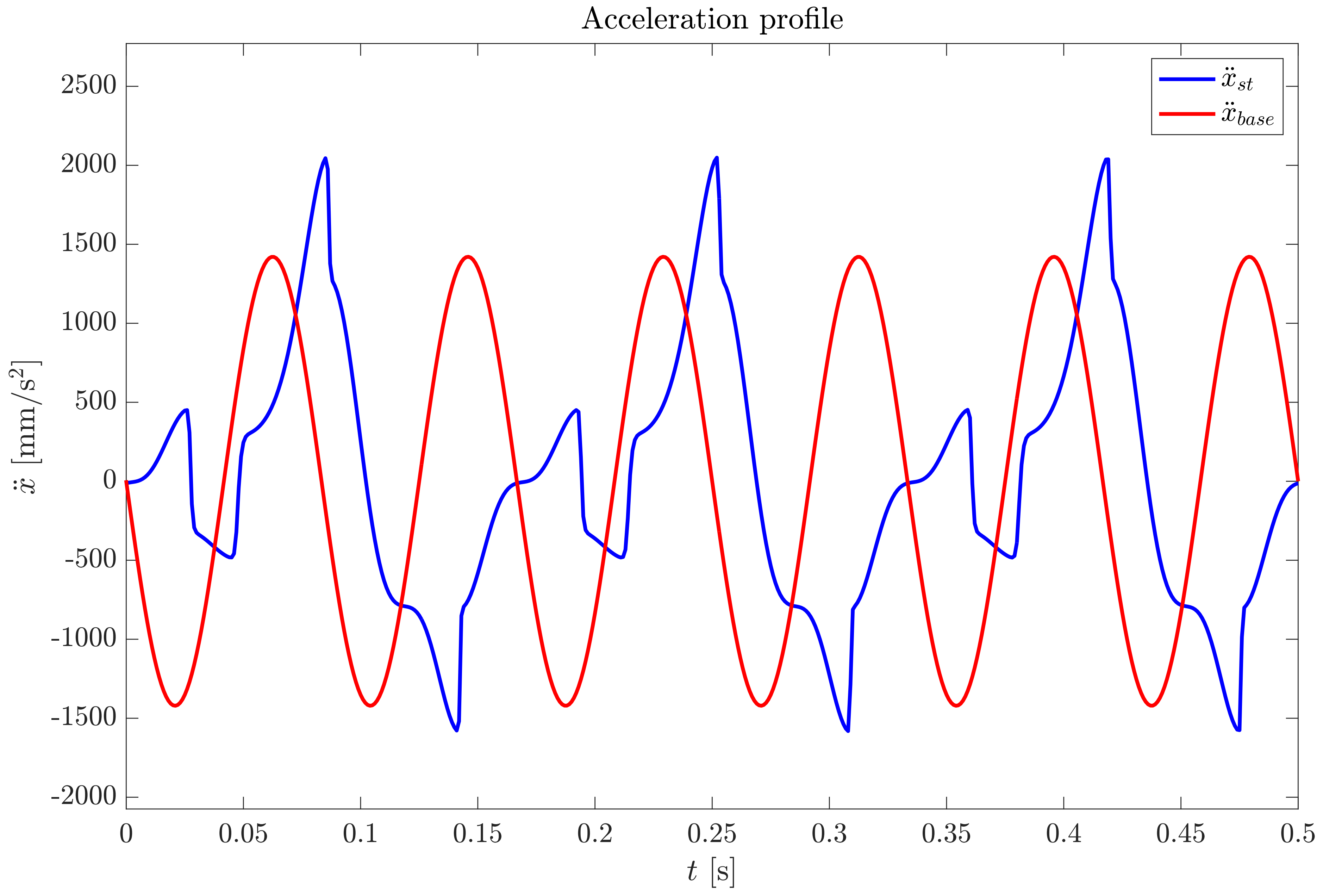

Figure - Simulation result for $f = 12$ Hz

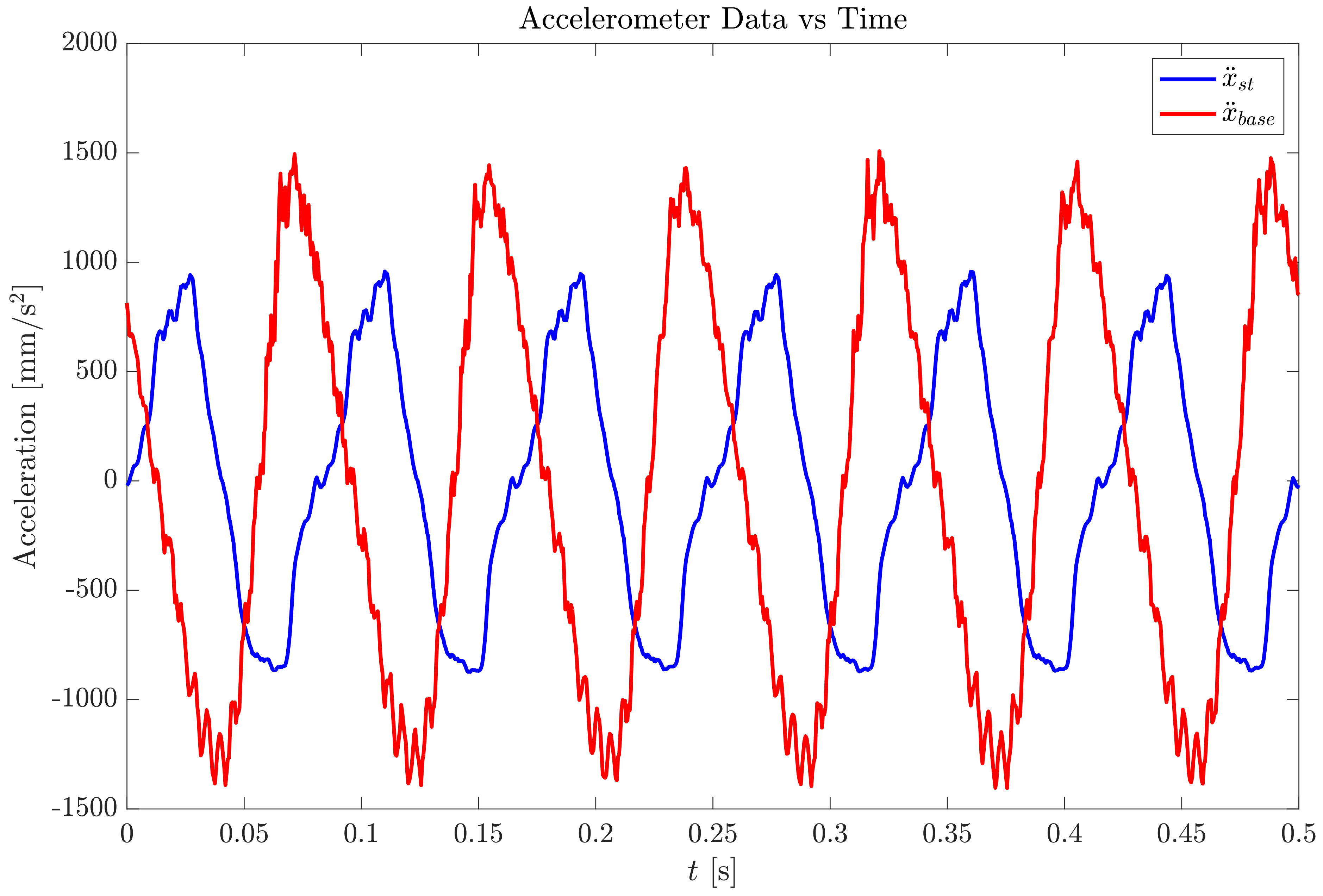

Figure - Experiment result for $f = 12$ Hz

Case 6 - $f = 14$ Hz

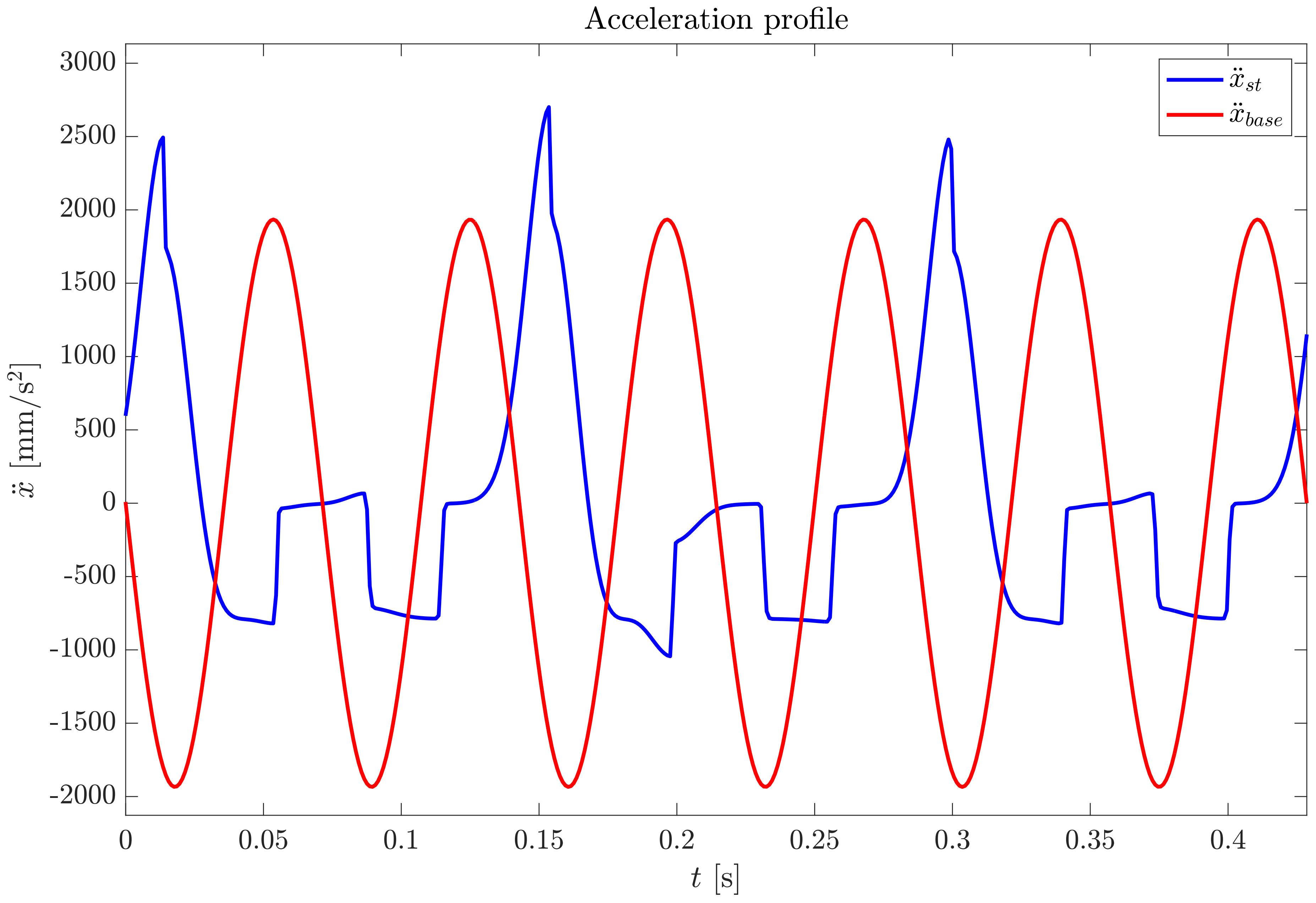

Figure - Simulation result for $f = 14$ Hz

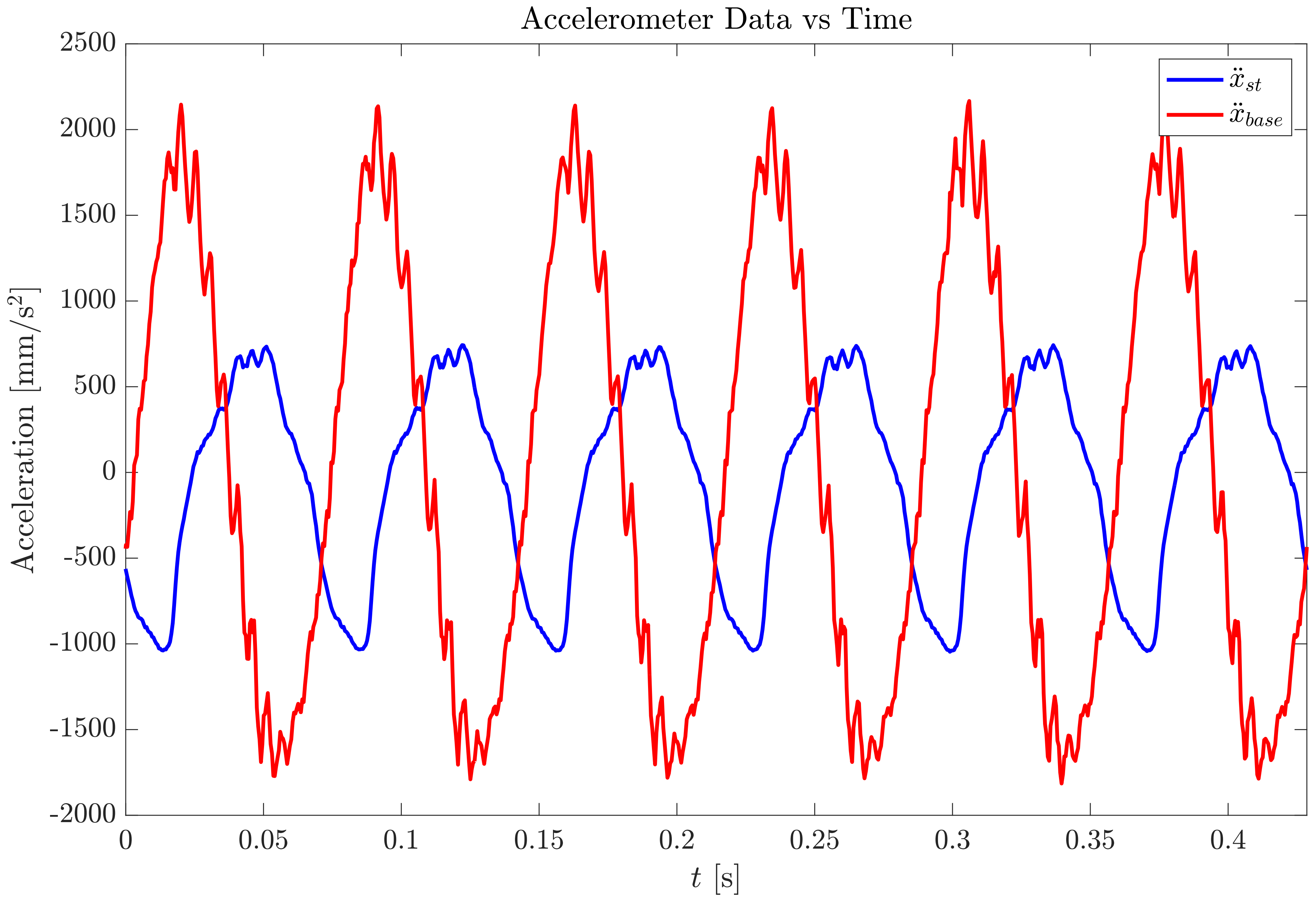

Figure - Experiment result for $f = 14$ Hz

Case 7 - $f = 16$ Hz

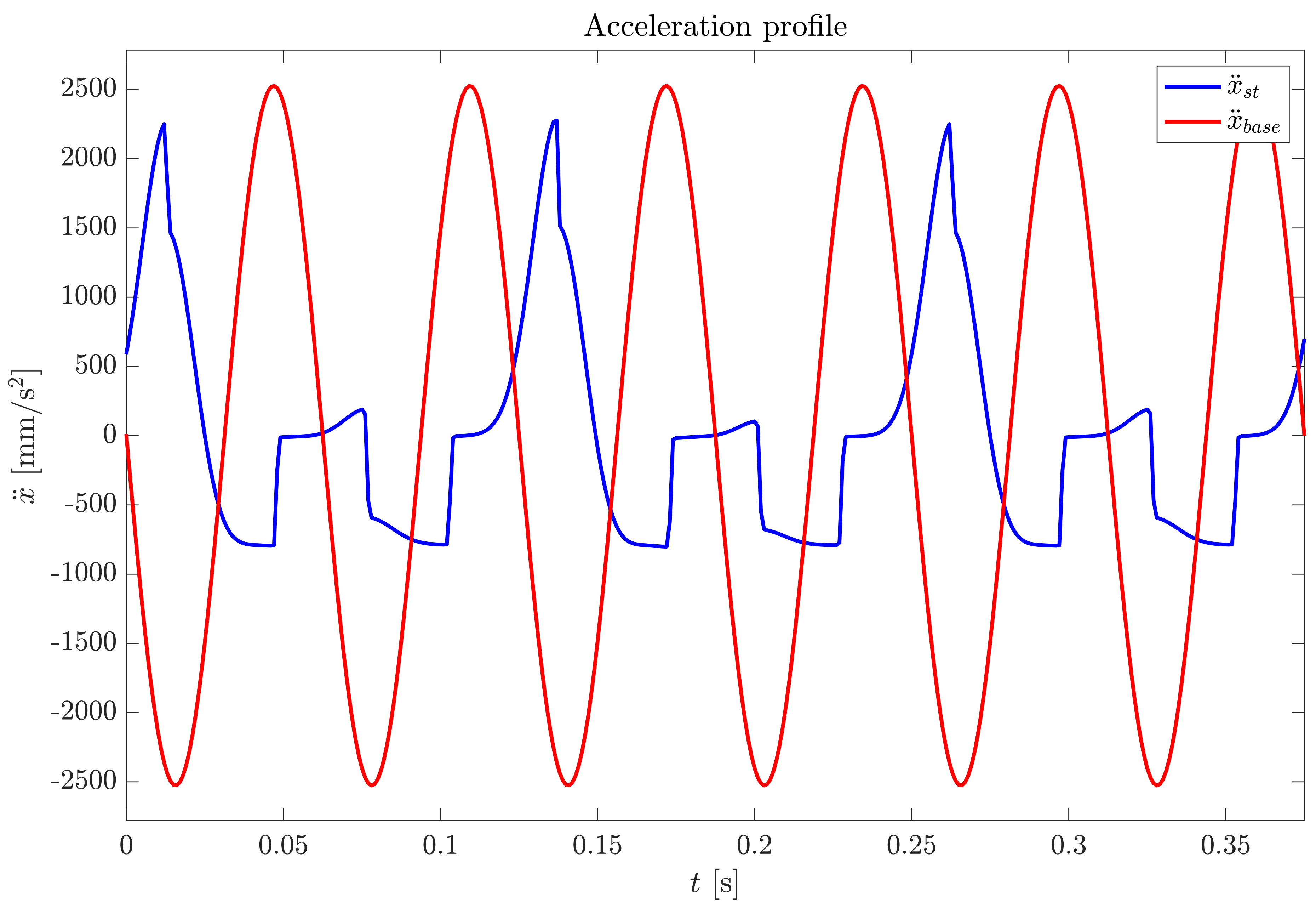

Figure - Simulation result for $f = 16$ Hz

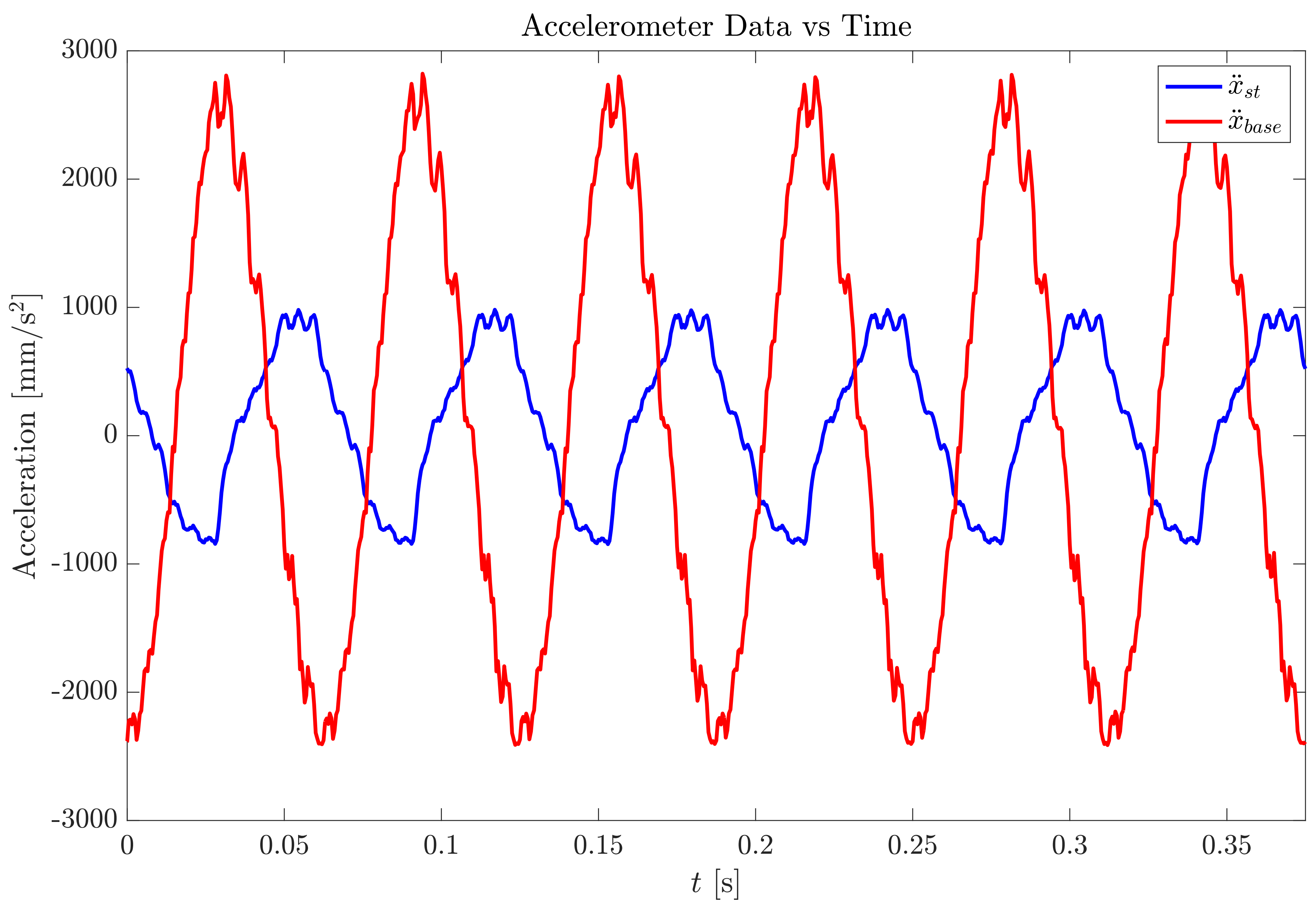

Figure - Experiment result for $f = 16$ Hz

Case 8 - $f = 18$ Hz

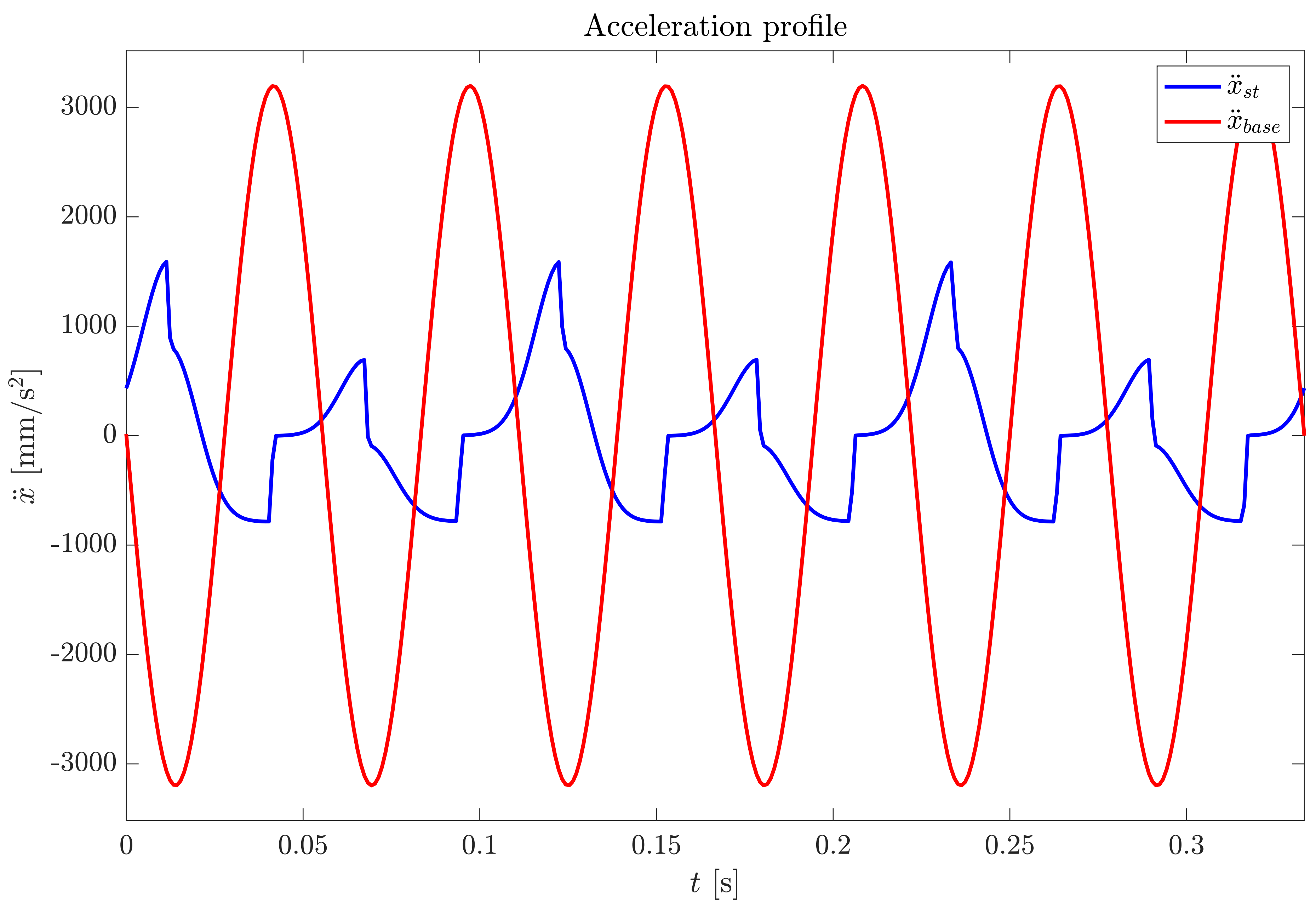

Figure - Simulation result for $f = 18$ Hz

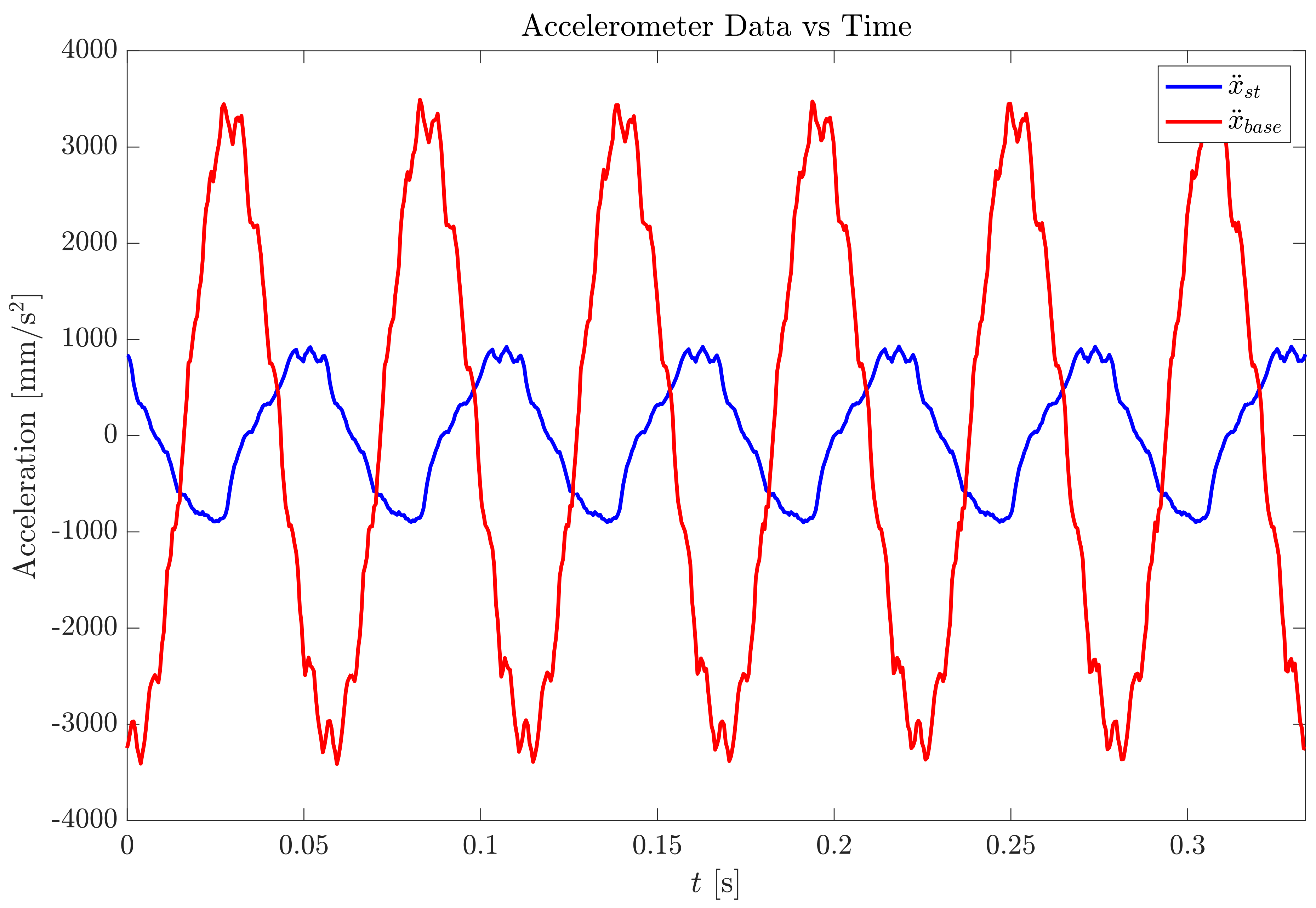

Figure - Experiment result for $f = 18$ Hz

Case 9 - $f = 20$ Hz

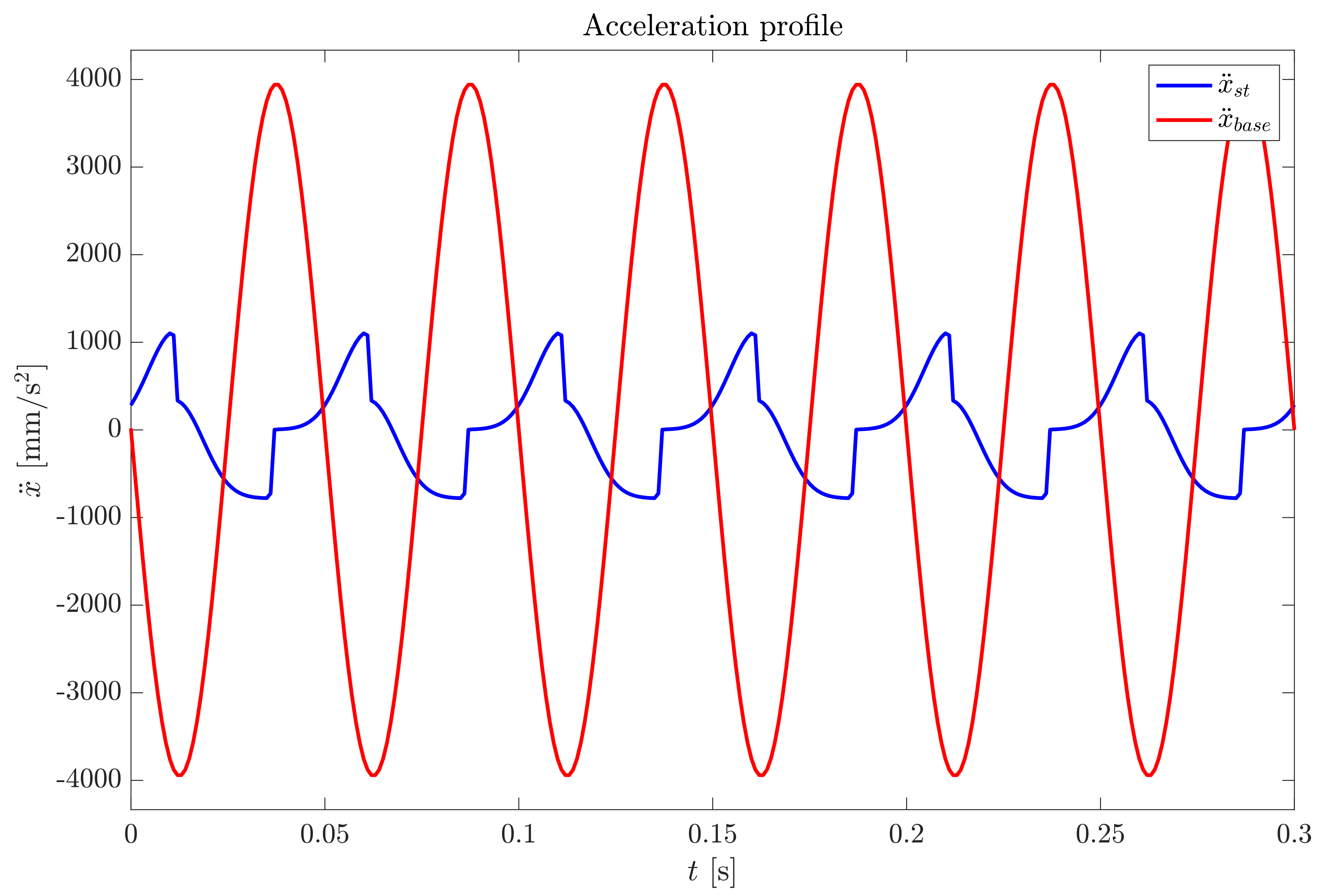

Figure - Simulation result for $f = 20$ Hz

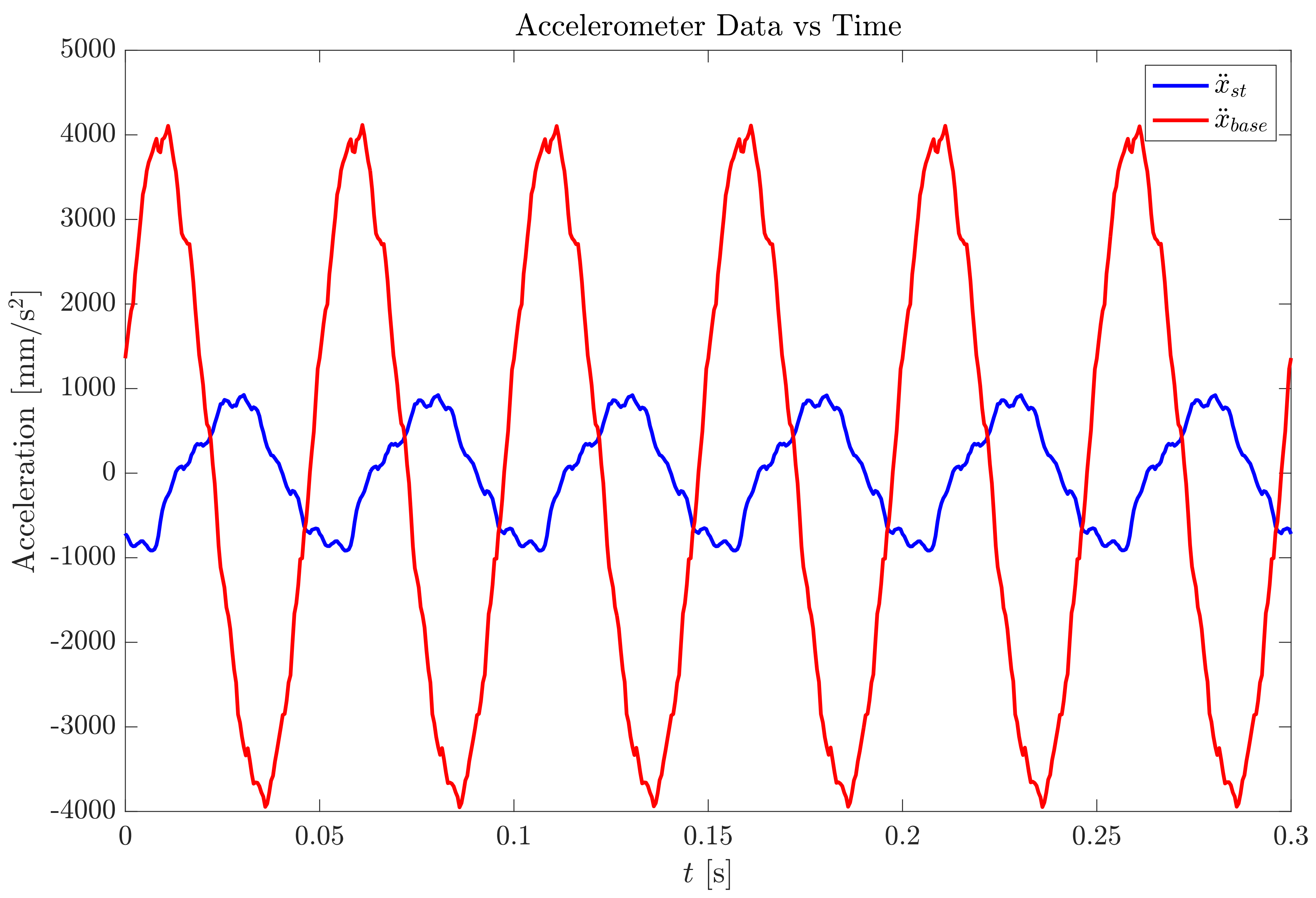

Figure - Experiment result for $f = 20$ Hz

More **phase delay** compared to the results obtained for viscous damping!

Case 10 - $f = 22$ Hz

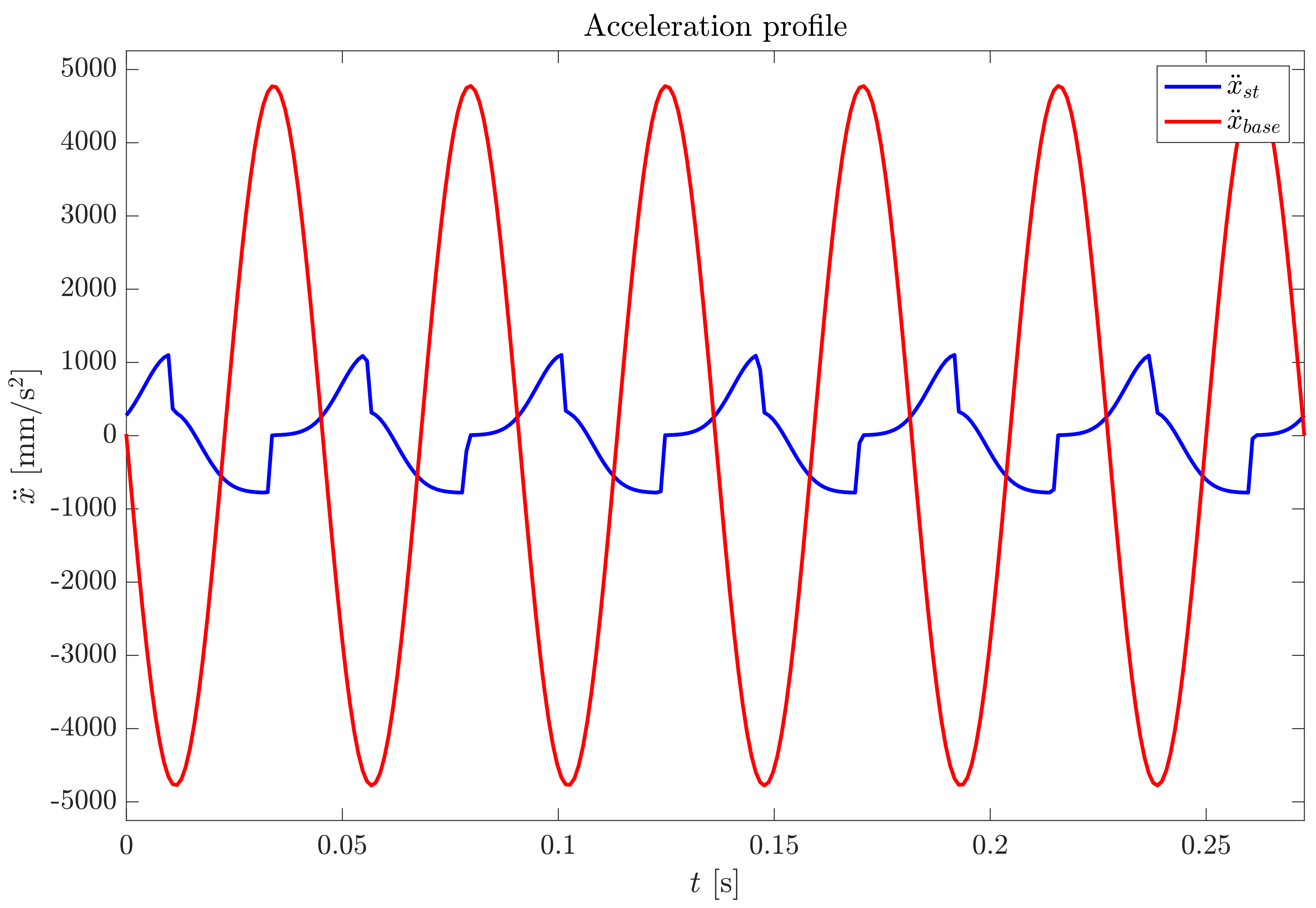

Figure - Simulation result for $f = 22$ Hz

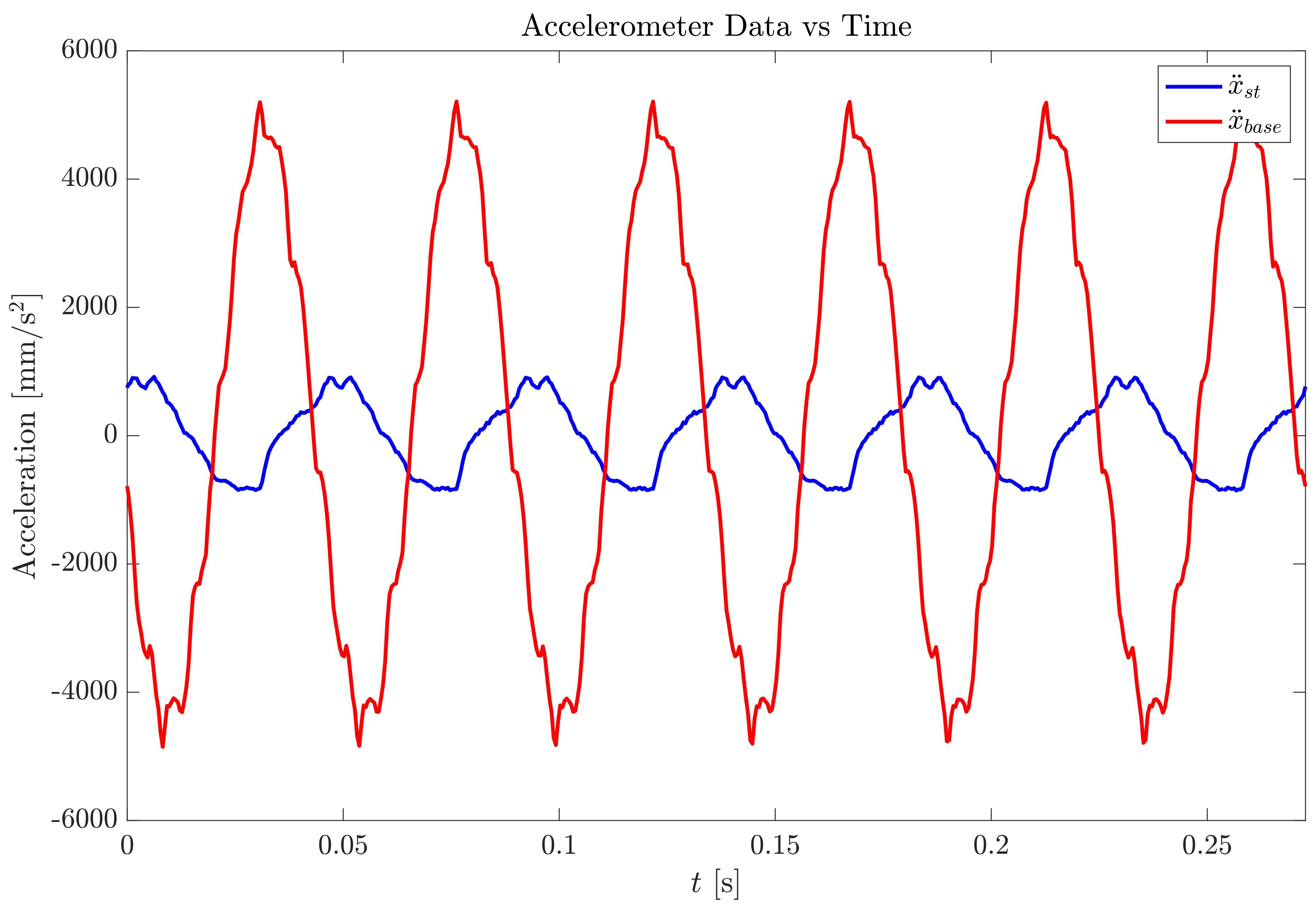

Figure - Experiment result for $f = 22$ Hz

Case 11 - $f = 24$ Hz

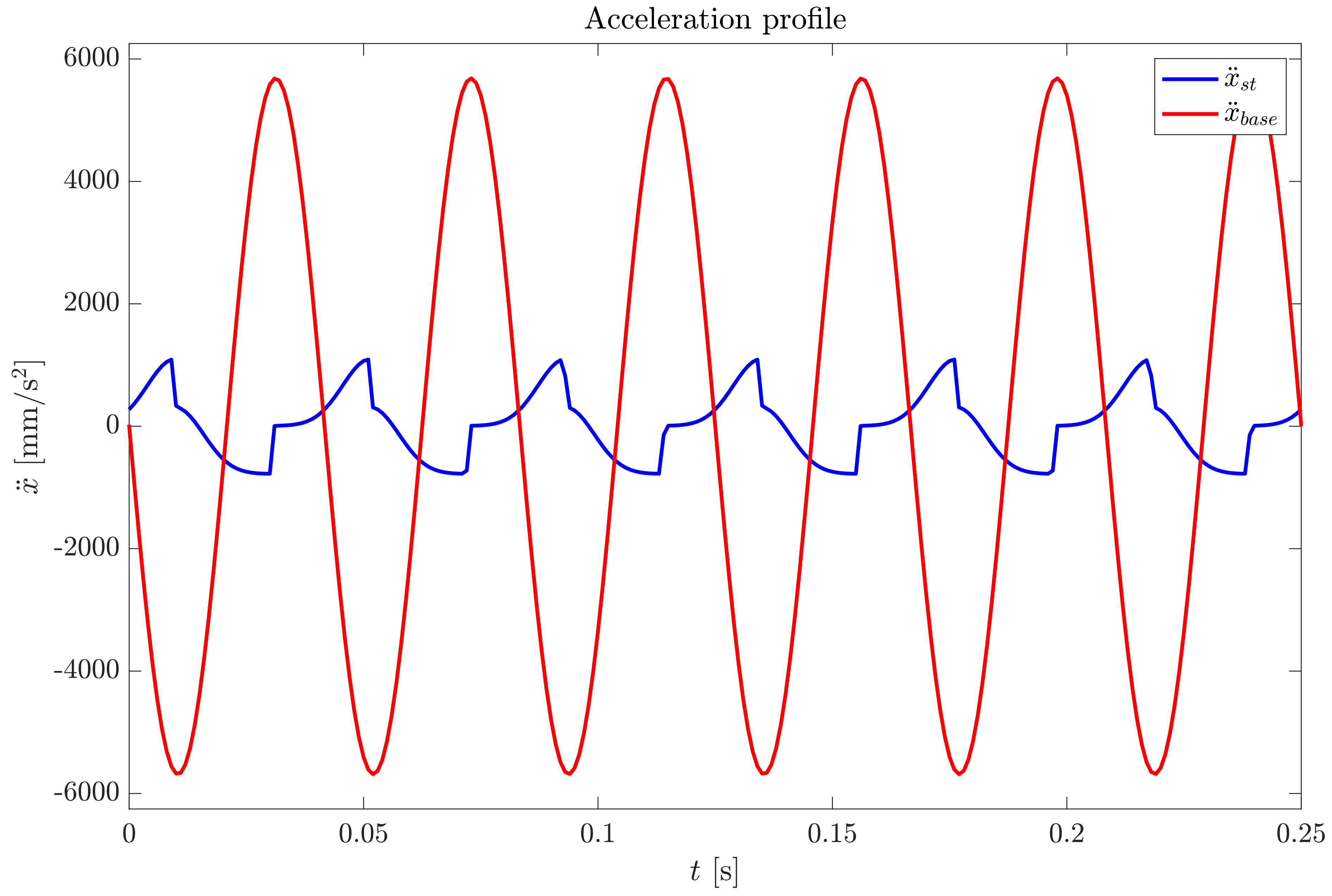

Figure - Simulation result for $f = 24$ Hz

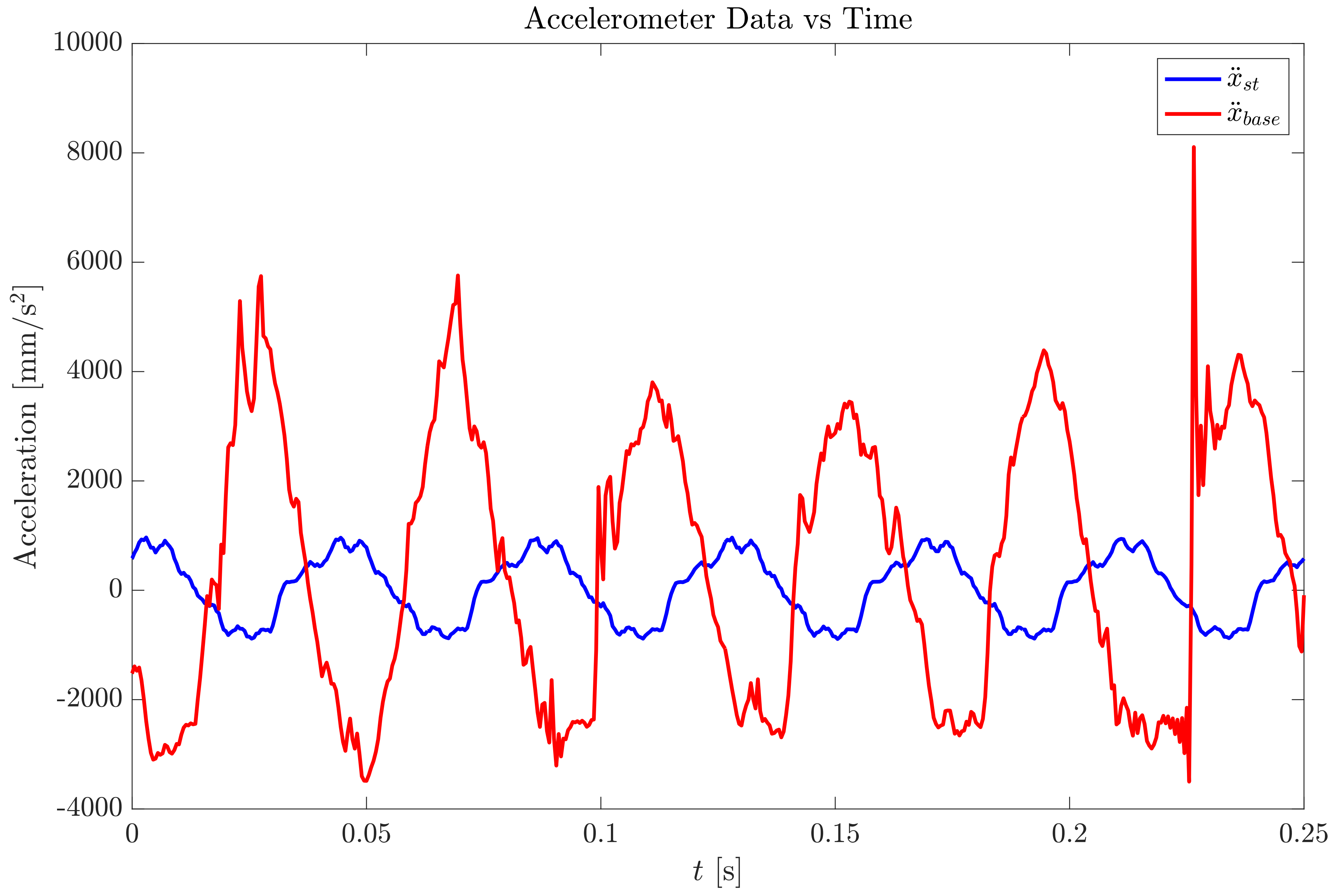

Figure - Experiment result for $f = 24$ Hz

Case 12 - $f = 26$ Hz

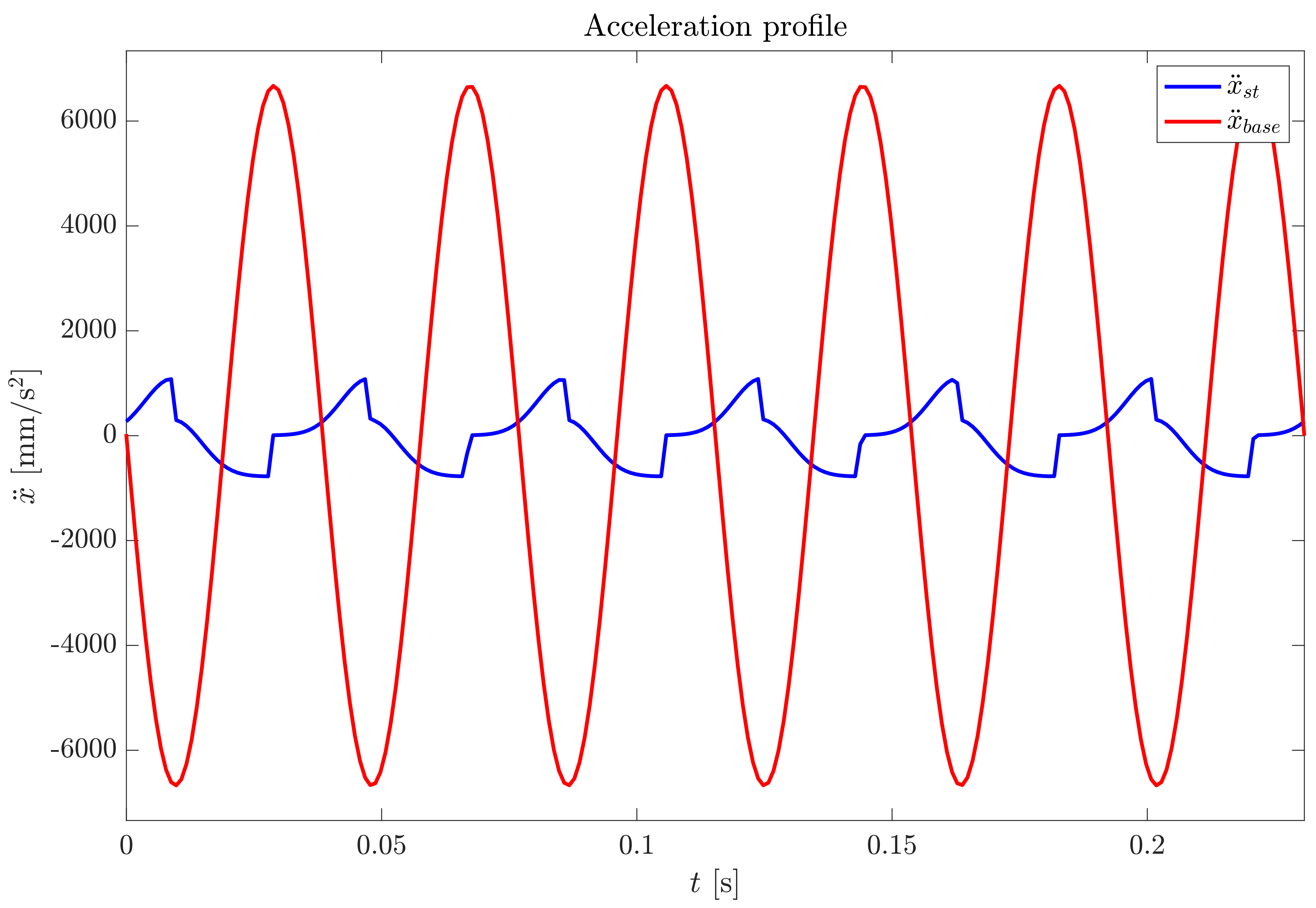

Figure - Simulation result for $f = 26$ Hz

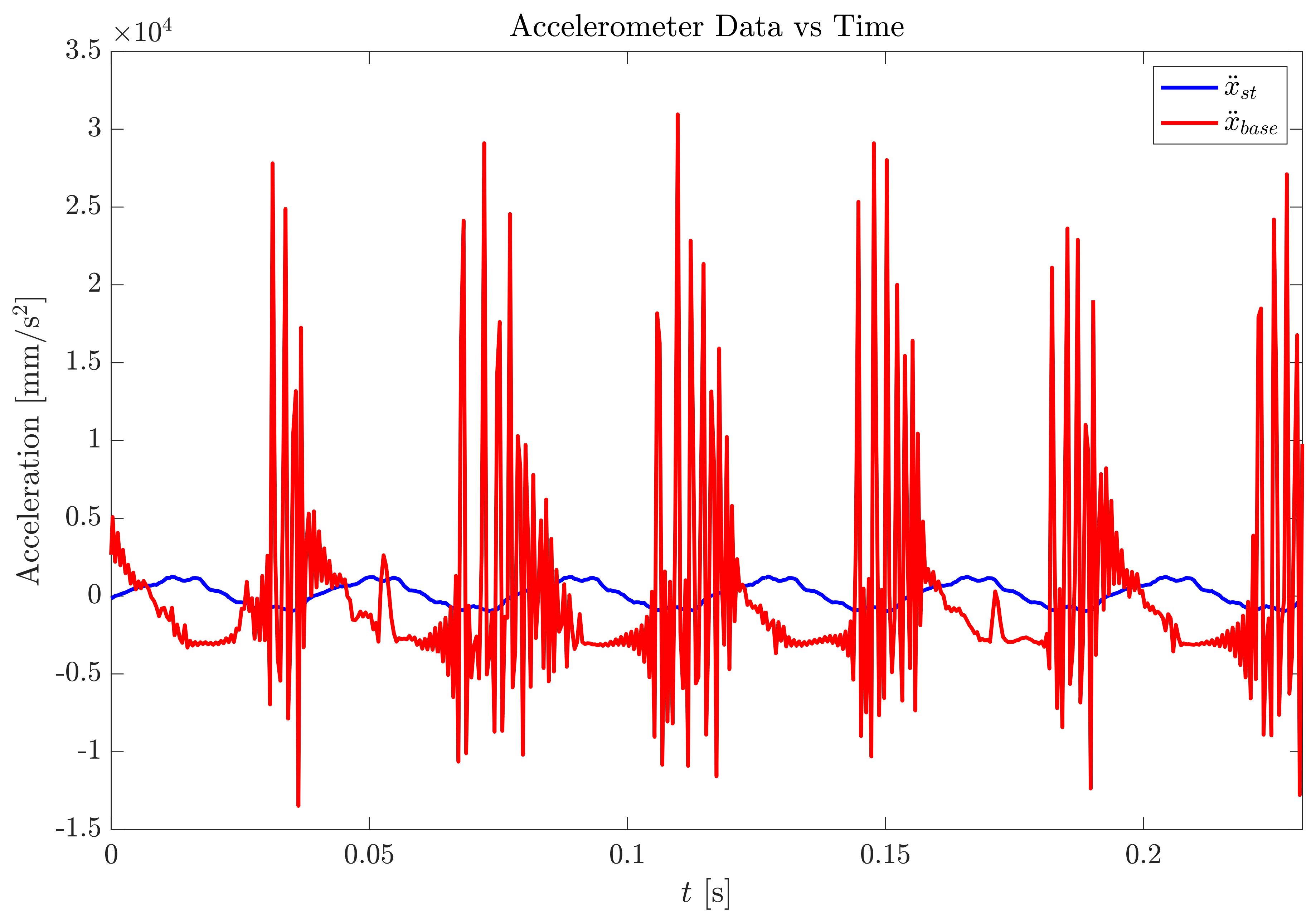

Figure - Experiment result for $f = 26$ Hz

Motion Transmissibility Results

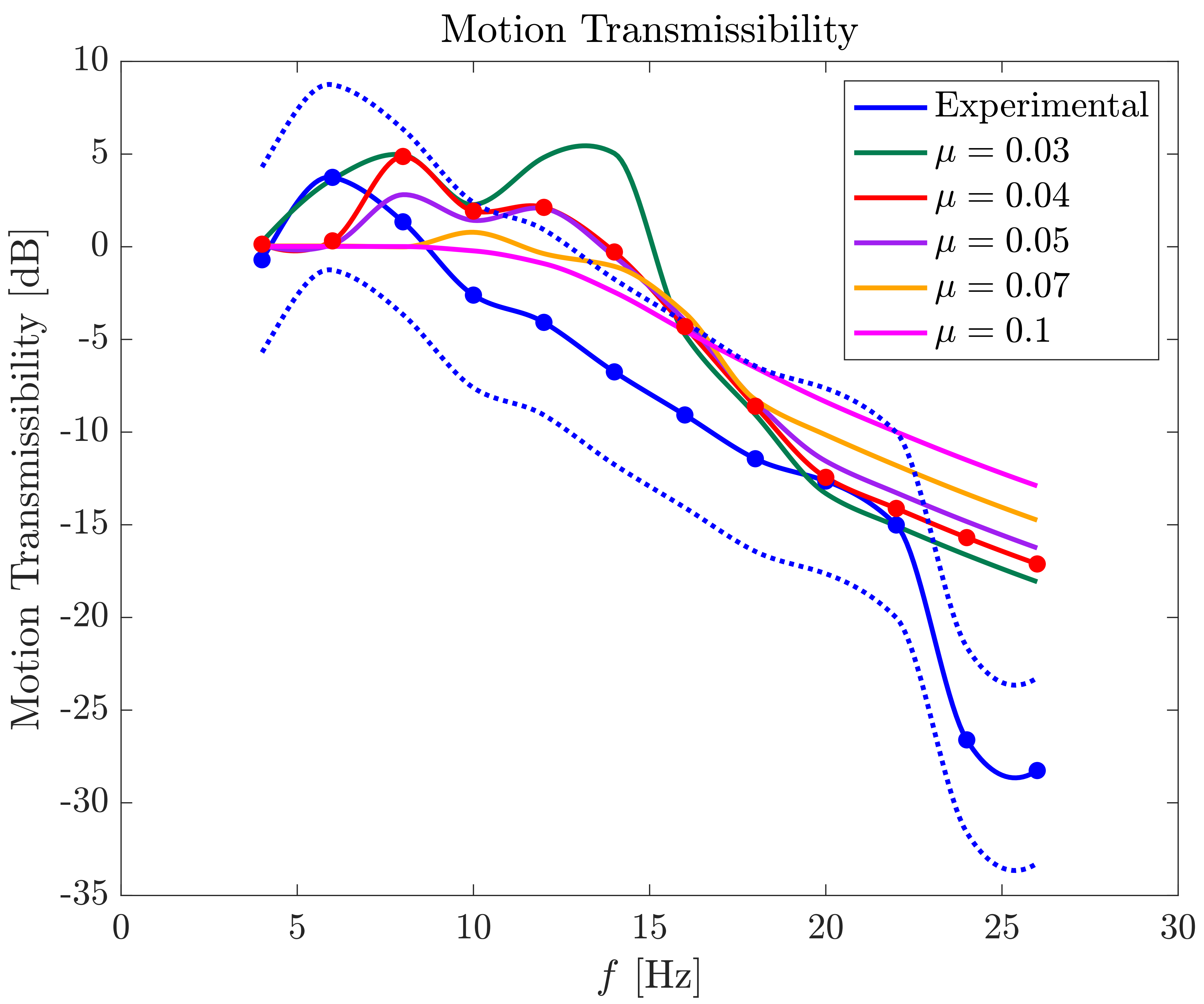

Figure - Motion Transmissibility curves for different μ values

Simulation with Mixed Damping

PARAMETERS -

- $h_1/\tau = h_2/\tau = 1.41$
- $E = 210$ GPa
- $m = 11.2$ kg
- $c = 0.2$ Ns/mm, $\mu = 0.03$
- $x_{base}(t) = 0.25\sin(2\pi ft)$ (in mm)

f is the frequency of the base excitation, which is varied from **4 Hz to 26 Hz** at intervals of **2 Hz**

Case 1 - $f = 4$ Hz

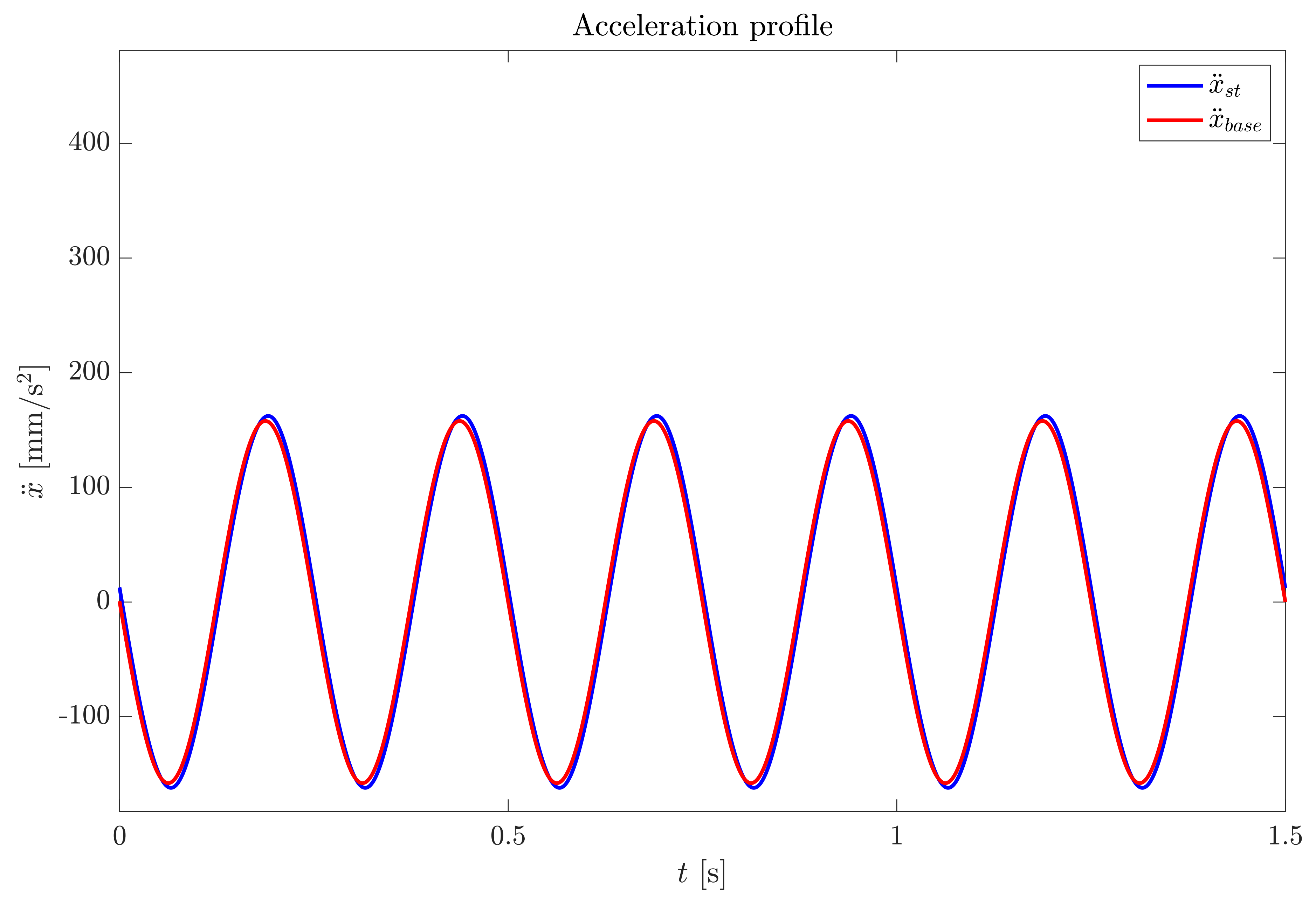

Figure - Simulation result for $f = 4$ Hz

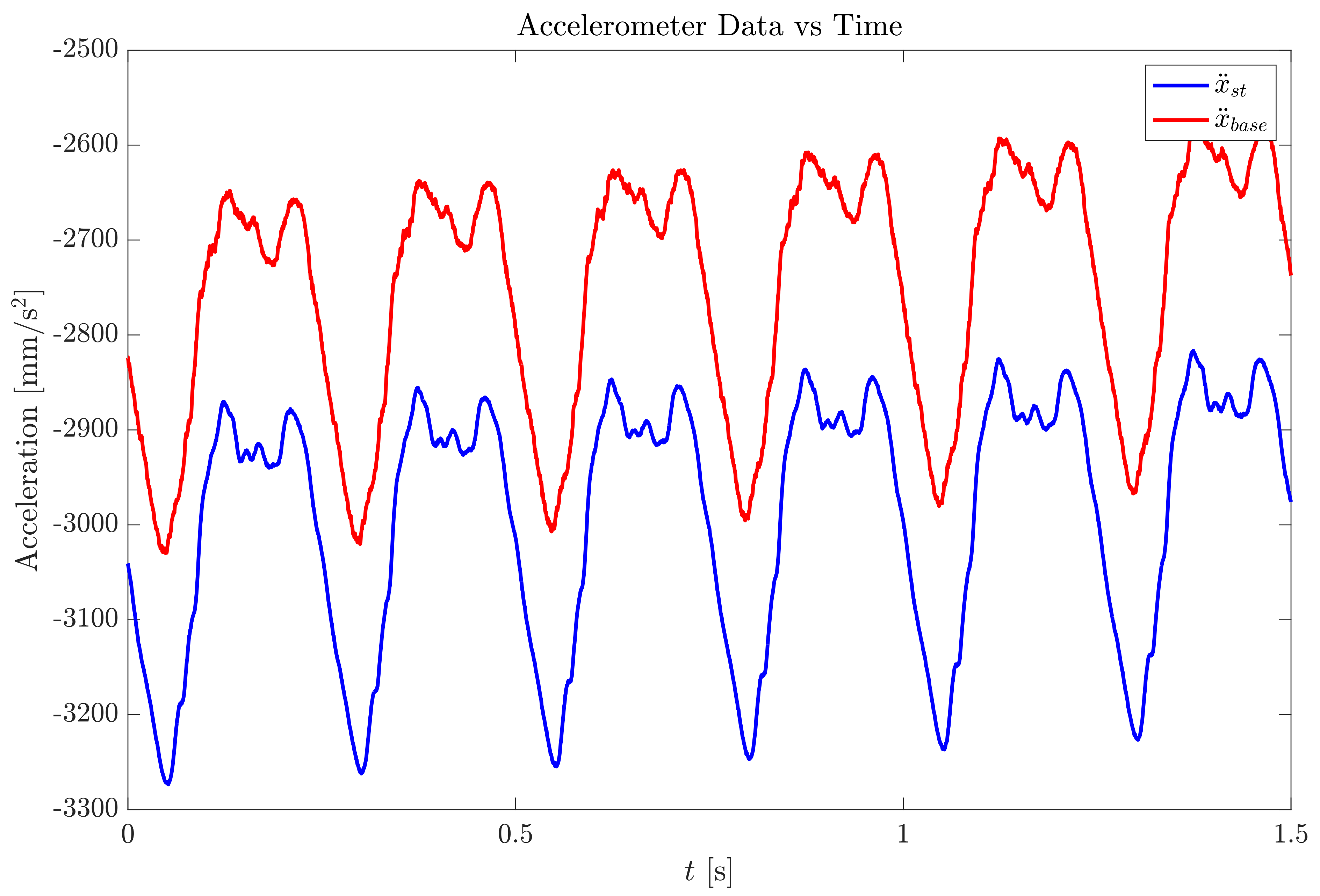

Figure - Experiment result for $f = 4$ Hz

Case 2 - $f = 6$ Hz

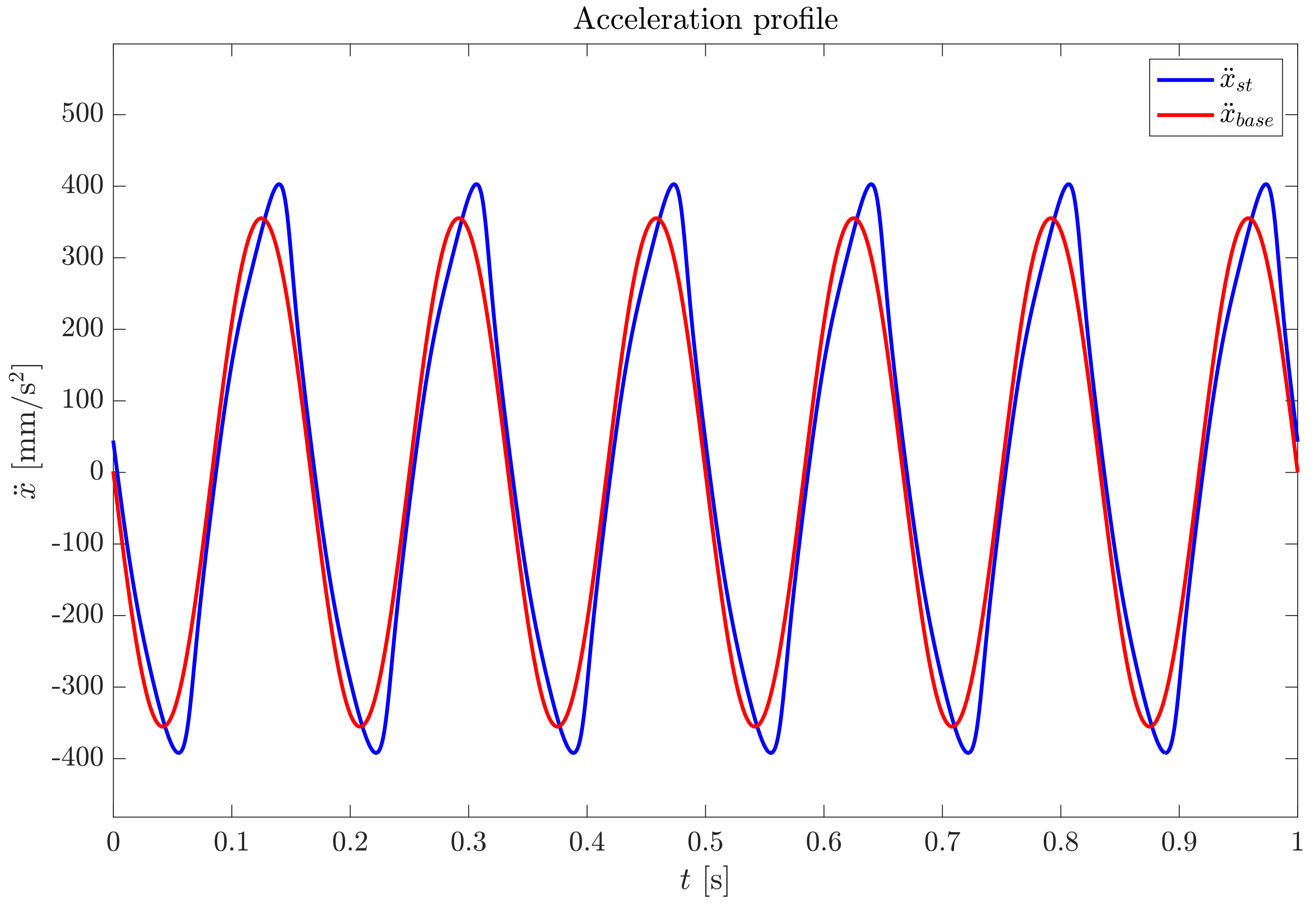

Figure - Simulation result for $f = 6$ Hz

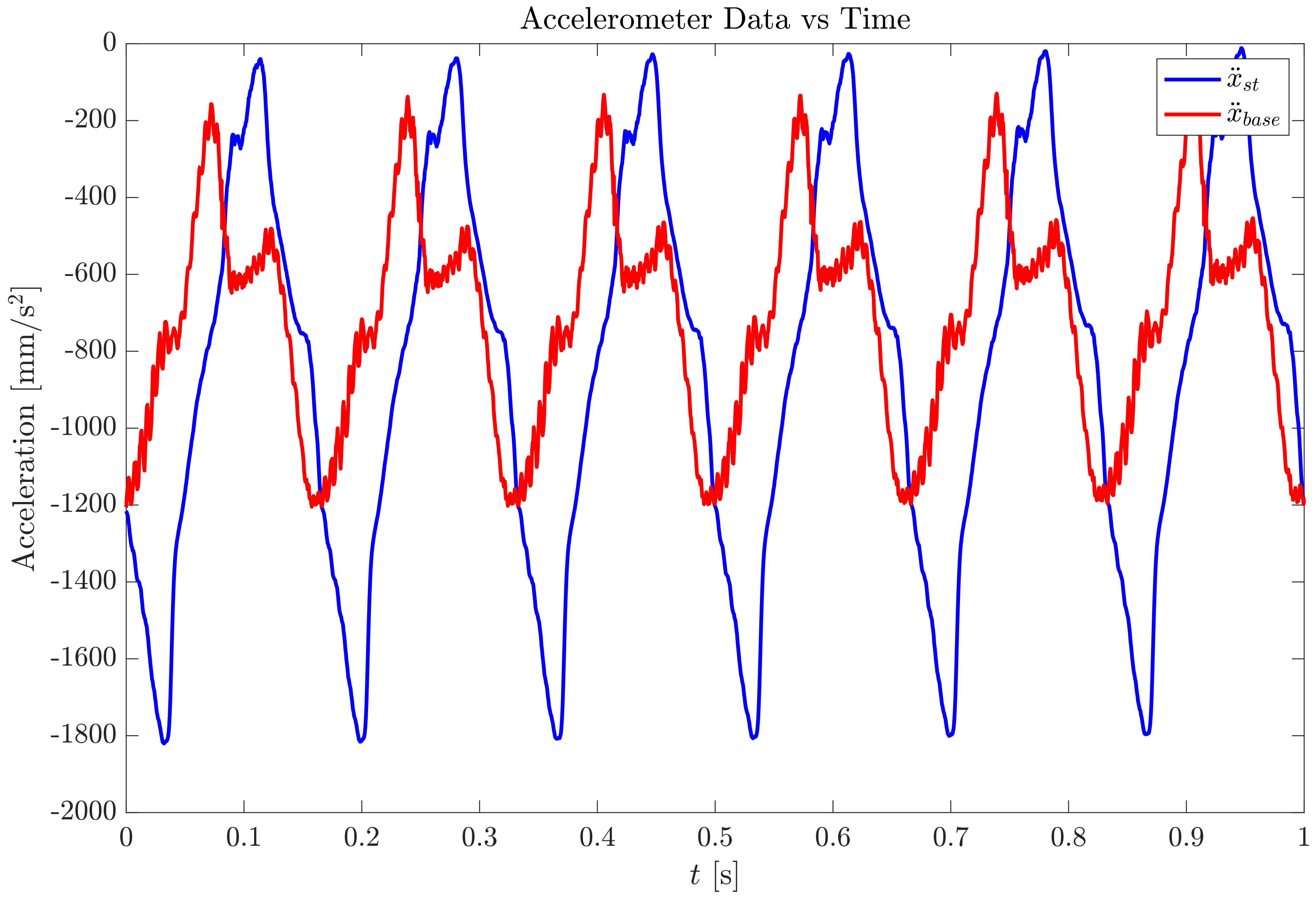

Figure - Experiment result for $f = 6$ Hz

Case 3 - $f = 8$ Hz

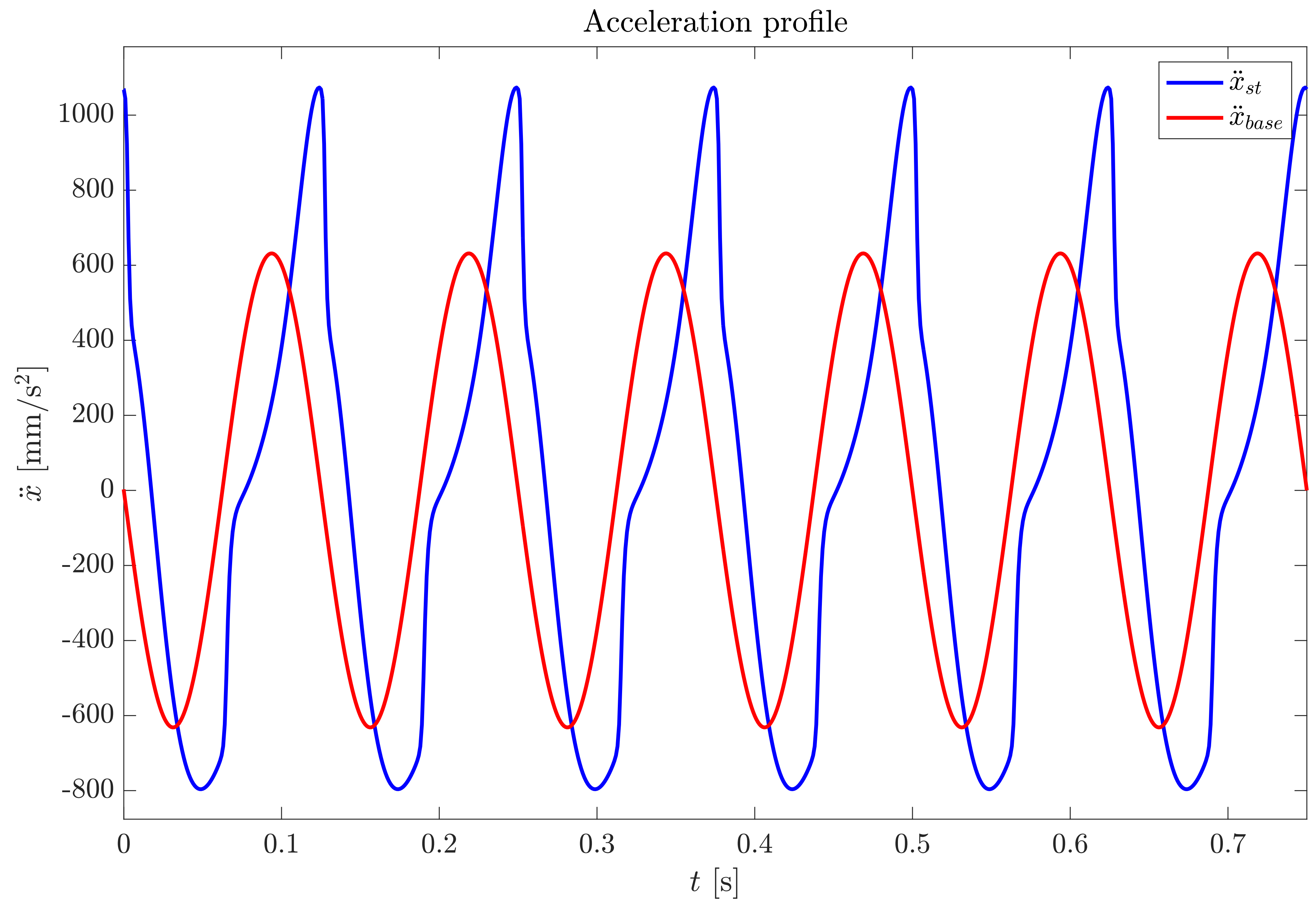

Figure - Simulation result for $f = 8$ Hz

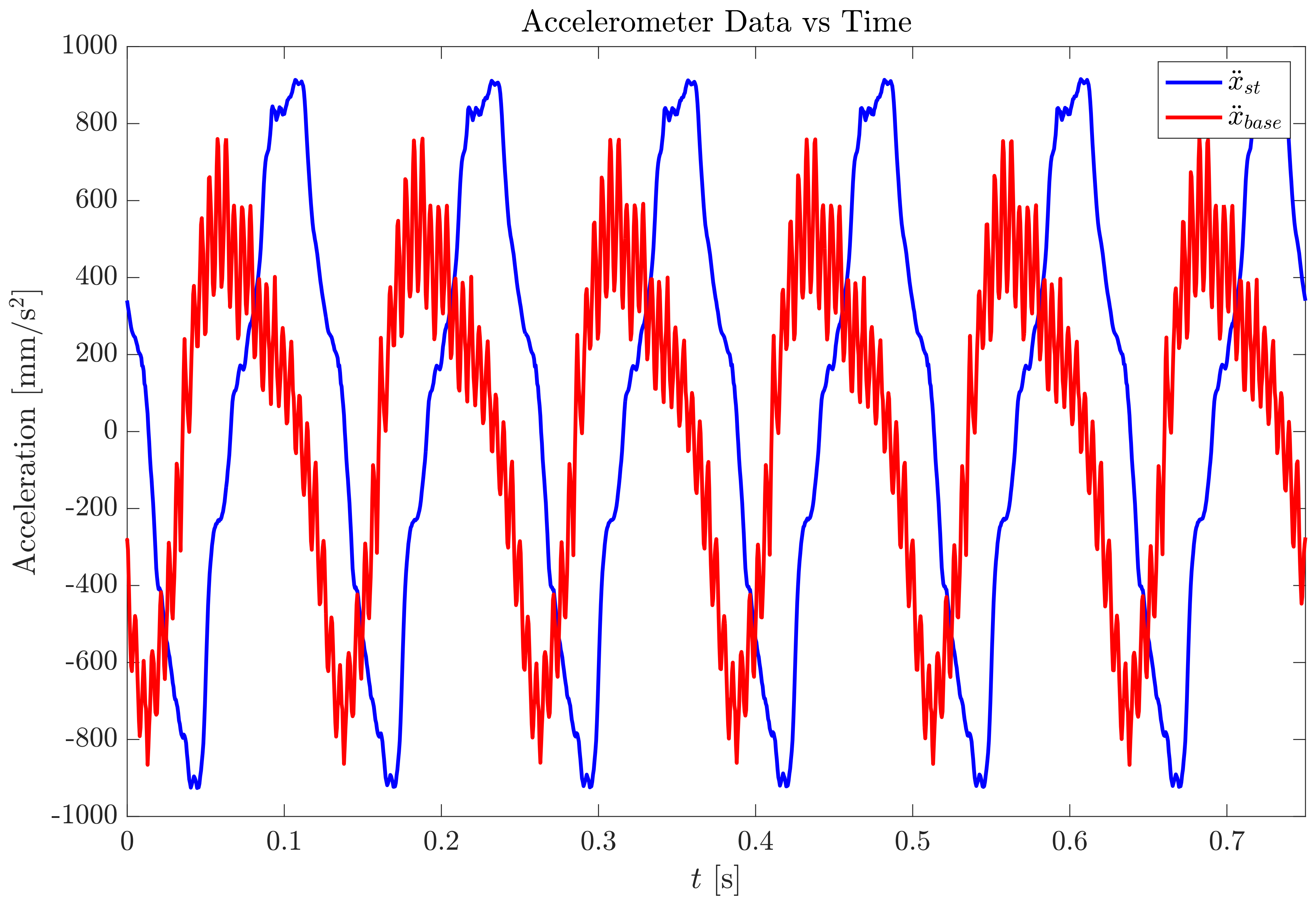

Figure - Experiment result for $f = 8$ Hz

Case 4 - $f = 10$ Hz

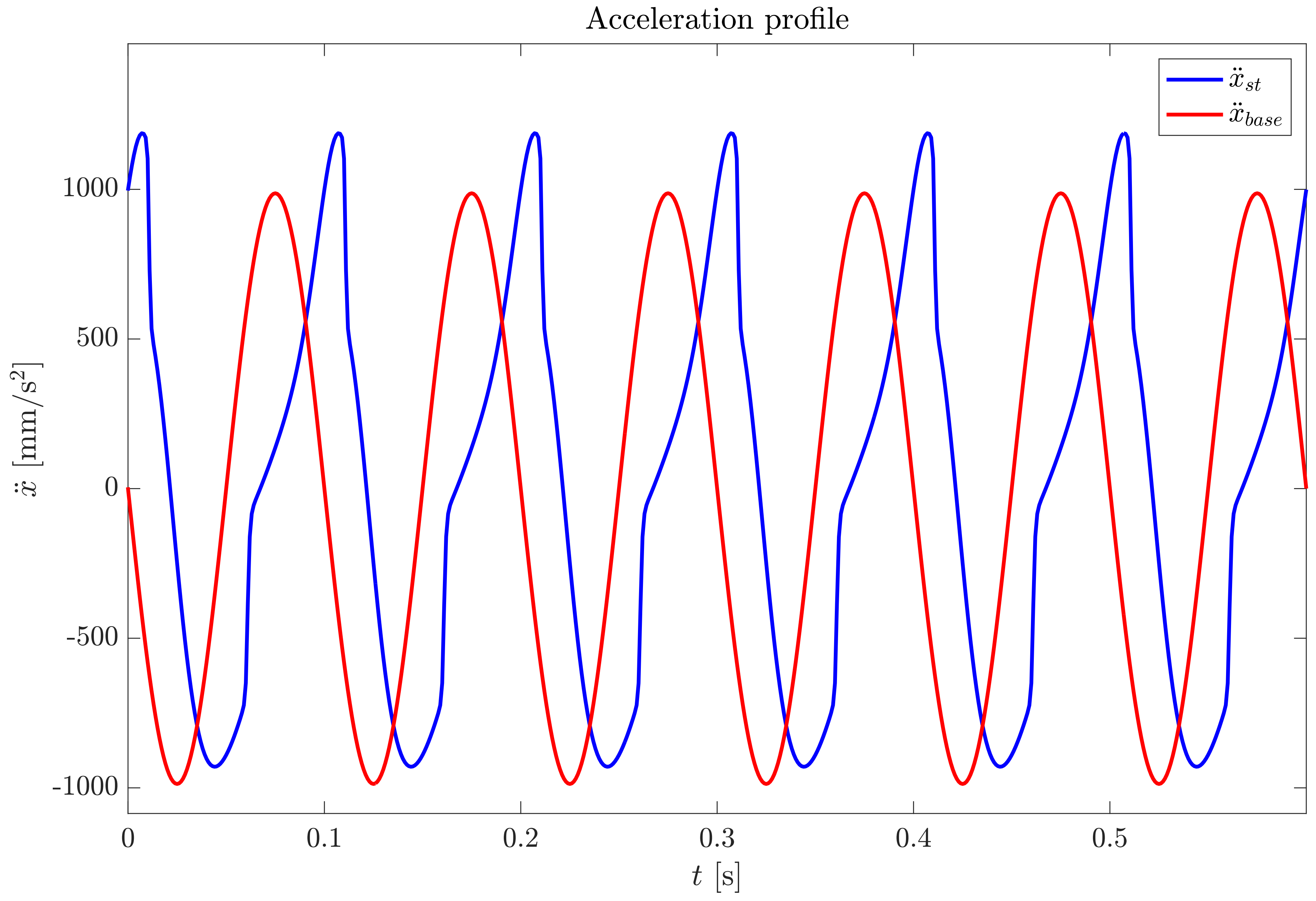

Figure - Simulation result for $f = 10$ Hz

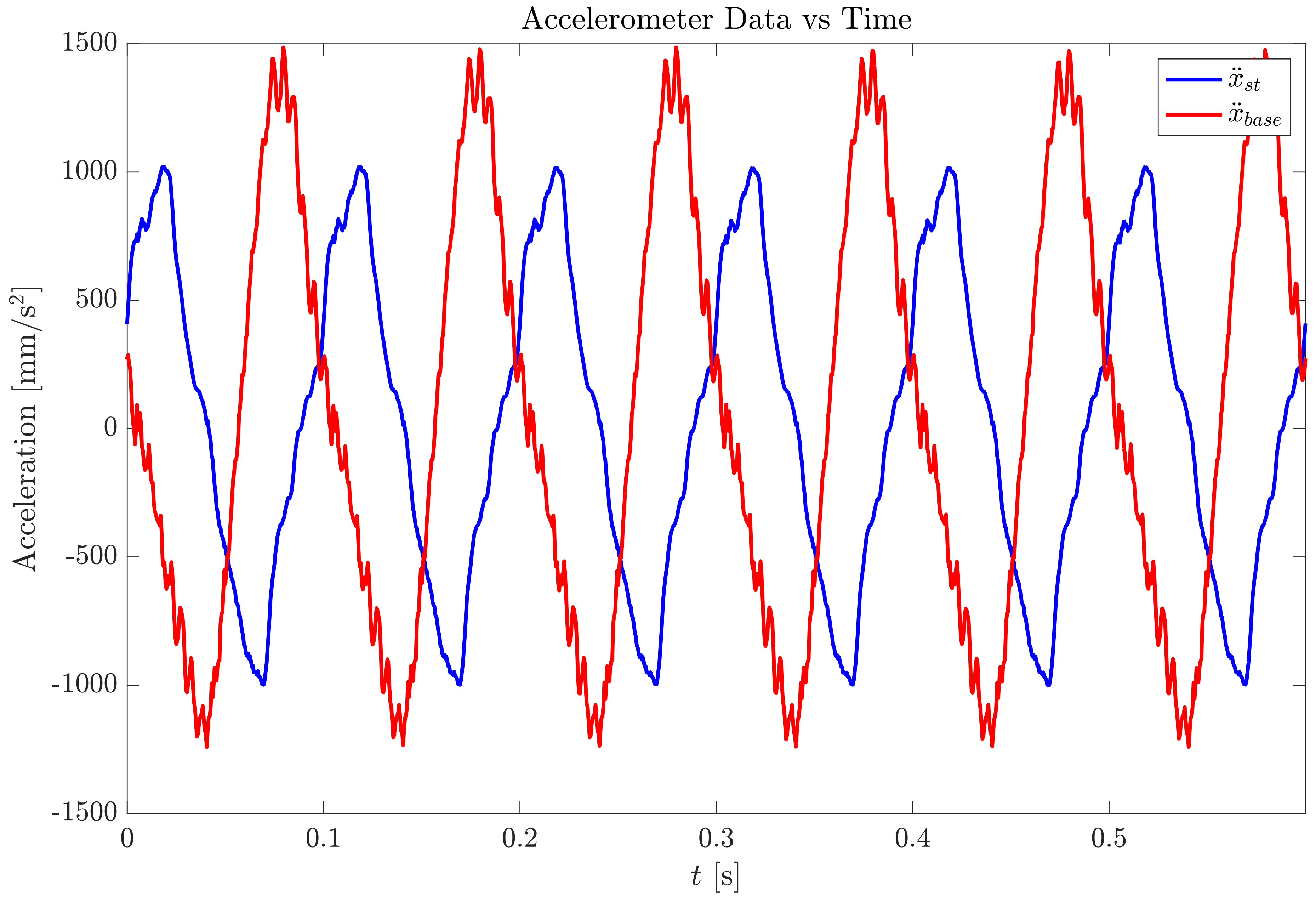

Figure - Experiment result for $f = 10$ Hz

Case 5 - $f = 12$ Hz

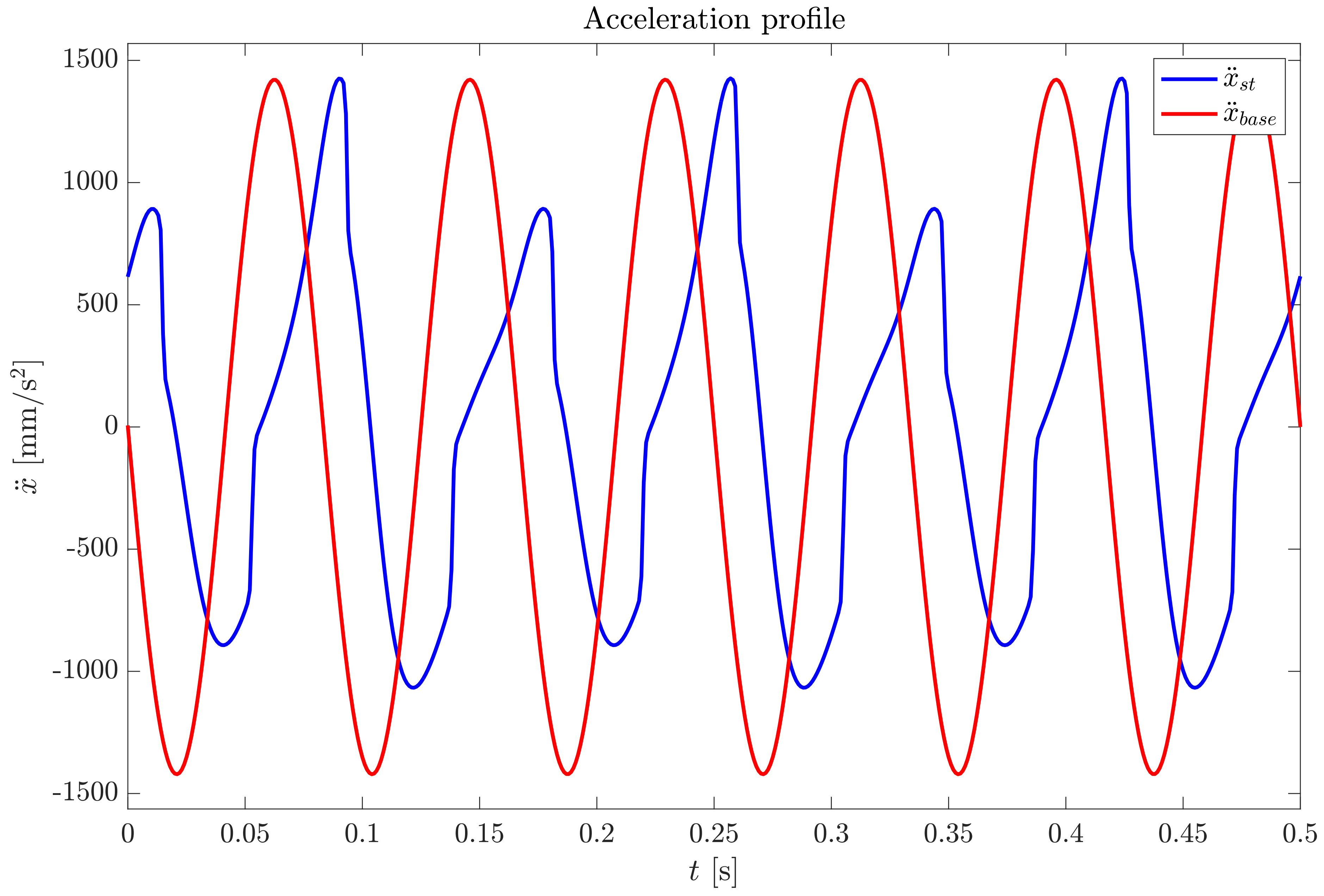

Figure - Simulation result for $f = 12$ Hz

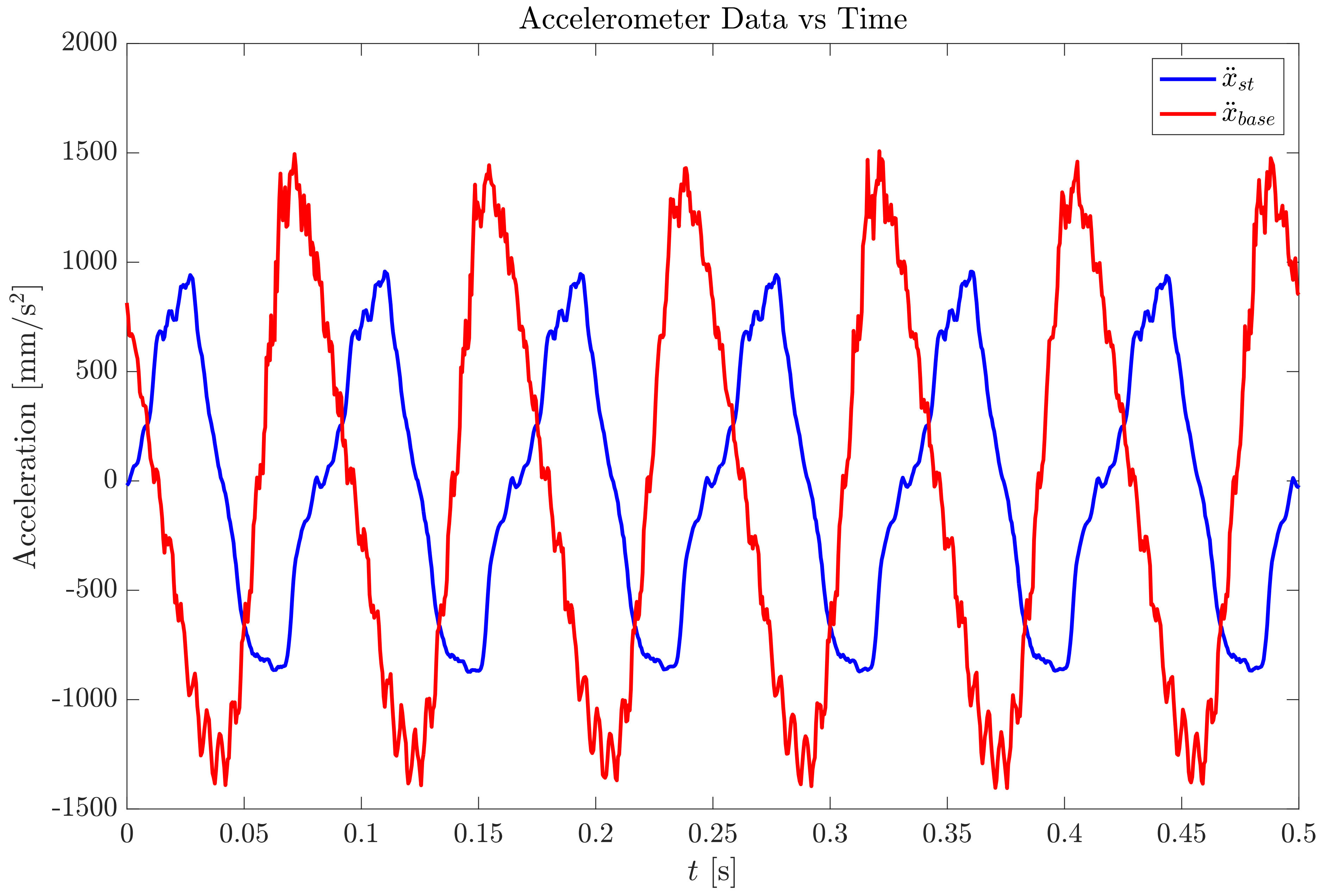

Figure - Experiment result for $f = 12$ Hz

Case 6 - $f = 14$ Hz

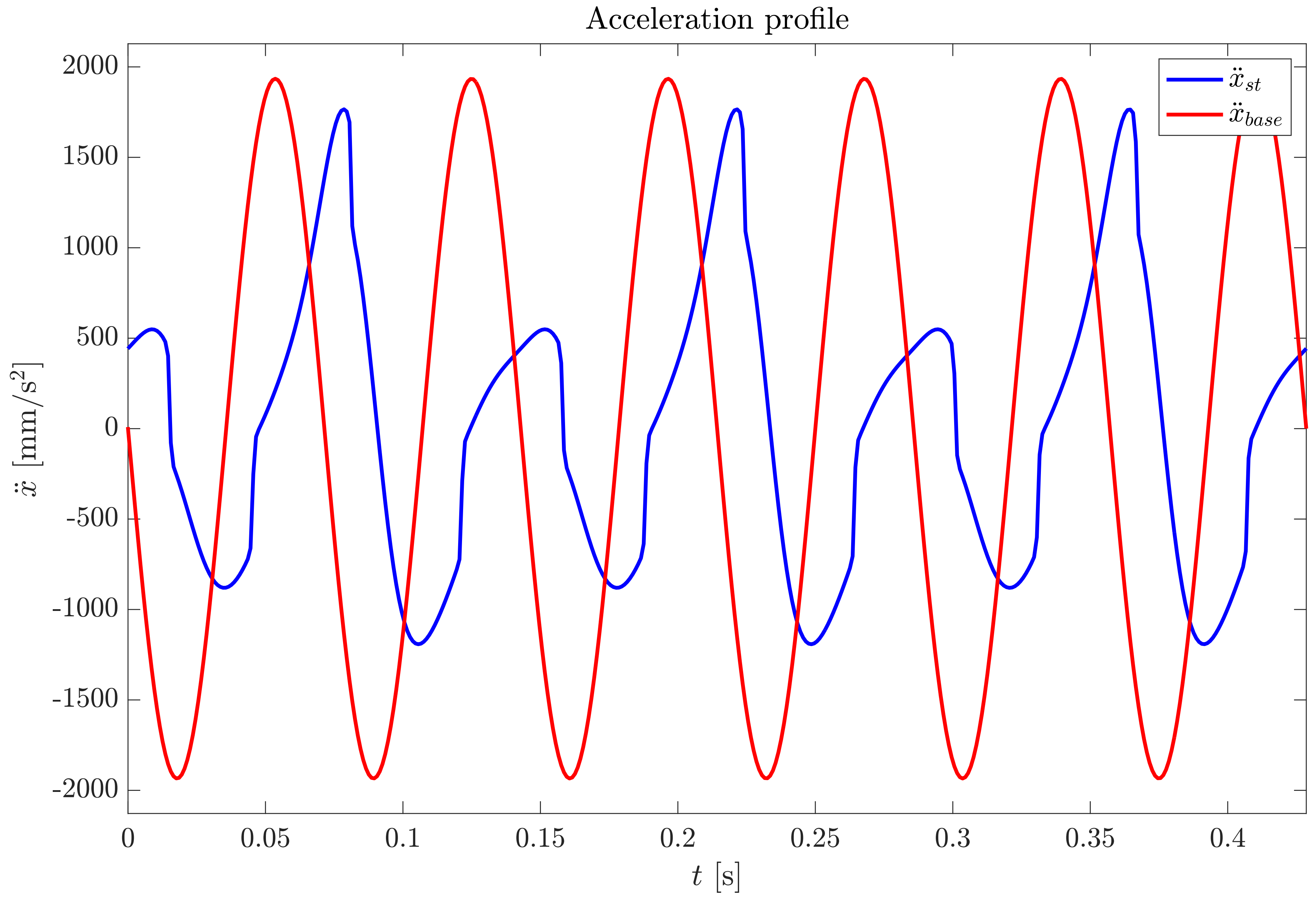

Figure - Simulation result for $f = 14$ Hz

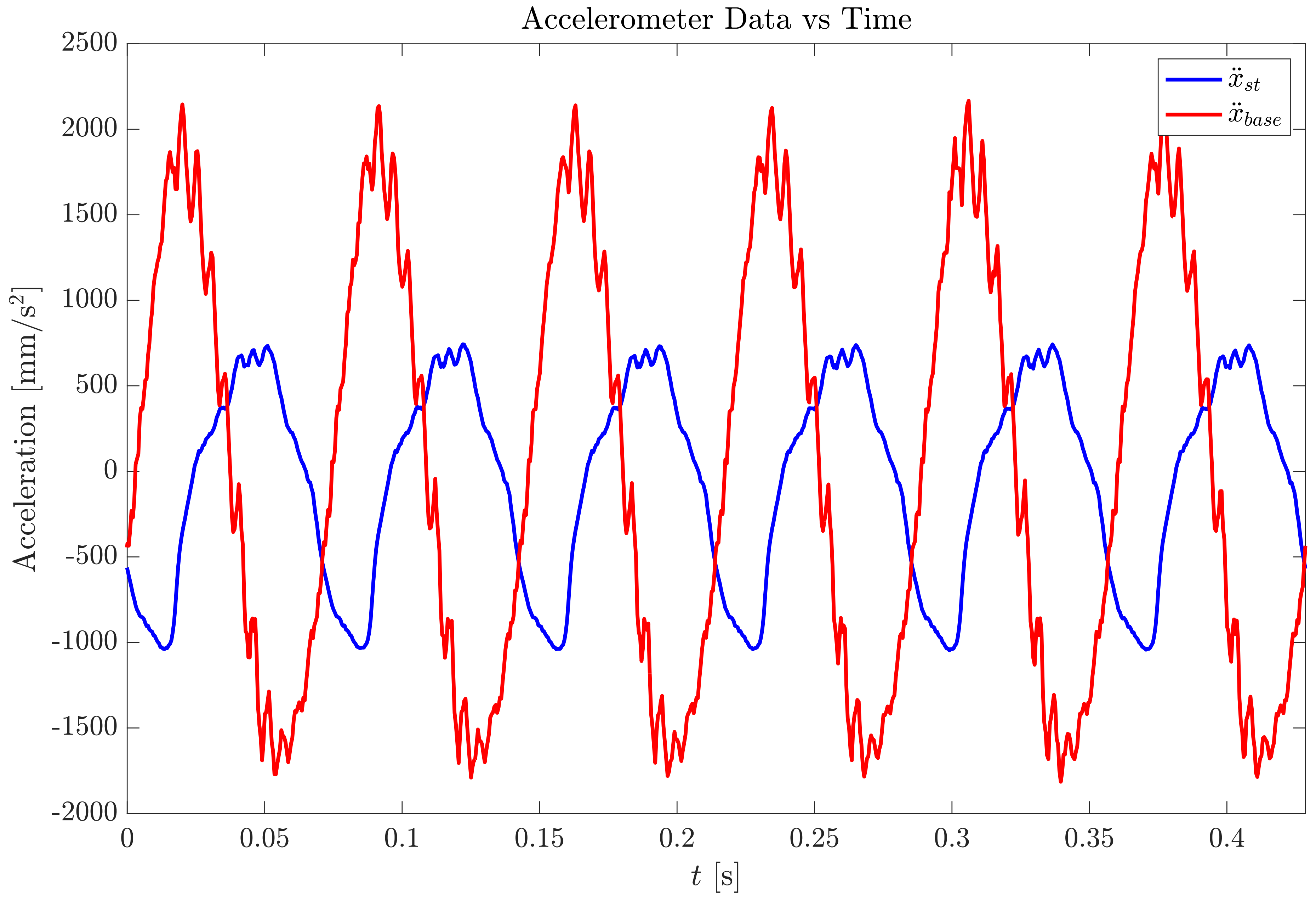

Figure - Experiment result for $f = 14$ Hz

Case 7 - $f = 16$ Hz

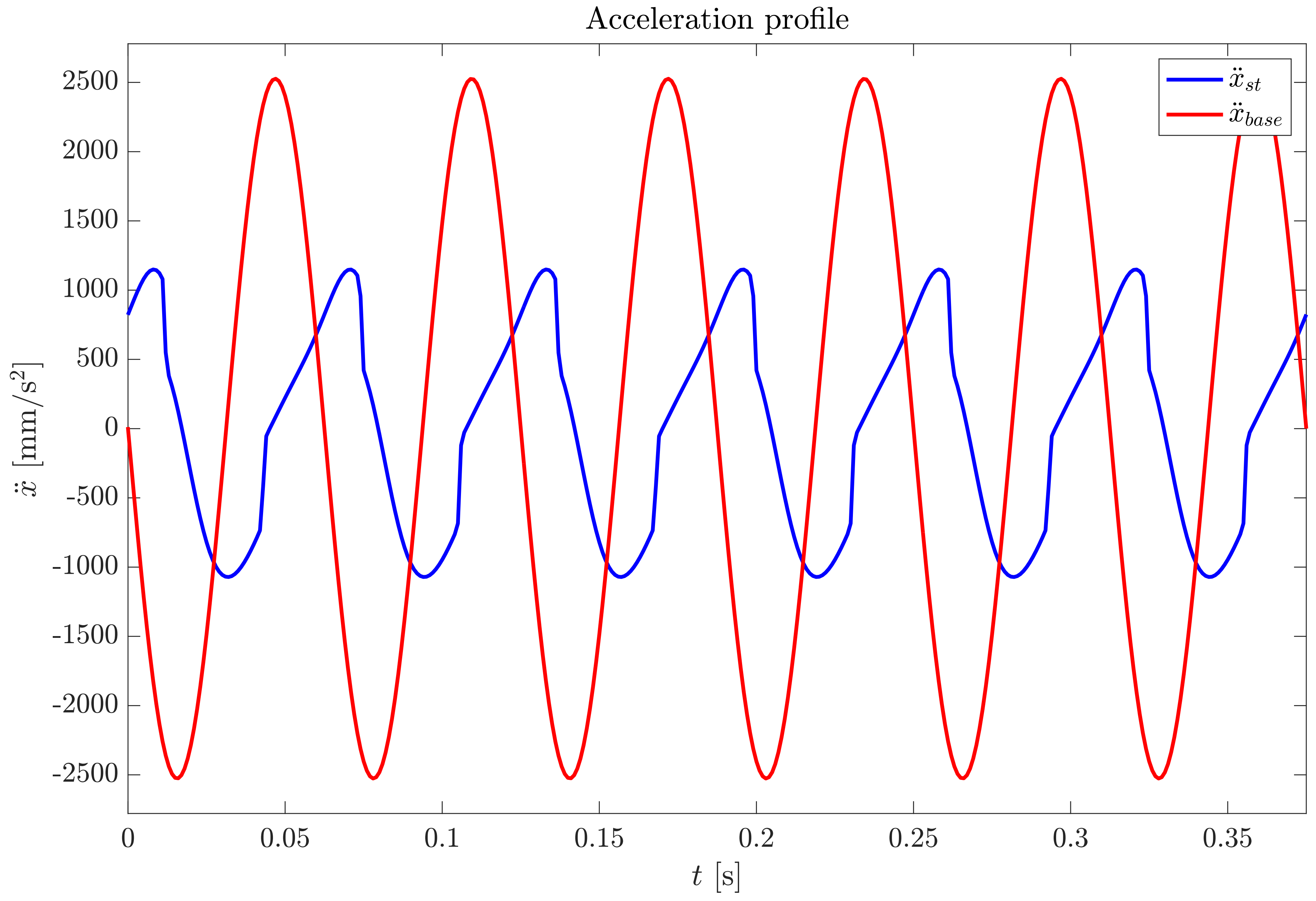

Figure - Simulation result for $f = 16$ Hz

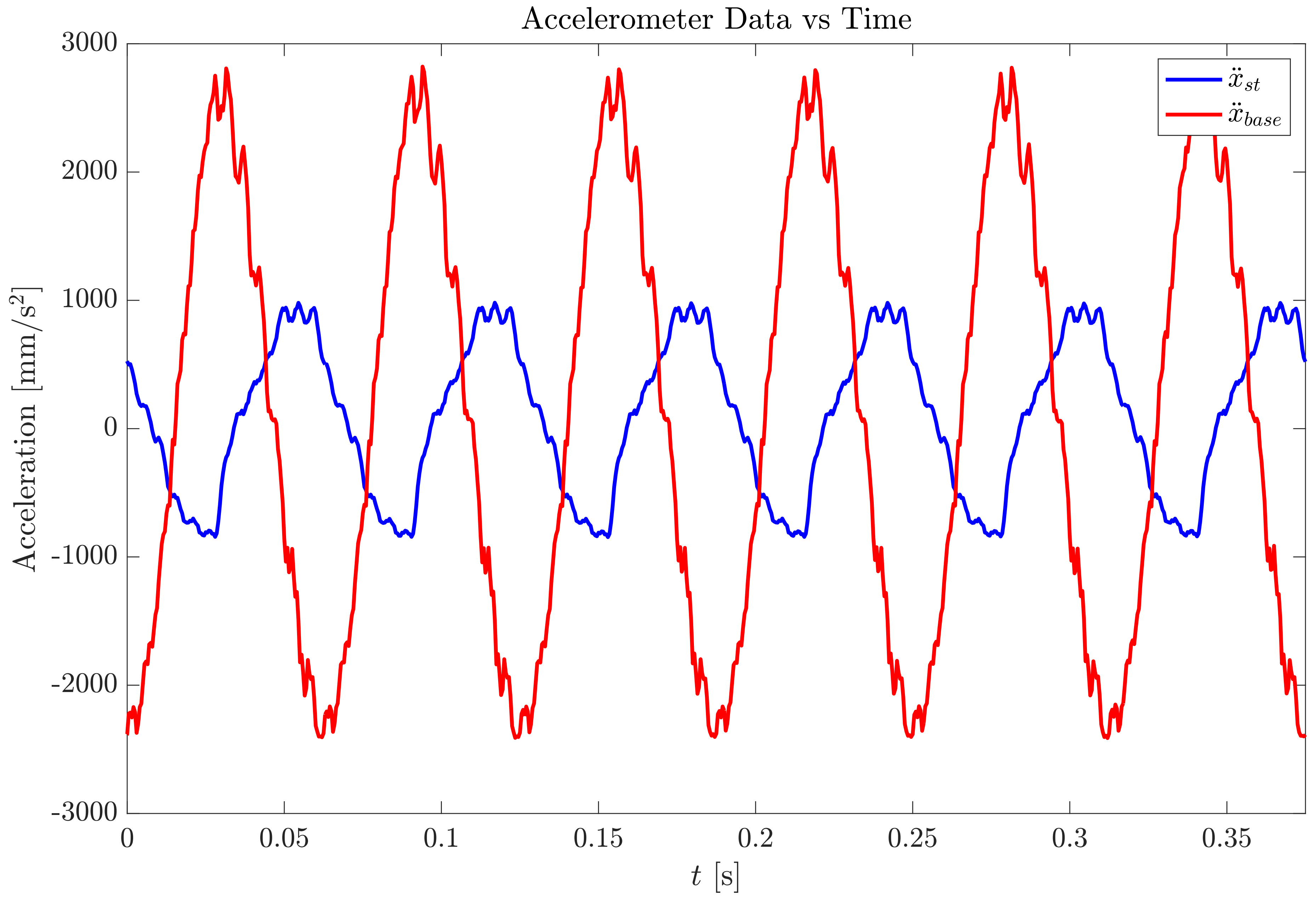

Figure - Experiment result for $f = 16$ Hz

Case 8 - $f = 18$ Hz

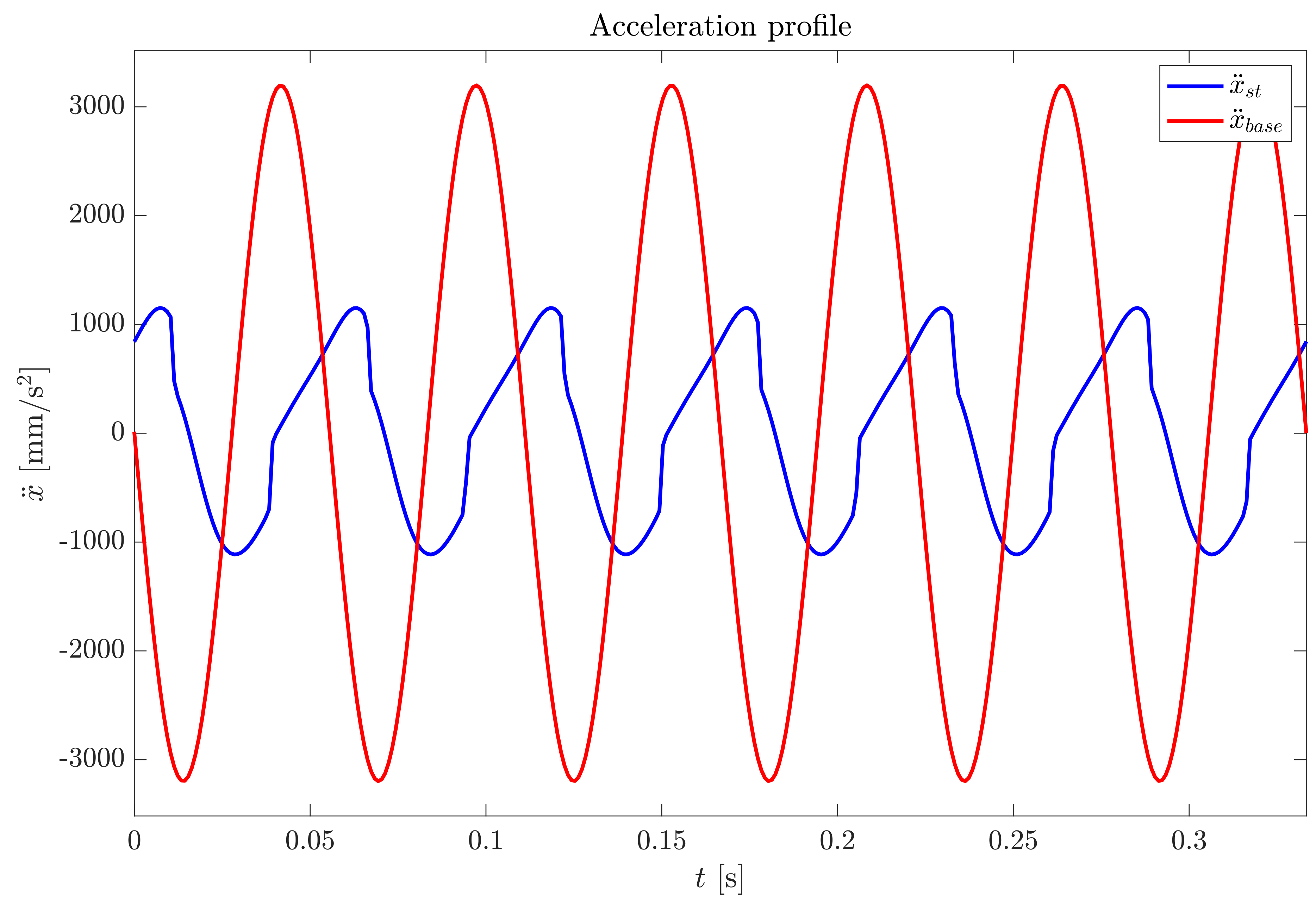

Figure - Simulation result for $f = 18$ Hz

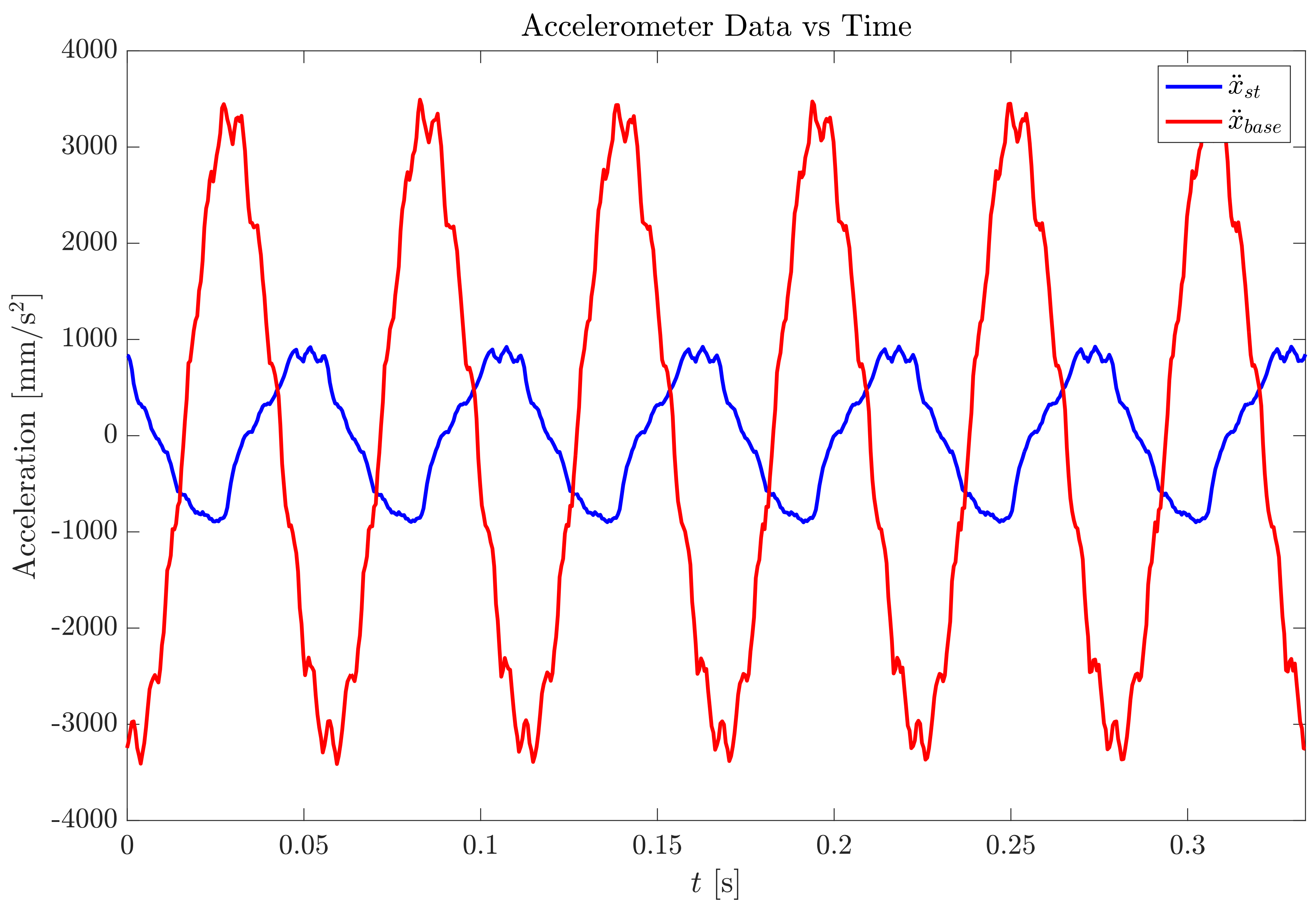

Figure - Experiment result for $f = 18$ Hz

Case 9 - $f = 20$ Hz

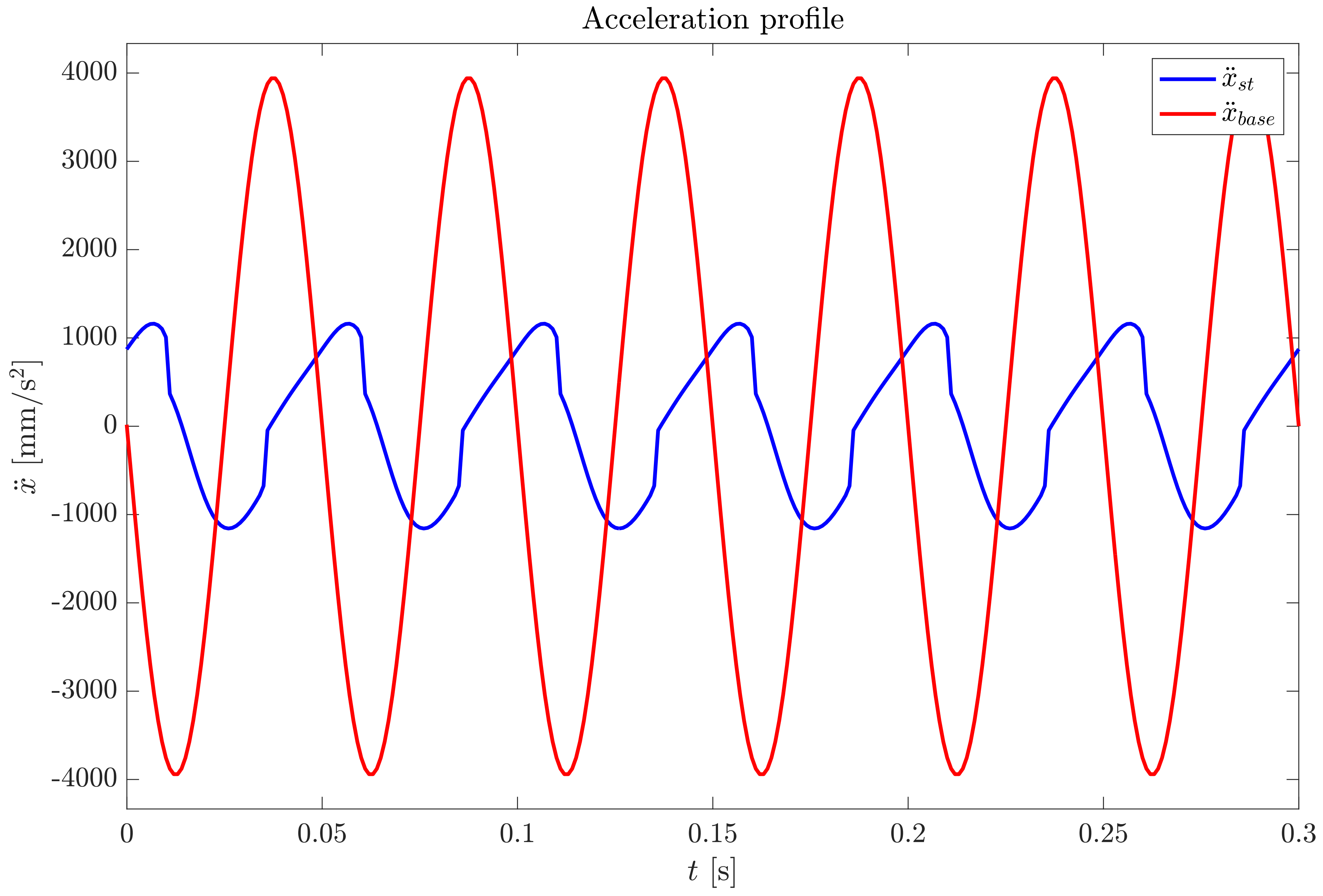

Figure - Simulation result for $f = 20$ Hz

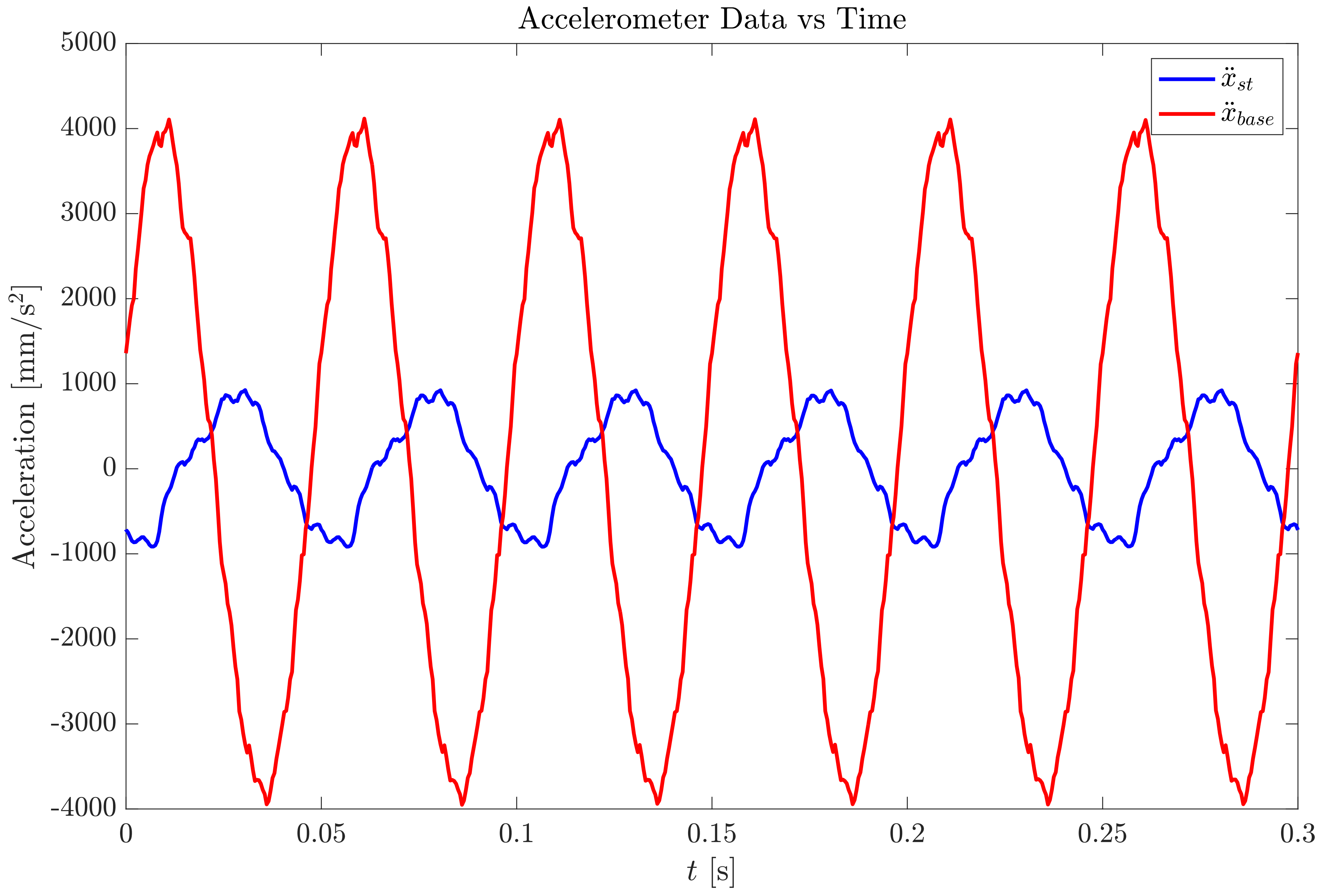

Figure - Experiment result for $f = 20$ Hz

The temporal profile is **closer** to the experimental one!

Case 10 - $f = 22$ Hz

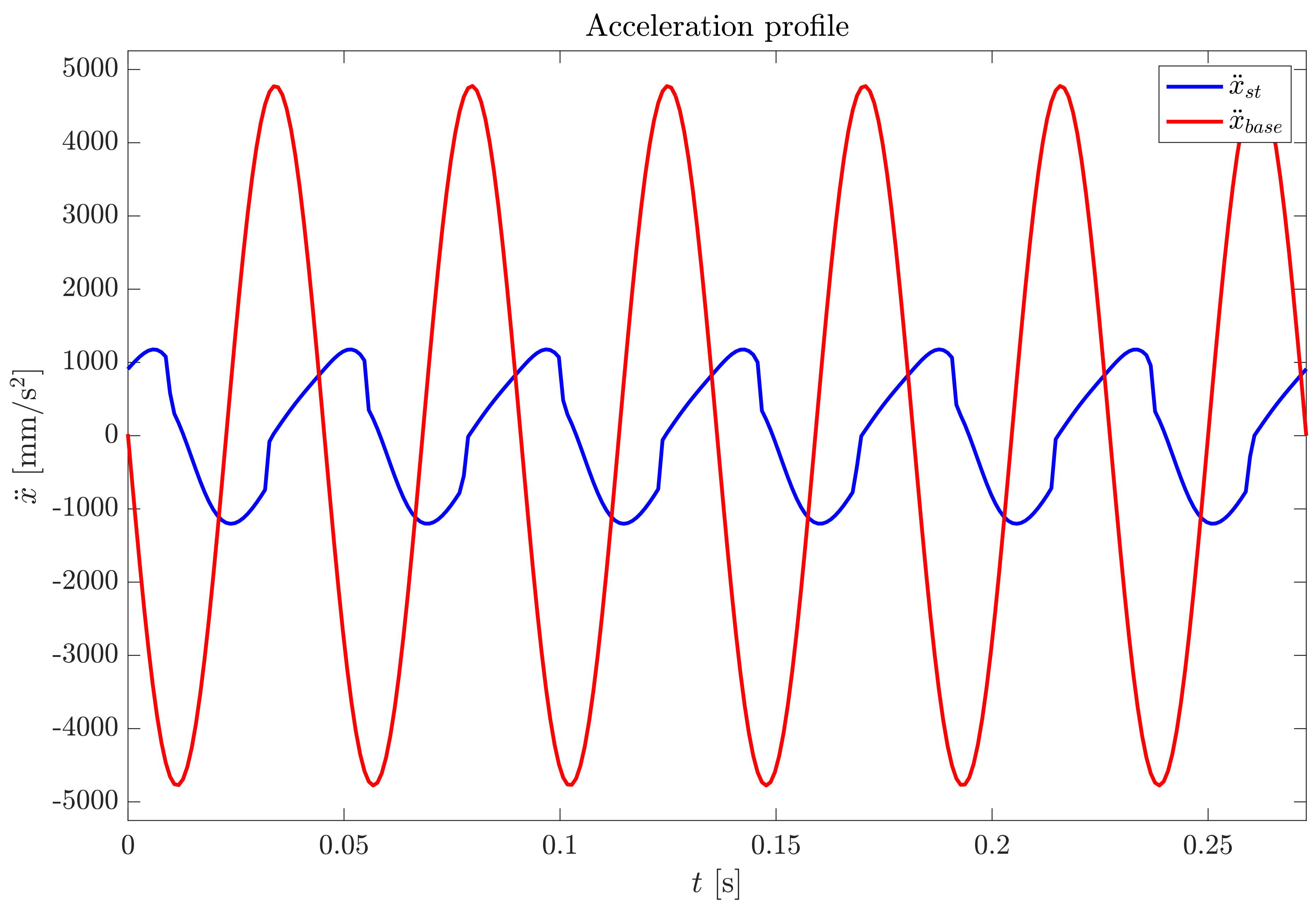

Figure - Simulation result for $f = 22$ Hz

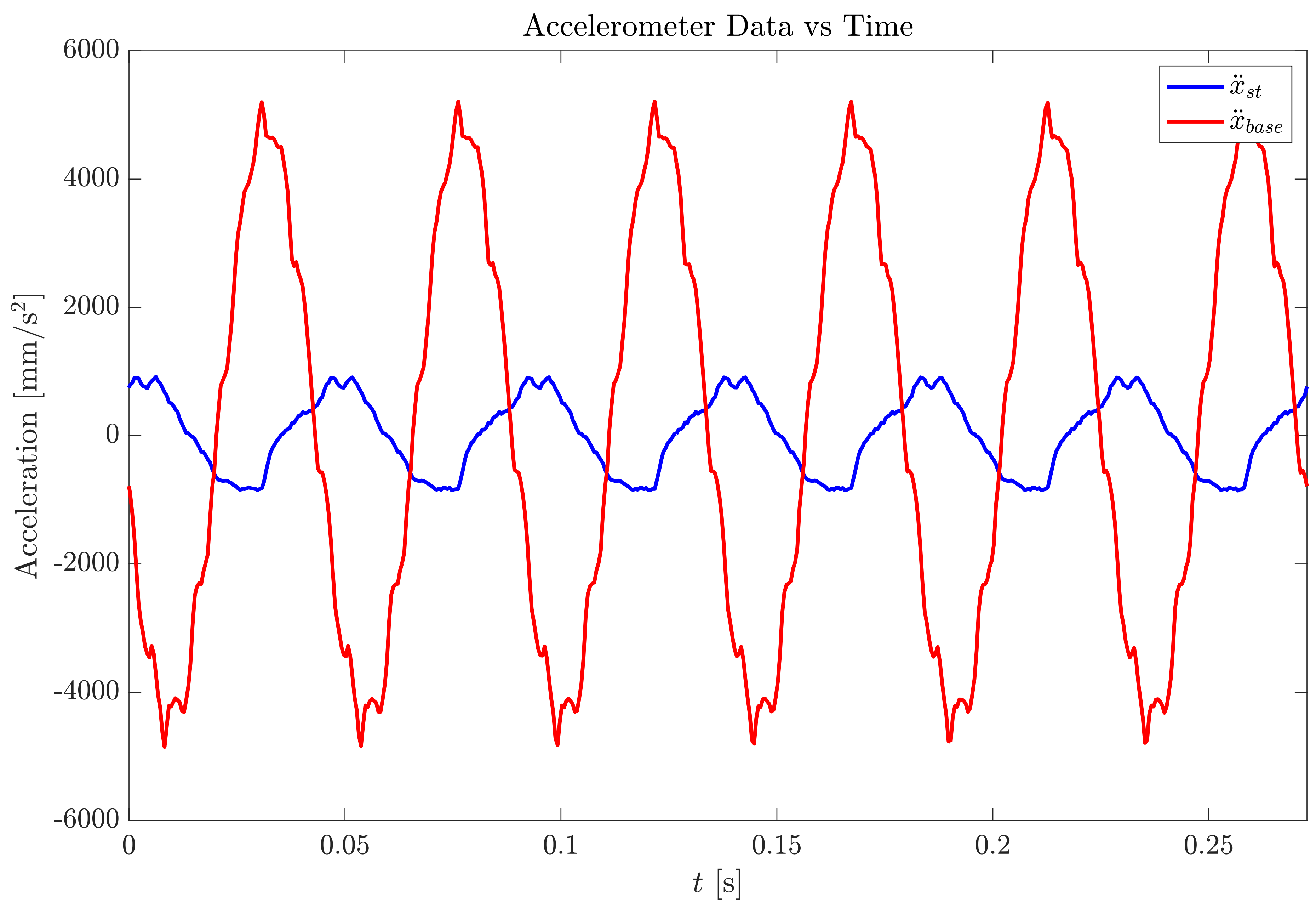

Figure - Experiment result for $f = 22$ Hz

Case 11 - $f = 24$ Hz

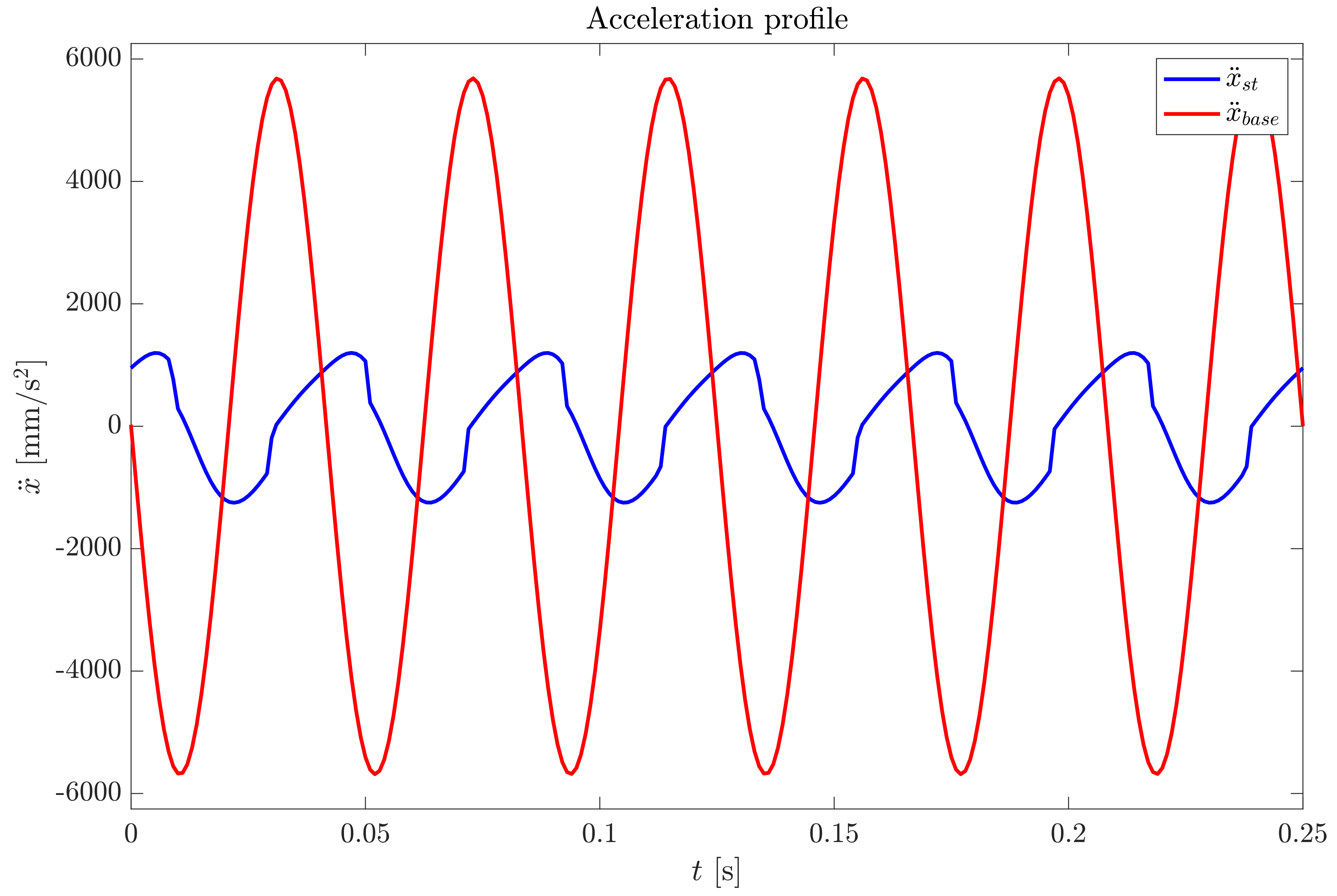

Figure - Simulation result for $f = 24$ Hz

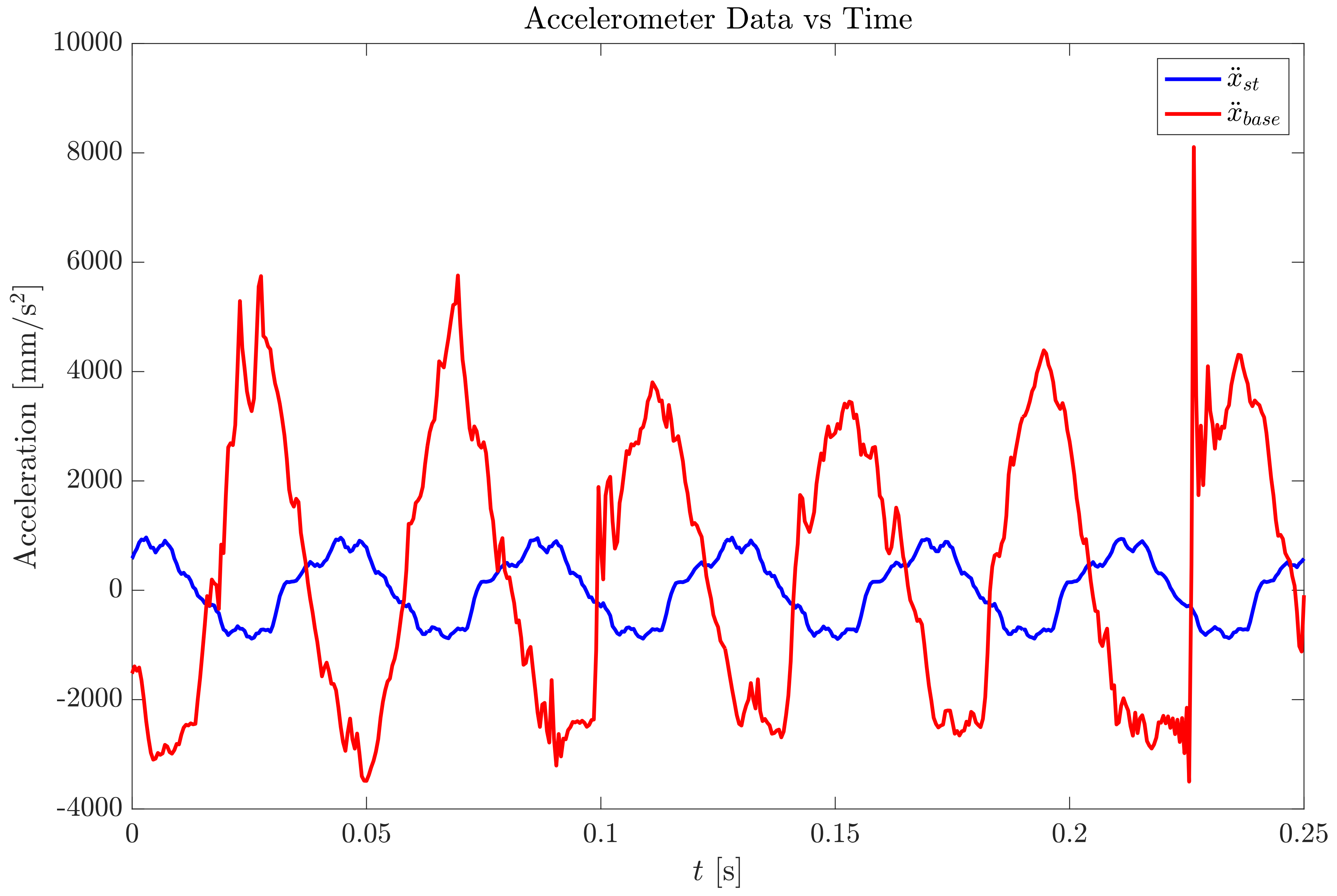

Figure - Experiment result for $f = 24$ Hz

Case 12 - $f = 26$ Hz

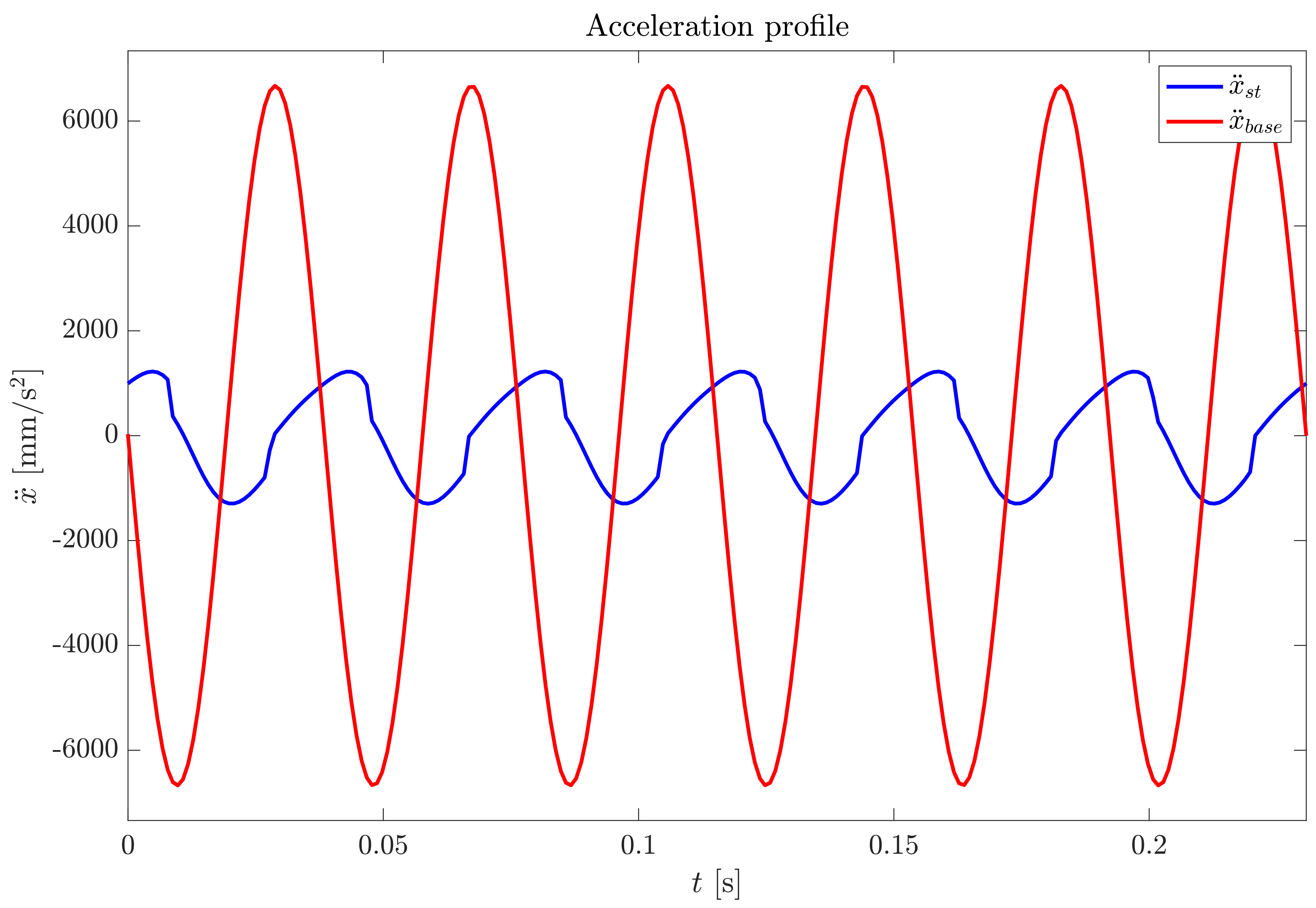

Figure - Simulation result for $f = 26$ Hz

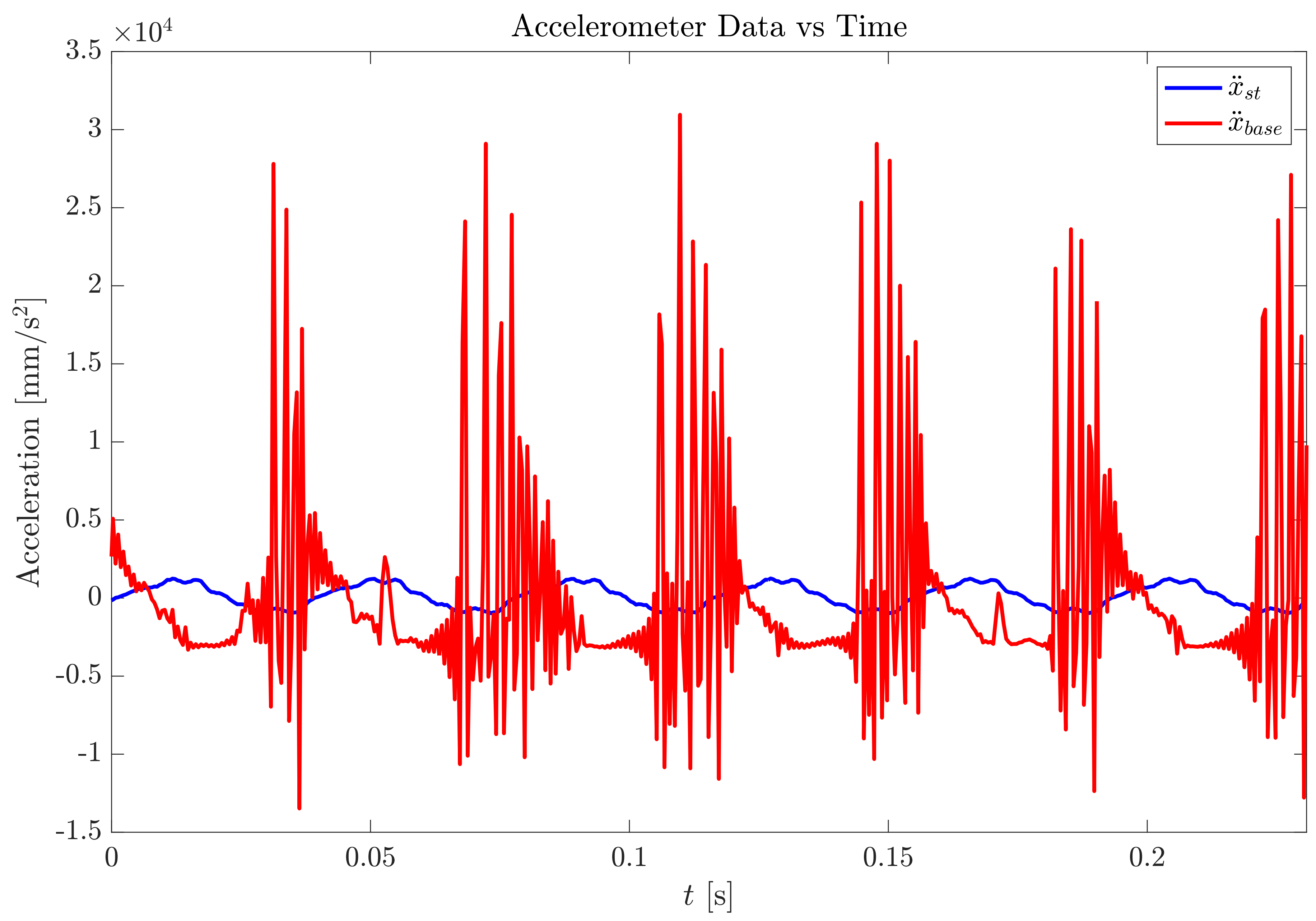

Figure - Experiment result for $f = 26$ Hz

Motion Transmissibility Results

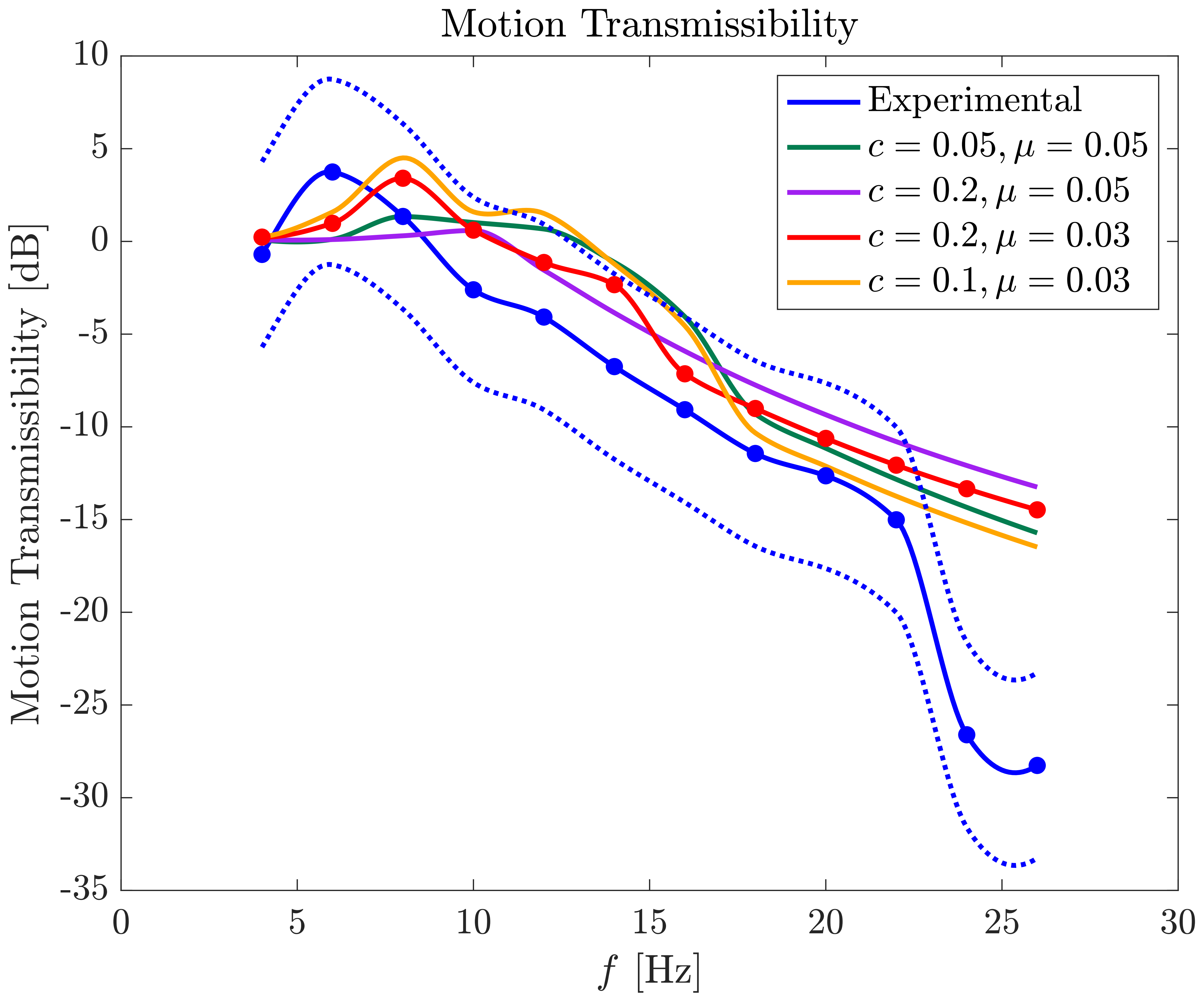

Figure - Motion Transmissibility curves for different (c, μ) pairs

Comparing Damping Models

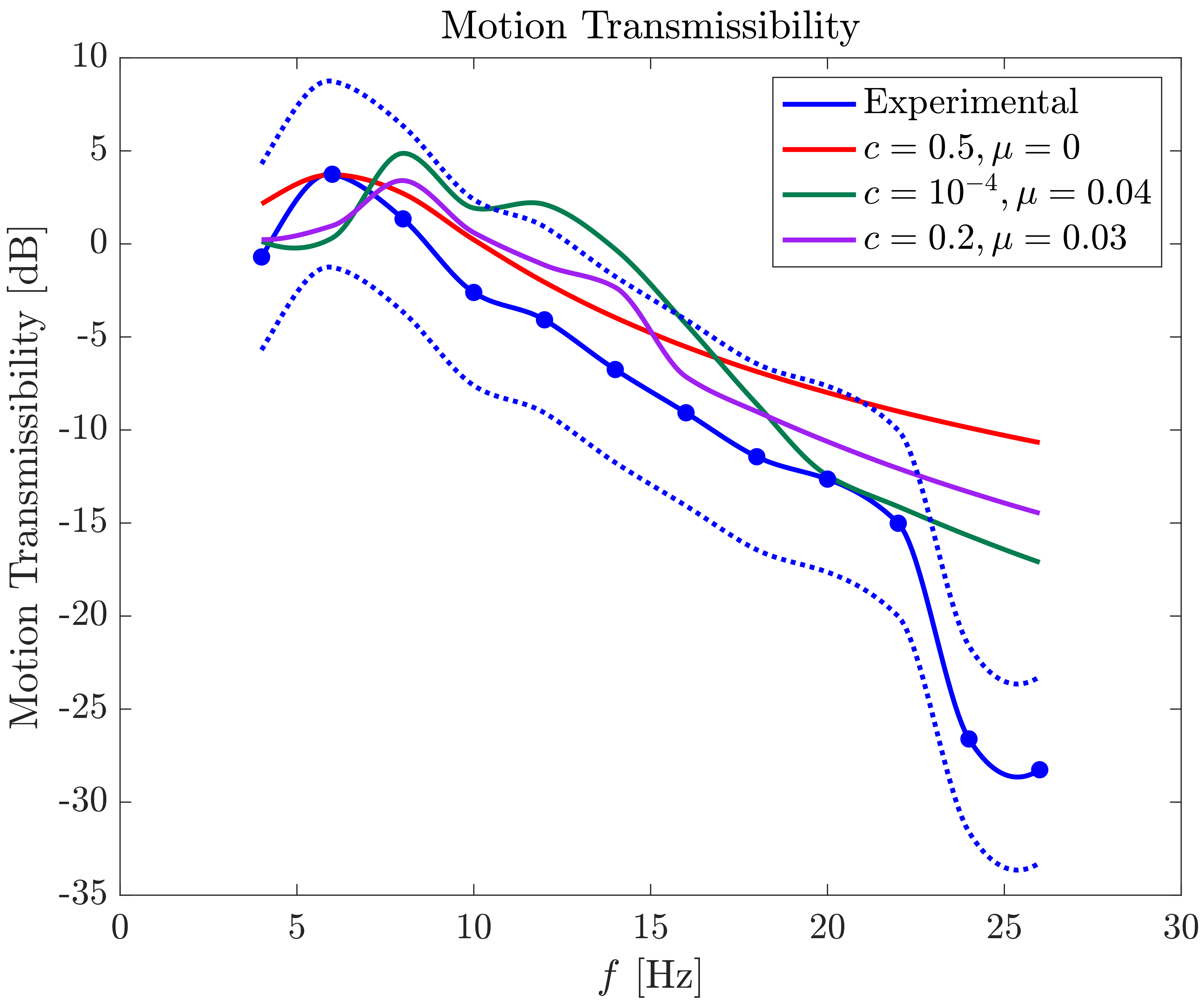

Figure - Comparison of different damping models

- **Viscous damping** best captures the motion transmissibility behavior in the **low frequency** range
- **Coulomb friction** best captures the motion transmissibility behavior in the **high frequency** range

Simulation - Experiment 2

PARAMETERS -

- $h_1/\tau = h_2/\tau = 1.41$
- $E = 210$ GPa
- $m = 6.3$ kg
- $x_{base}(t) = 0.1\sin(2\pi f t)$ (in mm)

f is the frequency of the base excitation, which is varied from **4 Hz to 26 Hz** at intervals of **2 Hz**

DAMPING CASES -

- $c = 0.5$ Ns/mm, $\mu = 0$
- $c = 10^{-4}$ Ns/mm, $\mu = 0.04$
- $c = 0.2$ Ns/mm, $\mu = 0.03$

Motion Transmissibility Results

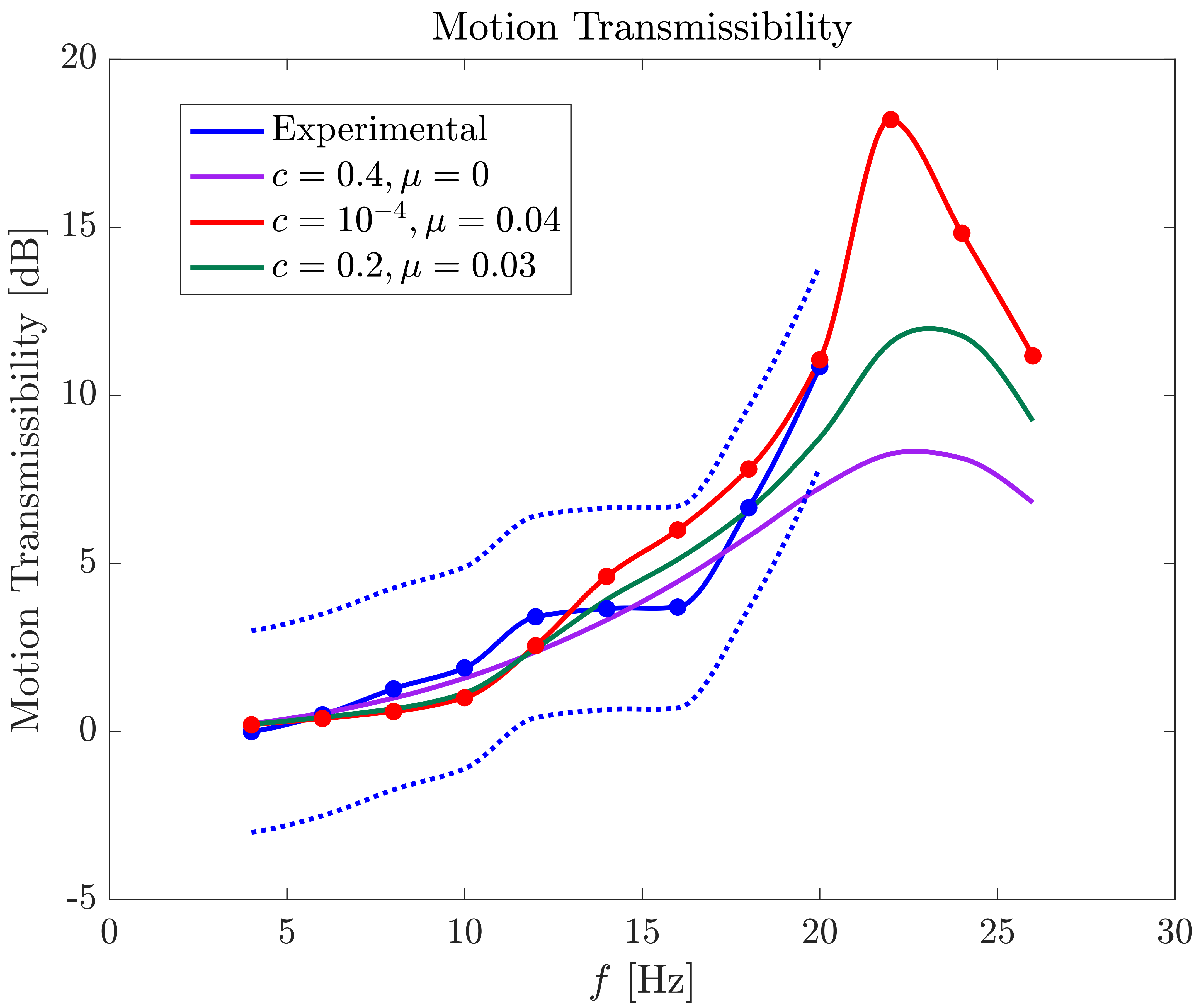

Figure - Motion Transmissibility curves for different damping models

- All 3 models predict resonance frequency between **20-24 Hz**
- Similar to Experiment 1, viscous damping and Coulomb friction best capture the motion transmissibility in the low and high frequency ranges respectively.