

## **Chapter 6**

### **Vibration Prediction for Inside the Cab**

Structural vibration predictions presented in the previous chapter indicate a high correlation between the experimental and analytical vibration results. A further validation of the analytical prediction process is presented in this chapter. The analytical model is used to approximate vibrations at select locations inside the cab. Comparisons of the predicted and actual results in hard-mounted and soft-mounted configurations will be made. For the soft-mounted case, comparison of the results will be made for three sets of mounts with varying vertical stiffness.

#### **6.1 Hard-Mounted Cab Results**

Acceleration data for the hard-mounted cab was collected at four locations inside the cab, as described in section 3.4. The locations where the data was collected were on the conductor console, cab floor, CA1 cabinet door, and on the floor opposite the lavatory door. The process followed to compare the test results with the analytical predictions is as described earlier in Fig. 5.1.

As noted in the previous chapter, the experimental results were used in conjunction with the MATLAB code to predict the velocities at various locations. The hard-mounted cab approximations, shown in Figs. 6.1-6.4, were generated using the results of the cab with soft mounts with a vertical stiffness of 23,300 lb/in.

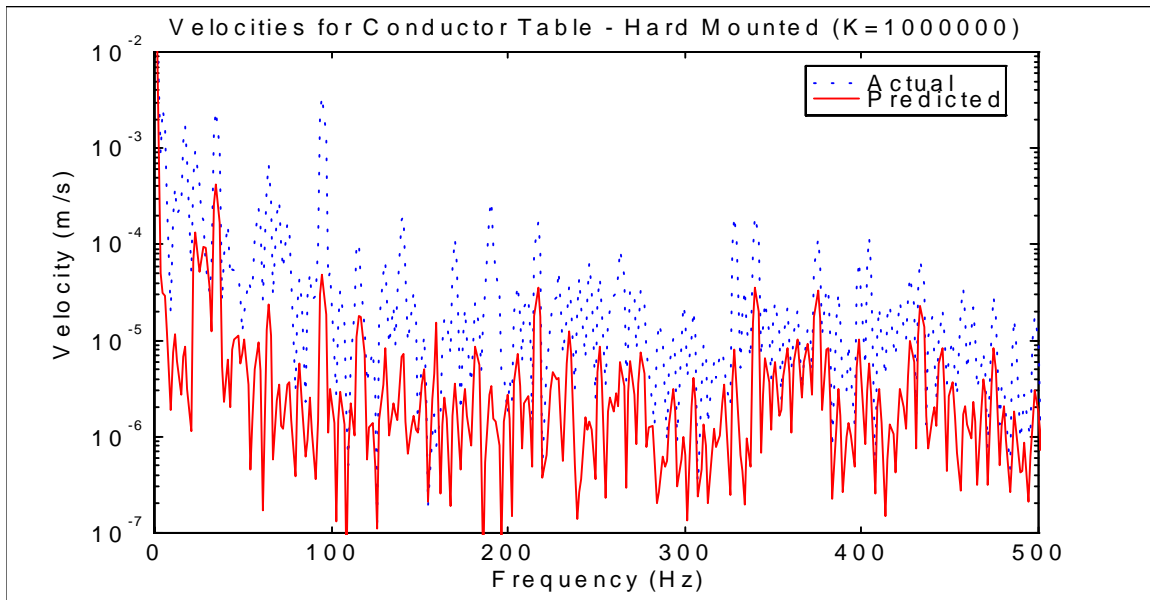


Figure 6.1 Comparison Between Actual and Predicted Results for the Hard-Mounted Case ( $K=1,000,000$  lb/in) at Conductor Table

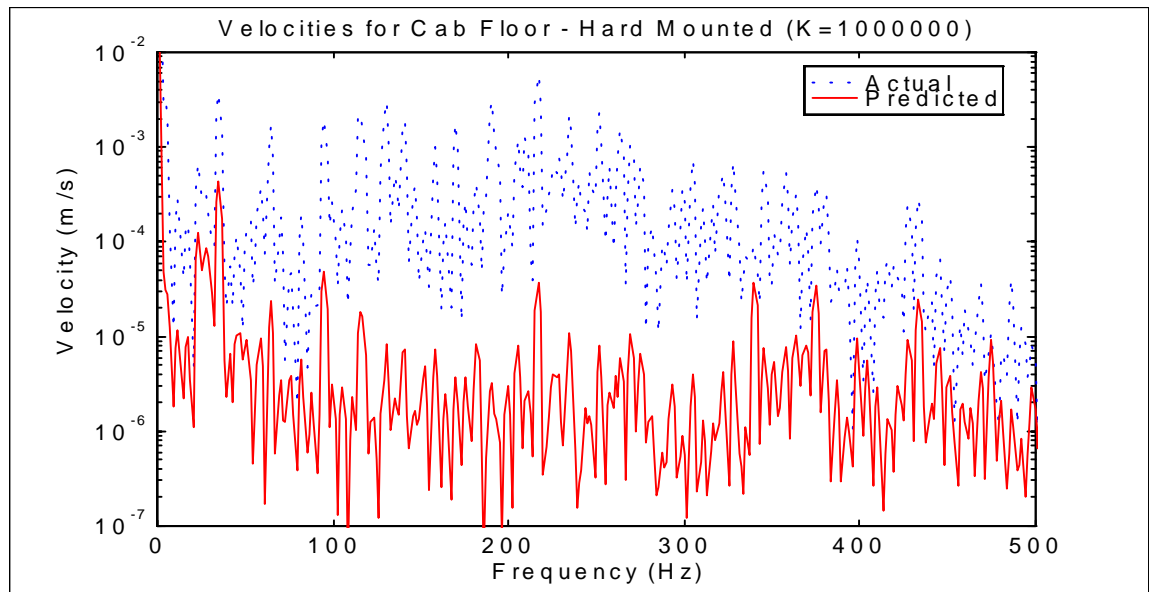


Figure 6.2 Comparison Between Actual and Predicted Results for the Hard-Mounted Case ( $K=1,000,000$  lb/in) at Cab Floor

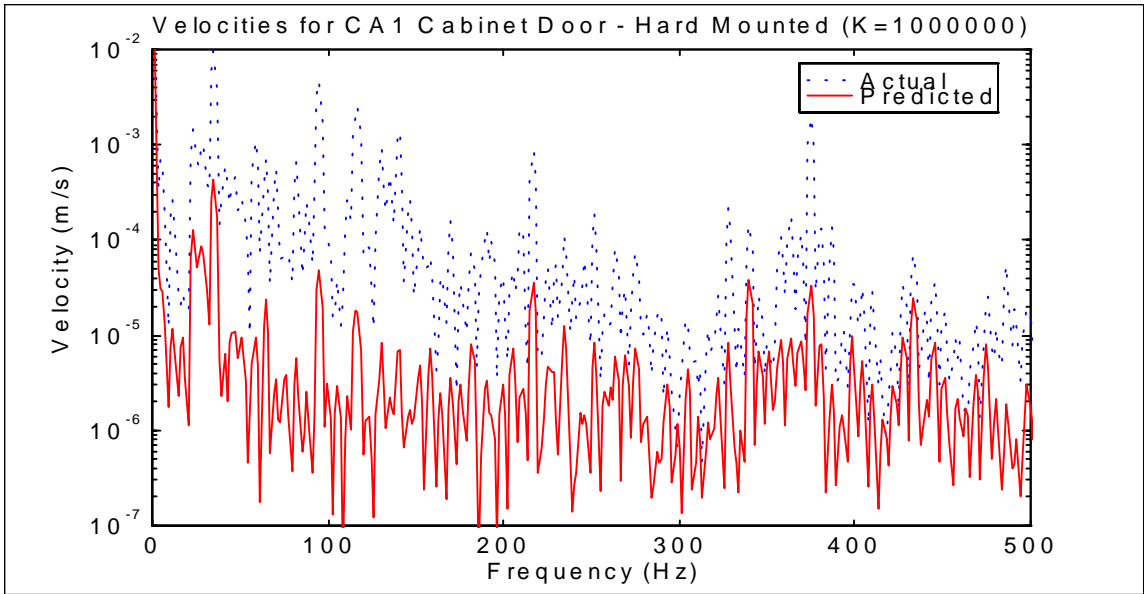


Figure 6.3 Comparison Between Actual and Predicted Results for the Hard-Mounted Case ( $K=1,000,000$  lb/in) at CA1 Cabinet Door

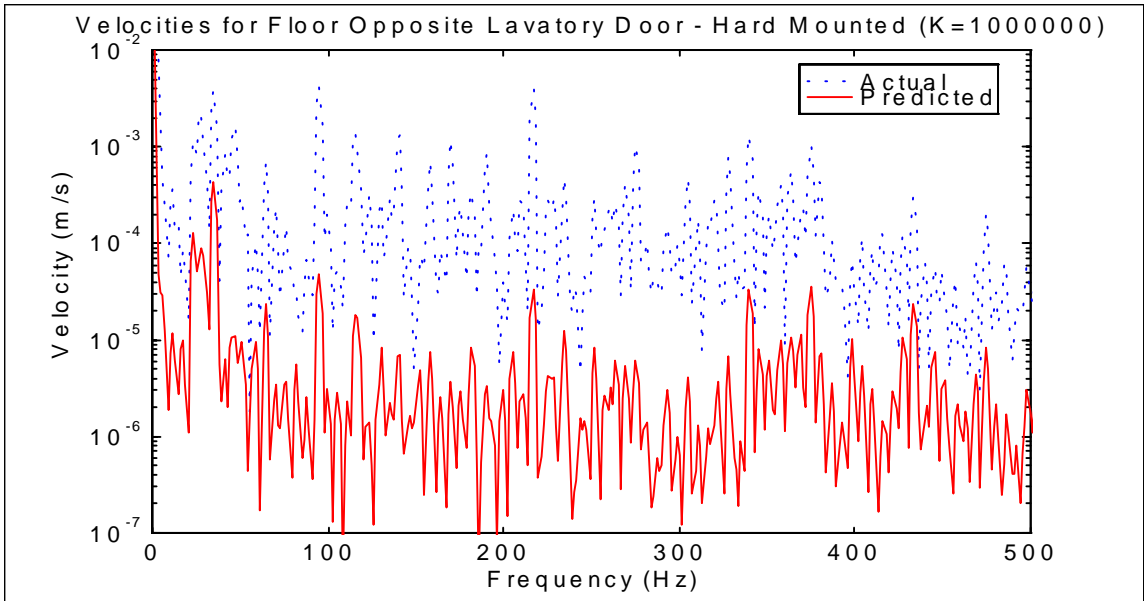


Figure 6.4 Comparison Between Actual and Predicted Results for the Hard-Mounted Case ( $K=1,000,000$  lb/in) at Floor Opposite Lavatory Door

The results of the experiment reveal the conductor console prediction to be the only case where the model approximations closely resemble the actual velocity results. The cab floor results show a good correlation in the frequency range of 0 to 50 Hz and 450 to 500 Hz. Although the trends in the remainder of the frequency range do not correlate well with the actual velocities, various velocity peaks at discrete frequencies, such as 225 Hz, matched.

The CA1 cabinet door results also demonstrate a high correlation to the actual velocities in the frequency range of 0 to 50 Hz and 200 to 500 Hz. Similar to the cab floor, velocity peaks in the remaining frequency range matched up with the experimental values.

Finally, the results for the floor opposite the lavatory door illustrate a good correlation from 0 to 50 Hz. The trends in the remainder of the frequency range also show similar trends. The differences in the results can possibly be attributed to localized vibration effects as well as the nonlinearities in the structure.

## **6.2 Soft-Mounted Cab Results**

Acceleration data for the soft-mounted cab was collected at the same four locations in the cab as the hard-mounted case. The cab was installed on four elastomeric mounts at its four corners. The results of the cab in the soft-mounted configuration will be reviewed in a manner similar to the previous chapter. Configuration A will refer to the cab having mounts with a vertical stiffness of 10,000 lb/in, while configurations B and C will refer to the cab having mounts with a vertical stiffness of 16,700 and 23,300 lb/in, respectively.

### **6.2.1 Configuration A - Soft-Mounted Cab**

The results of the isolated cab shown in Figs. 6.5-6.8 revealed a better correlation between the analytical prediction and experimental results than the hard-mounted case. The results from the cab having soft mounts with a vertical stiffness of 16,700 lb/in were used to approximate the velocities. The conductor table and CA1 cabinet door velocities were found to have similar amplitudes when compared to the actual results, and they also followed similar trends throughout the frequency range.

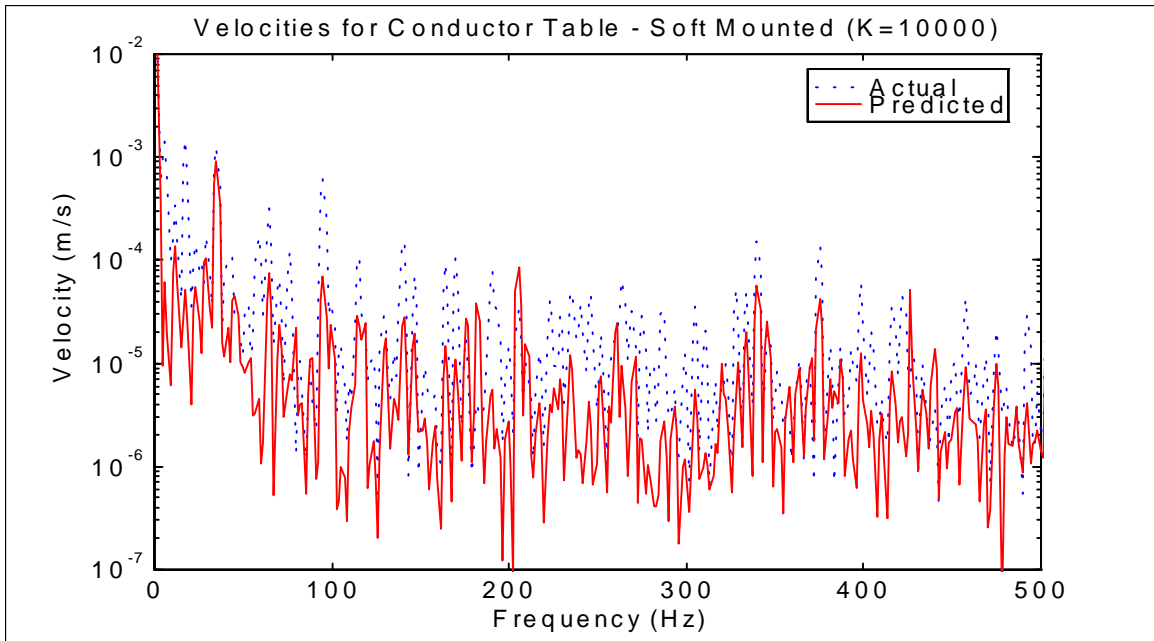


Figure 6.5 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=10,000$  lb/in) at Conductor Table

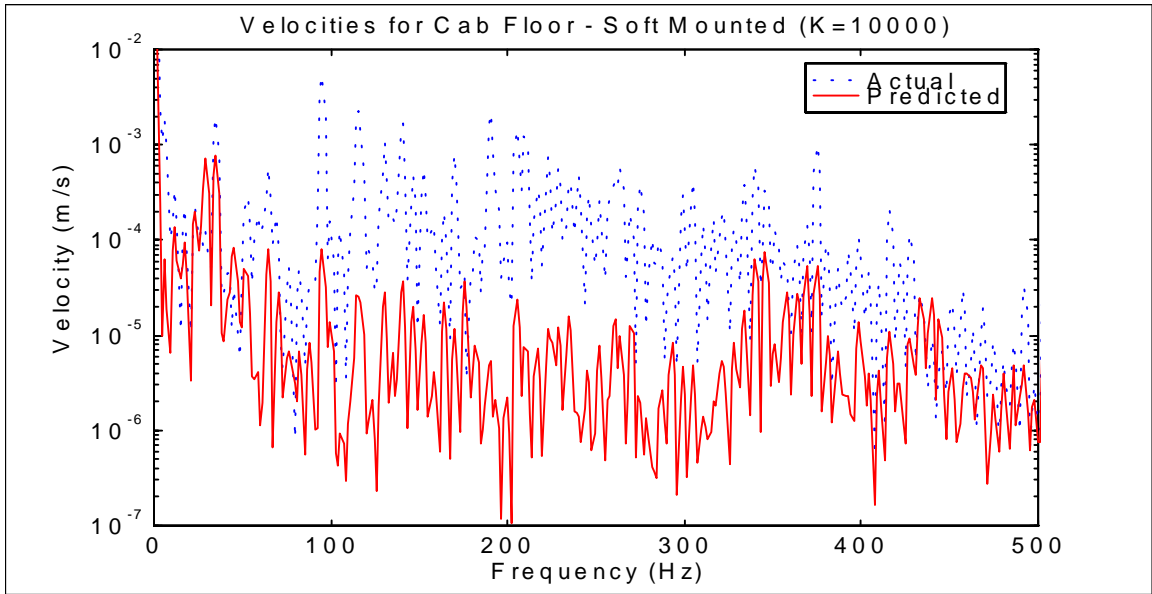


Figure 6.6 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=10,000$  lb/in) at Cab Floor

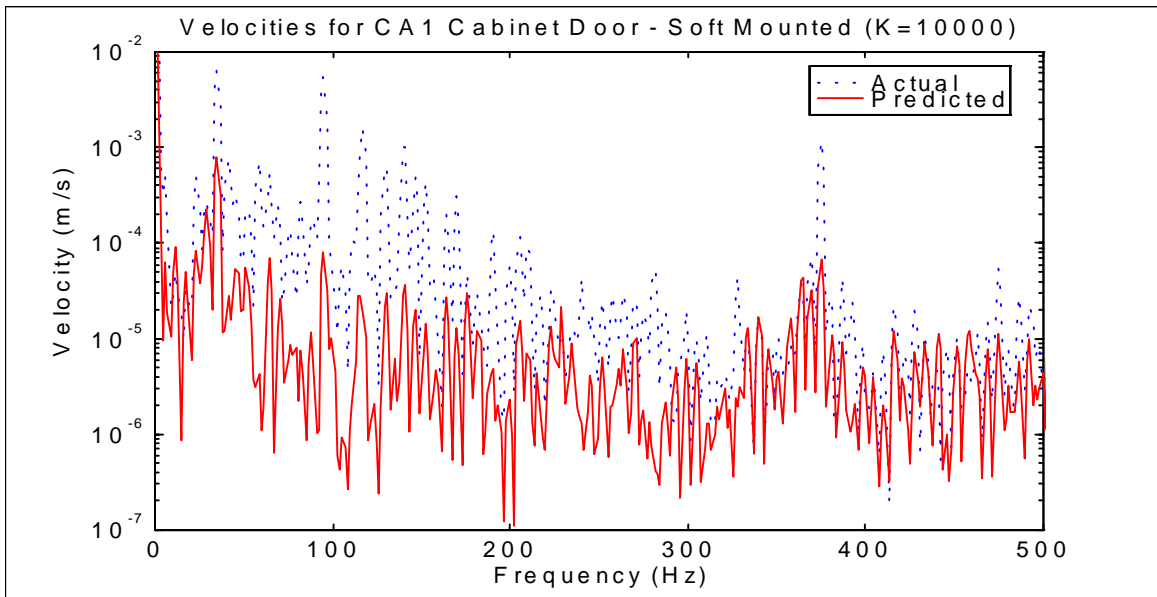


Figure 6.7 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=10,000$  lb/in) at CA1 Cabinet Door

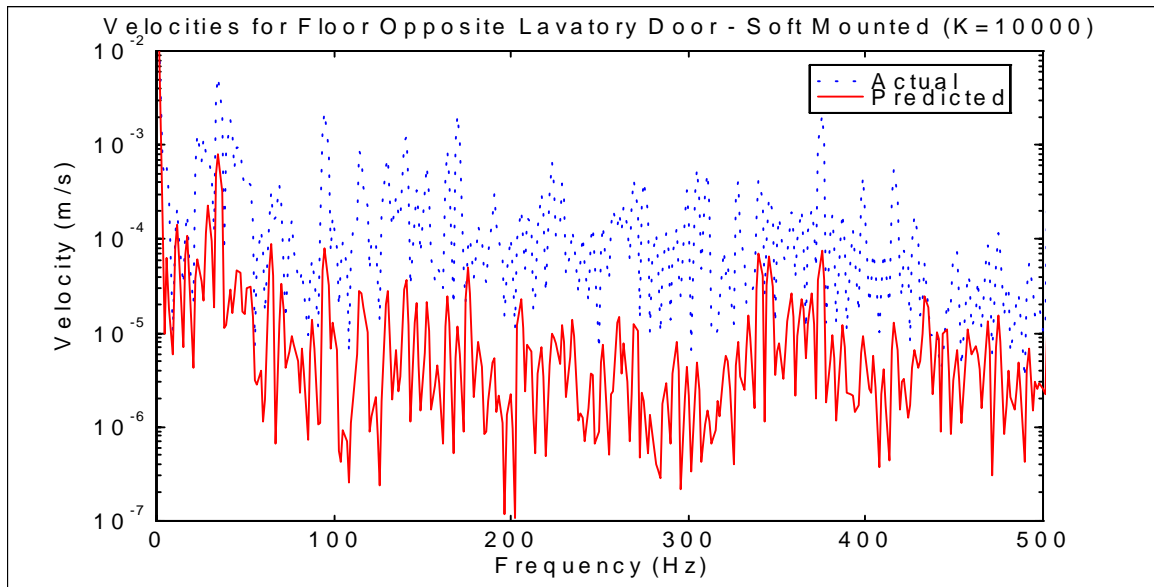


Figure 6.8 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=10,000$  lb/in) at Floor Opposite Lavatory Door

The results of the remaining locations are not identical to the actual velocities, but they did show similar trends. The velocity approximations of the cab floor correlate well to the experimental data in the frequency range of 0 to 100 Hz and 350 to 500 Hz, while the results for the floor opposite the lavatory show a high correlation only below 50Hz.

The results of soft-mounting the cab are also evident in the configuration A figures. The amplitude levels at all four locations inside the cab decreased due to the effect of isolation.

### 6.2.2 Configuration B - Soft-Mounted Cab

The results for configuration B are shown in Figs. 6.9-6.12. The results were generated using the experimental data of the cab while it was soft-mounted with mounts having a vertical stiffness of 10,000 lb/in. As with the previous configuration, a comparison

between the analytical and experimental results reveal that the velocities of the conductor's console and CA1 cabinet door have a high correlation. However, the cab floor along with the floor opposite the lavatory door, had noticeable differences between the predicted and actual results.

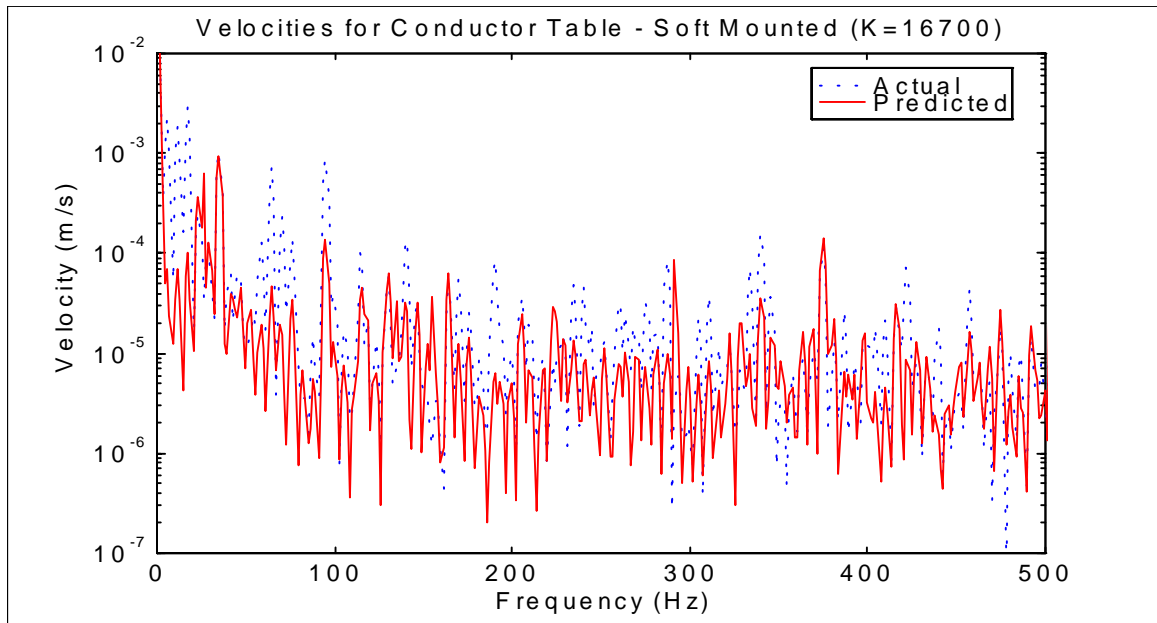


Figure 6.9 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=16,700$  lb/in) at Conductor Table



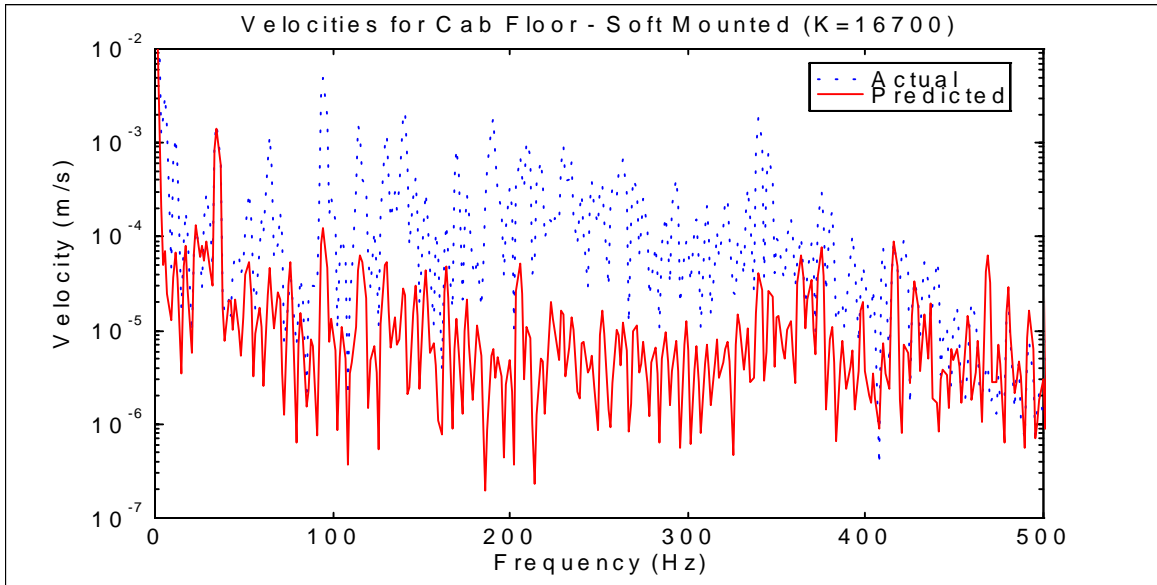


Figure 6.10 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=16,700$  lb/in) at Cab Floor

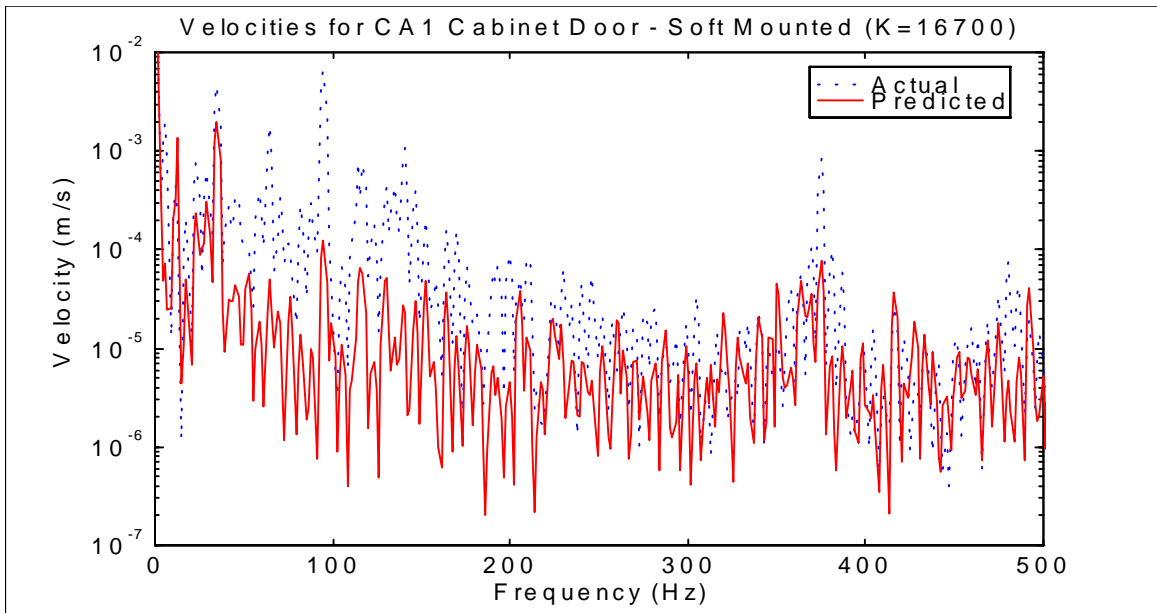


Figure 6.11 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=16,700$  lb/in) at CA1 Cabinet door

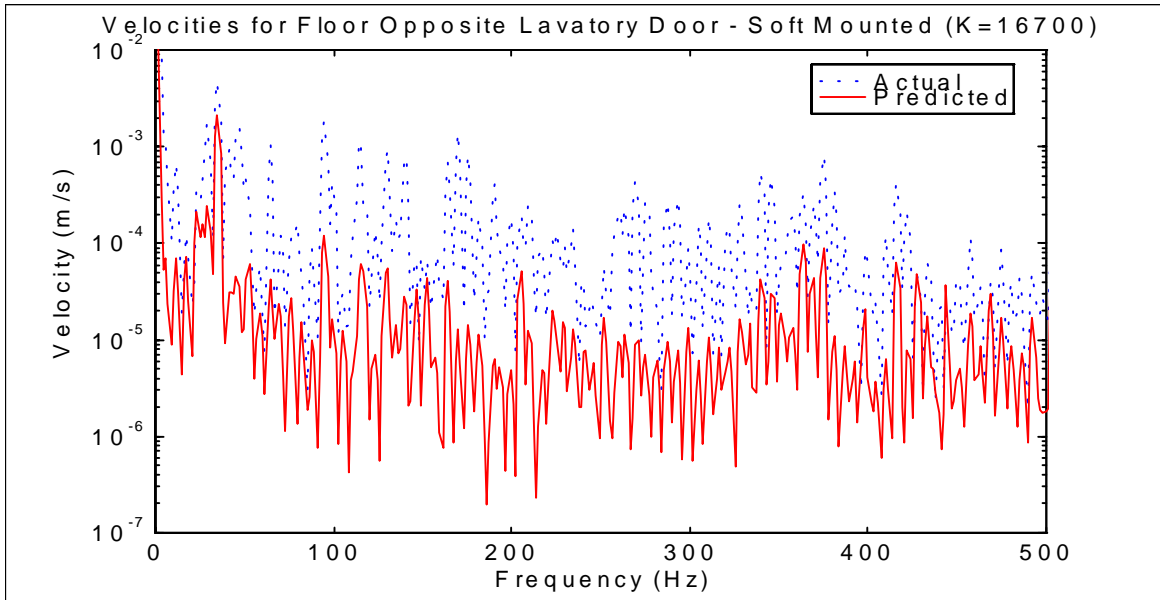


Figure 6.12 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=16,700$  lb/in) at Floor Opposite Lavatory Door

### 6.2.3 Configuration C - Soft-Mounted Cab

The final configuration of the soft-mounted cab was performed using the results of the 10,000 lb/in soft mounts. The results, shown in Figs. 6.13 - 6.16, follow the same trends as the results in the previous configurations. The predicted velocities for the conductor console and CA1 cabinet door are quite similar to the actual velocities.

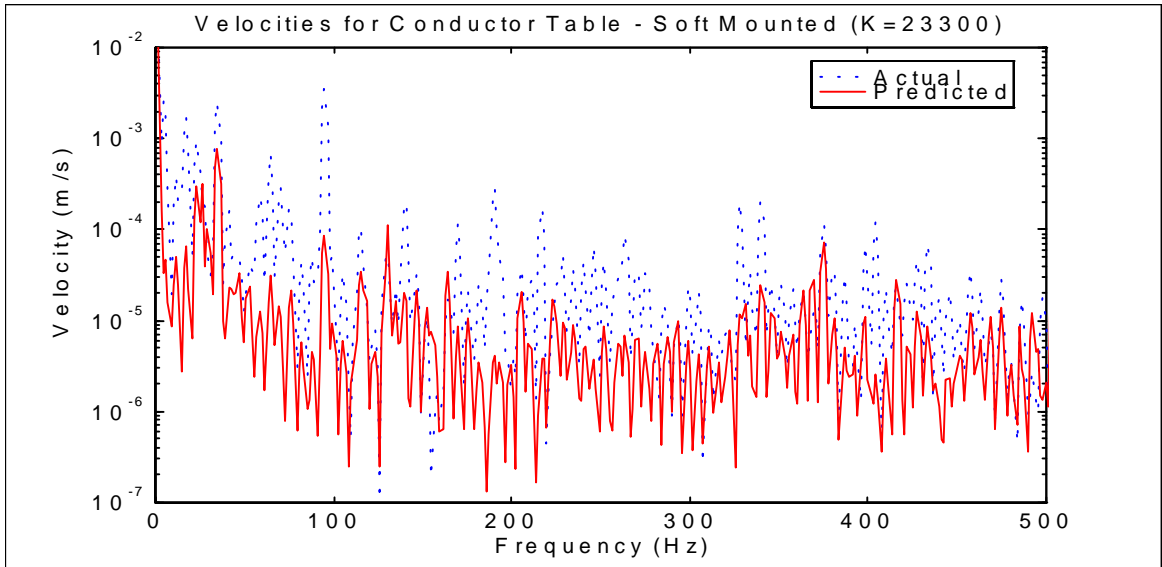


Figure 6.13 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=23,300$  lb/in) at Conductor Table

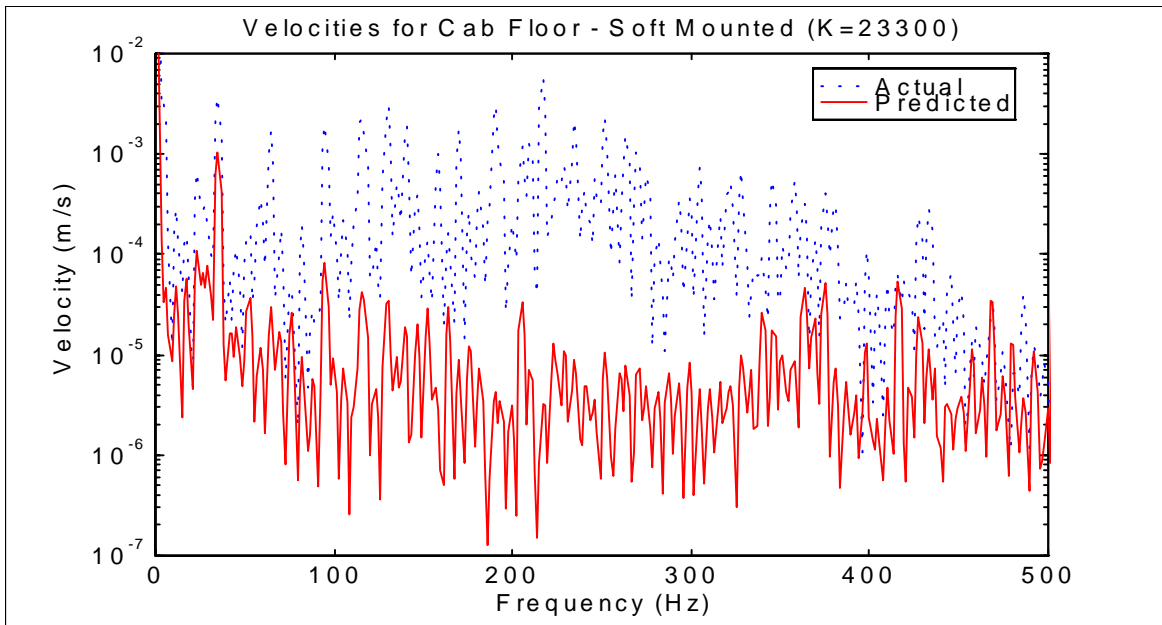


Figure 6.14 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=23,300$  lb/in) at Cab Floor

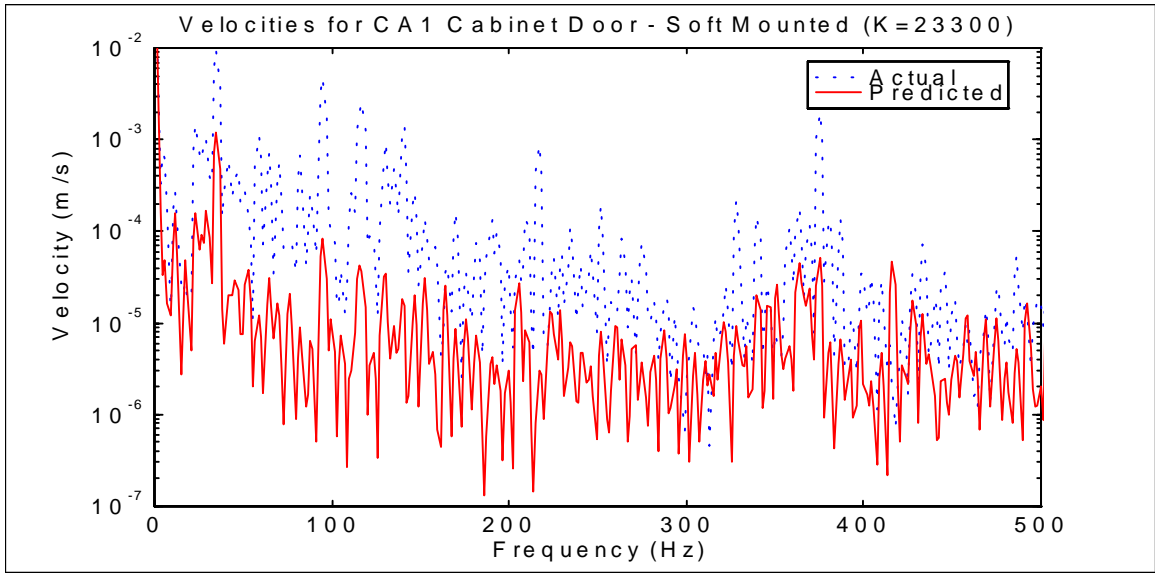


Figure 6.15 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=23,300$  lb/in) at CA1 Cabinet Door

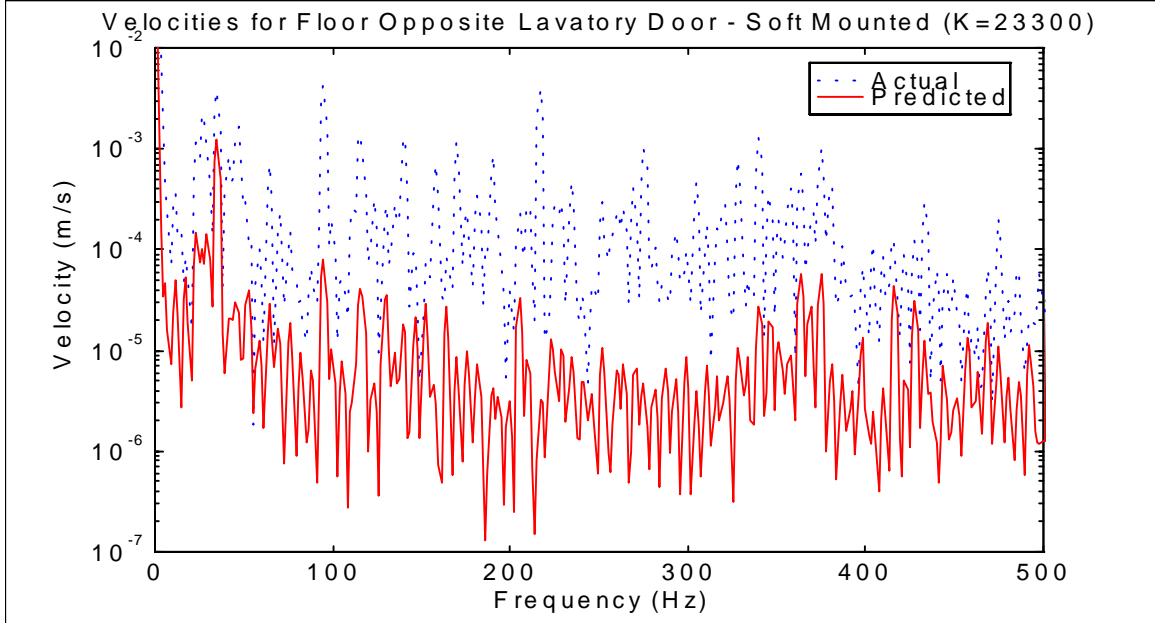


Figure 6.16 Comparison Between Actual and Predicted Results for the Soft-Mounted Case ( $K=23,300$  lb/in) at Floor Opposite Lavatory Door

### 6.3 Concluding Remarks

Table 6.1 is shown to quantify the relationship between the predictions and experimental values for data points inside the cab. The mean, RMS, and standard deviation between the predicted velocities and actual velocities for the hard-mounted as well as a single soft-mounted case are shown. From the statistical results, it can be concluded that the prediction model is not as accurate in predicting structural vibrations for points within the cab as it is for locations outside the cab.

Table 6.1 Error Criteria for Experimental and Analytical Predictions

Configuration	Location	Mean ( $\mu$ )	RMS	Standard Dev. ( $\sigma$ )
Hard-Mounted k=1,000,000 lb/in	Conductor Table	2.73E-05	1.42E-04	1.40E-04
	Cab Floor	1.37E-04	8.38E-04	8.26E-04
	CA1 Cabinet Door	8.50E-05	4.86E-04	4.78E-04
	Floor Opp. Lavatory	1.23E-04	4.06E-04	3.87E-04
Soft-Mounted k=10,000 lb/in	Conductor Table	1.64E-04	3.16E-03	3.16E-03
	Cab Floor	1.26E-04	4.66E-04	4.49E-04
	CA1 Cabinet Door	7.86E-05	4.07E-04	3.99E-04
	Floor Opp. Lavatory	1.18E-04	3.53E-04	3.33E-04

The results of these experiments provided further validation of the analytical technique and generated additional questions on the merits of the method. Analysis of a very complex structure can provide some of the reasons for the miss-match between the predicted and actual results. In order to further validate the prediction technique such that it can be applied to a variety of other configurations, experiments on a less complex structure should be completed. A less complex structure will make it possible to differentiate the precise effects of different mounting systems. Another possibility is to modify prediction model so that the impedance characteristics of each mount is accounted for in the vibration approximations of the interior locations.