

Small Bore Bypass Line Vibration Control

ZetaQuest Technologies, LLC has developed vibration damping hardware for use with piping and other mechanical systems that is ideal for control of resonant vibration on small bore piping. Small-bore piping resonances can result in fatigue failure of the piping that can be prevented by adding adequate damping to the piping system.

Bypass Line

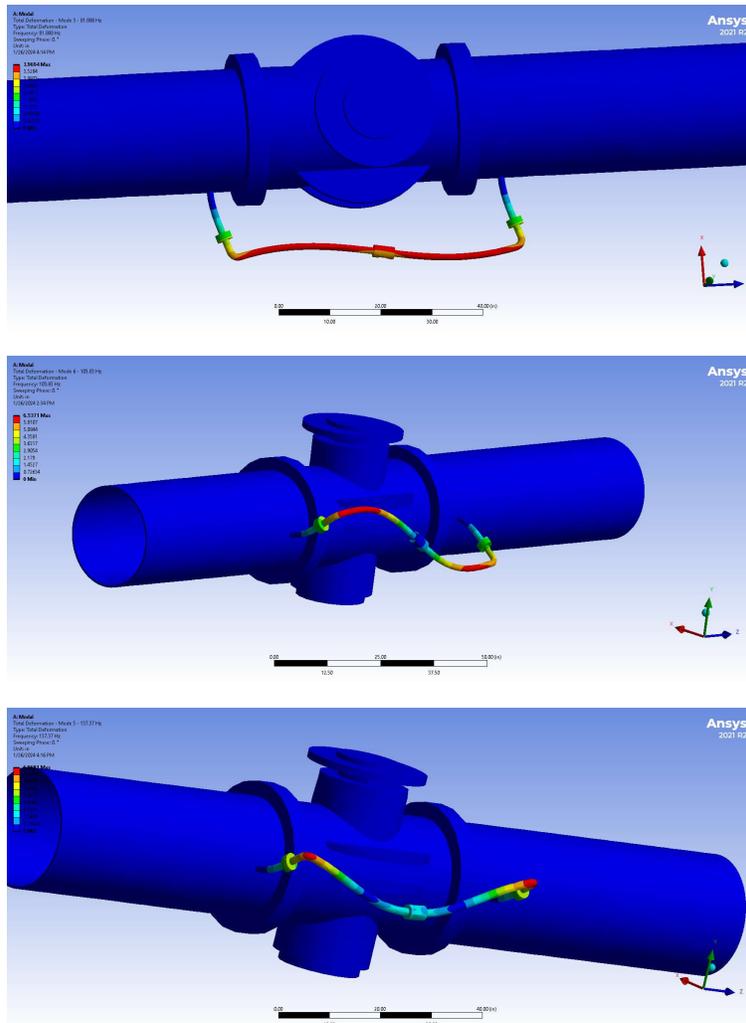
One common vibration issue is on small-bore pipe such as a bypass around a large valve or other routed lines connected to larger pipe. An example of a common bypass arrangement is shown below. The bypass piping will have natural frequencies that are excited by vibration of the main pipe. When this occurs, the vibration on the small-bore line can be as much as 30-100 times higher than the main pipe.



An example of a basic bypass line with two ZetaQuest dampers installed is shown above. The damper orientation is selected based on the mode shapes and direction of high vibration. For this example, the dominant vibration was in the vertical direction at both elbows as well as axial in the direction of flow in the main pipe. If the dominant vibration was vertical near the small ball valve, a damper would have been located near the valve to control vibration of the middle of the bypass line.

Selection

The system was modeled to determine the natural frequencies and mode shapes with the intent to eliminate a known resonance in the field near 100 Hz. To achieve this, an ANSYS model was used to determine natural frequencies and mode shapes. The results are shown below for the modes nearest 100 Hz, with an axial mode at 82 Hz, a mode at about 104 Hz with out of phase vertical vibration near the elbows, and a mode near 137 Hz with the elbows in phase.

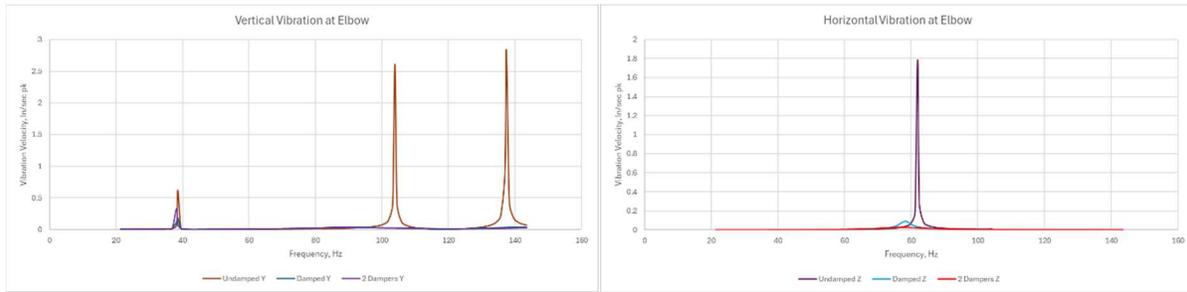


Device Selection

Since the modes of concern were observed near 100 Hz at the elbows and there were resonances both above and below the frequency of concern, two standard product 1.5 lb dampers were selected with one tuned for 85 Hz and the other tuned for 120 Hz. Since the line was symmetric it did not matter which one was put on either end.

Assessment

The ANSYS model was used to estimate the impact of adding dampers by applying a dynamic force to one of the elbows acting in both the Y and Z directions to excite all the modes of interest. The response with and without the dampers is shown below:



In the plots above, the original vibration was near 3 in/sec pk near 100 Hz. With the addition of one damper tuned at 120 Hz, the vibration was greatly reduced with a single peak right below 80 Hz in the horizontal direction. Both dampers were successful at reducing the vibration well below 0.1 in/sec Pk. The calculated damping for all modes from 80-140 Hz was 7-20%.

Conclusion

ZetaQuest clamp on dampers have been proven to eliminate resonance of small-bore piping and to dramatically reduce vibration on small-bore piping. Contact ZetaQuest application engineering support for selection and application guidance.

Product Matrix

The devices are selected based on the damper mass (1.5 Lb, 3 Lb, 6 Lb, 12 Lb or 24 Lb) and the target frequency that the device is optimal at.

Target Frequency, Hz	21.2	30.0	42.4	60.0	84.9
Min Freq, Hz	18.10	25.60	36.21	51.21	72.42
Max Freq, Hz	25.60	36.21	51.21	72.42	102.41

Target Frequency, Hz	120.0	169.7	240.0	339.4	480.0
Min Freq, Hz	102.41	144.84	204.83	289.67	409.66
Max Freq, Hz	144.84	204.83	289.67	409.66	579.34