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VIBRATION DAMPING FOR SHIPBOARD VIBRATION AND NOISE CONTROL

Francis Kirschner and John E. Koch

The Soundcoat Company, Inc.
175 Pearl Street
Brooklyn, New York 11201

INTRODUCTION

Structureborne vibration and noise has long been recognized as a source of discomfort for crew and passengers alike. The increasing use of onboard data processing systems and sensitive measuring and recording equipment on research and exploration vessels adds to the importance of controlling this vibration and noise.

Several installations have shown that a properly designed vibration damping system can effectively reduce the vibrations of deck plates and bulkheads and the noise radiating from these surfaces. Substantial damping has been obtained at low frequencies as well. This complements the performance of typical floating floor installations which have reduced effectiveness at low frequencies.

GAS TURBINE POWERED TANKER

The major noise problem in the gas turbine powered tanker, shown in Fig. 1, was transmission of structureborne vibrations from the gas turbine generator room to the living quarters through the deck plates and bulkheads and re-radiation of airborne sound from these plates. A vibration damping system was very effective in reducing these structureborne vibrations. Absorption and sound barrier materials were also used.

The constrained layer damping system consisted of a 0.050" thick sheet of vibration damping elastomer (DYAD 606)[2] sandwiched between the deck plate and a 1/4" thick aluminum constraining plate using a structural epoxy adhesive. A typical section of this damping treatment on the underside of the deck plate and the adjacent bulkhead is shown in Fig. 2. It was applied to one complete deck, a portion of another deck and carried down twelve inches on bulkheads on the fully treated deck. The general layout is shown in Fig. 3 which also indicates the

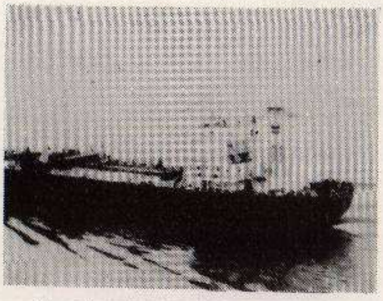

Fig. 1. Gas Turbine Powered Tanker.

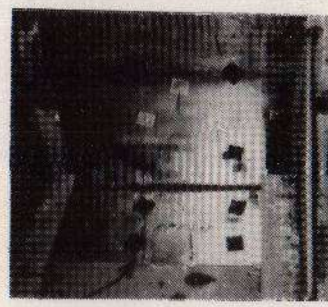

Fig. 2. Typical Section of Damping Installation.

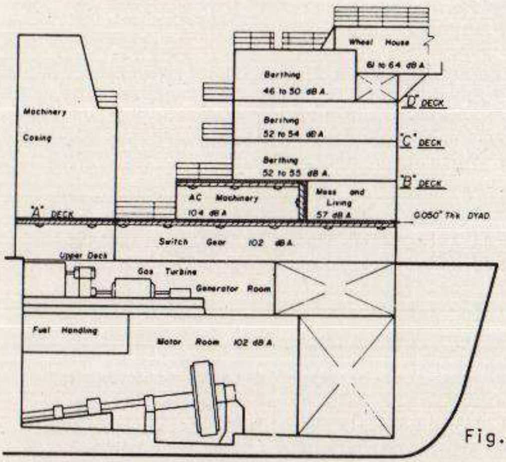

Fig. 3. General Layout of Tanker.

levels measured while under way. The gas turbine room had levels of 115 dBA, while at the same time the level in the mess and living area was 57 dBA, and in the crew quarters it ranged from 46.dBA to 55 dBA.

RESEARCH AND EXPLORATION VESSELS

Fig. 4 shows a research vessel which made use of a similar damping installation. An oil exploration vessel completed recently also made use of constrained layer vibration damping of the deck plate as part of a noise and vibration control system for the recording and data

Fig. 4. Research Vessel

processing room which was located over an auxiliary machinery compartment. It was necessary to control not only the sound levels within the room but, also, vibrations which could adversely affect the data processing equipment and instruments. Calculations made by an independent acoustic consultant indicated that a floating floor system supporting this room would not provide sufficient transmission loss at frequencies of 125 Hz. and below. Therefore, a constrained layer damping system was designed to provide maximum damping at these low frequencies. It consisted of a 0.020" thick sheet of vibration damping elastomer (DYAD 601[2] sandwiched between the deck plate and a 1/8" thick steel constraining plate. A structural epoxy adhesive was used to provide a permanent bond. To simplify installation, the damping system was applied to the top surface of the deck plate. After installation this was covered with a layer of concrete, 1-3/4" thick. The damping performance of the system was verified by laboratory tests which are summarized below. Measurements during sea trials confirmed that the 55 dBA noise level target was achieved.

LABORATORY TESTS OF DAMPING SYSTEMS

Laboratory tests measured the damping actually achieved by two of the damping configurations used in the exploration vessel:

1) Test panel with 0.020" thick damping layer (DYAD 601)[2] and 1/8" steel constraining plate.
2) Test panel with 0.020" thick damping layer (DYAD 601)[2] and 1/8" steel constraining plate and a 1-3/4" layer of concrete.

The test panels were fabricated from 5/16" steel plate with stiffeners of 3" x 5" steel angle on 24" centers.

Detailed measurements were made to determine the damping, resonant frequencies and mode shapes over a range of temperatures and frequencies. Fig. 5 shows the test set-up. Typical measured damping data for test panel #1 is shown in Fig. 6. The actual data points in the low frequency range of particular interest are plotted for the damped and undamped plate. Figs. 7 and 8 summarize the performance data for a range of temperatures and frequencies.

CONCLUSIONS

The use of well designed viscoelastic damping systems has been shown to provide substantial reductions in structureborne noise in ships.

REFERENCES

[1] T. Kihlman, "Noise Reduction with Constrained Visco-elastic Layers-A Case History", Proceedings-International Symposium on Shipboard Acoustics 1976, Session 3, P. 277.

[2] "Constrained Layer Damping Materials for Control of Noise and Vibration", Soundcoat Bulletin 810.

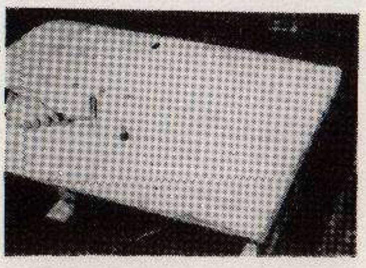

Fig. 5 Test Set-up. Test Panel #2.

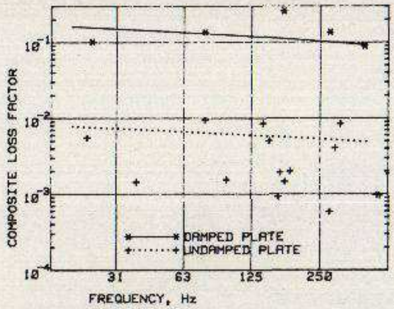

Fig. 6 Test Panel #1.
0.02" Damping Layer (DYAD 601)[2].
1/8" Steel Constraining Plate.
Test Temperature: 72 F.

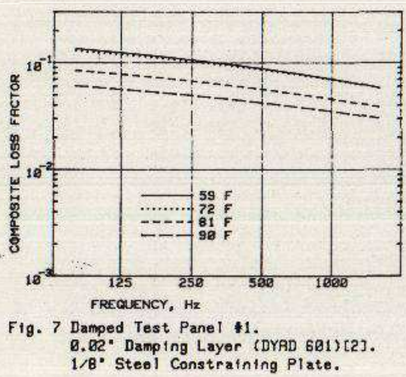

Fig. 7 Damped Test Panel #1.
0.02" Damping Layer (DYAD 601)[2].
1/8" Steel Constraining Plate.

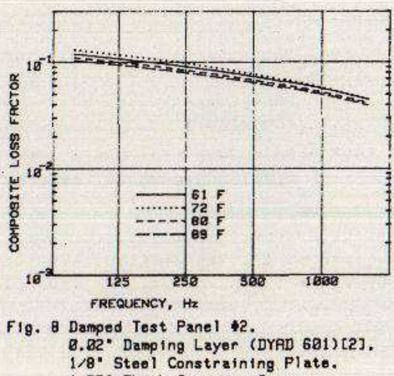

Fig. 8 Damped Test Panel #2.
0.02" Damping Layer (DYAD 601)[2].
1/8" Steel Constraining Plate.
1.75" Thick Concrete Cover.