

Vibro-Acoustic Analysis of QuietCoat 118

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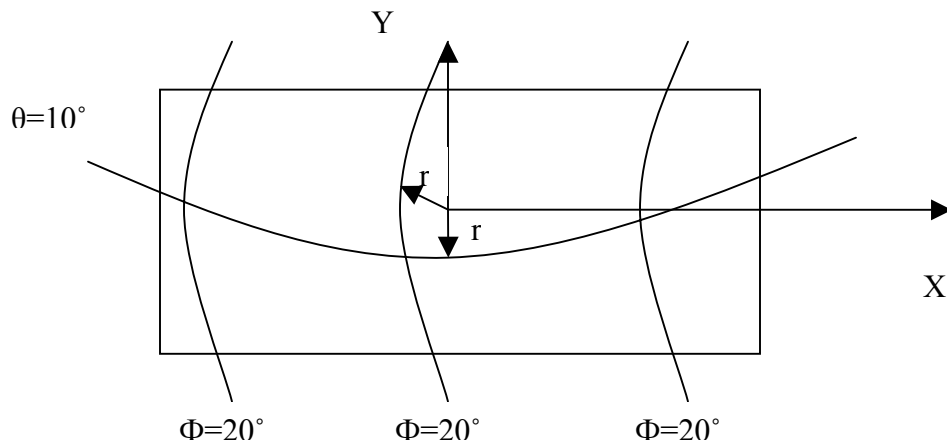
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RESULTS

Table 1 lists the results of the vibro-acoustic analysis performed on a free-free elastic steel plate with QC-118 spray damping material. The structural dynamics of the six plates provided were characterized using a Laser Scanning Vibrometer. The plate was hung freely and force was applied with an impact hammer. The vibrometer provides data on mode shape and natural frequency. Using the half-powered bandwidth method the loss factors were calculated. The percent loss factor is twice the value of the percent of viscous damping ratio; this relationship is applicable only at discrete modes. The acoustic radiation analysis was performed using a microphone and an impact hammer. An HP Dynamic Signal Analyzer was used for data processing. Four directivity paths were measured for the undamped plate (Case = 5, $\Gamma = 0$) while the plate hung freely. Measurements were taken along the center of the plate every 10 degrees in the X-direction and along the center and on either side of the plate every 20 degrees in the Y-direction. All measurements were taken at a radius of 0.5 meters from the center of the plate.



$$\text{Sound Directivity} = B(r, \theta, \Phi)$$

Figure 1 – Acoustic Radiation measurements

This data was then analyzed to find the location of maximum sound radiation for each mode of the plate. This location was used for all six cases to find the maximum sound radiation as listed in Table 1. The units for maximum sound radiation are in dB re 1 20 u micro-Pa/N.

Γ =Percent Coverage of the plate by ~1mm thickness of QuietCoat 118.

There were 6 plates tested.

The case where $\Gamma=0$ is a bare steel plate.

The cases where $\Gamma=.25$ have 25% coverage in two different patterns.

The case of $\Gamma=.5$ is 50% coverage and $\Gamma=.75$ is 75% coverage.

$\Gamma=1$ is 100% backside coverage of the plate with QuietCoat 118 and is the prescribed method of using the product in a production environment where practicable.

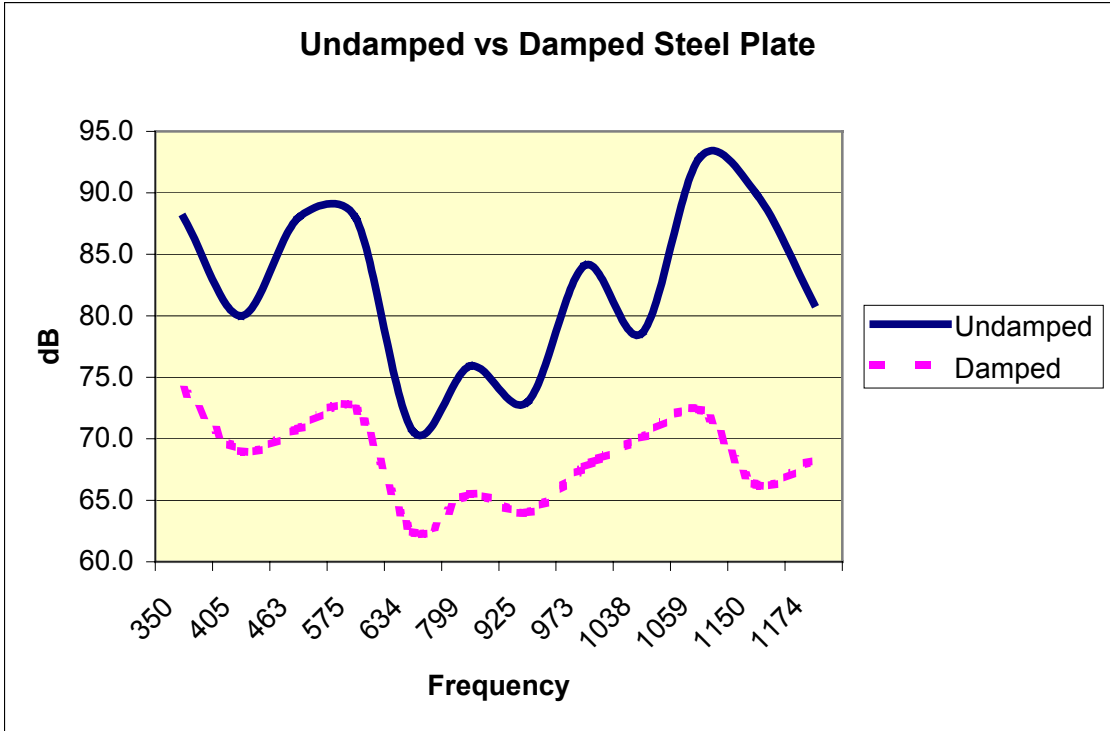
Table 1-Vibro-Acoustic Results of QC-118
Spray Damping Material

Mode Number	Mode (x,y)	Case 5 ($\Gamma=0$)			Case 1 ($\Gamma=.25$)			Case 2 ($\Gamma=.25$)			Average ₁₋₂ ($\Gamma=.25$)		
		$m = 549g$			$m = 551g$			$m = 561g$			$m = 556g$		
		ω_r (Hz)	$\eta_{r\%}$	p/F	ω_r (Hz)	$\eta_{r\%}$	p/F	ω_r (Hz)	$\eta_{r\%}$	p/F	ω_r (Hz)	$\eta_{r\%}$	p/F
1	(0,2)	350	0.60	88.0	359	1.12	75.9	348	1.63	74.8	353	1.38	75.3
2	(1,2)	405	0.78	80.0	408	0.63	67.5	403	0.75	71.1	405	0.69	69.5
3	(2,1)	463	0.46	88.0	463	0.91	75.4	459	1.15	73.1	461	1.03	74.4
4	(2,2)	575	0.59	88.0	579	0.30	76.6	570	0.85	73.9	574	0.58	75.4
5	(4,1)	634	0.31	70.6	638	0.34	68.4	629	0.91	65.4	633	0.63	67.0
6	(5,0)	799	0.20	75.9	799	0.56	71.1	799	0.72	68.9	799	0.64	70.1
7	(5,1)	925	0.20	73.1	929	0.46	68.8	919	0.75	65.5	924	0.61	67.3
8	(0,3)	973	0.21	84.1	979	0.49	76.6	963	1.92	76.0	971	1.21	76.3
9	(1,3)	1038	0.29	78.6	1041	0.35	74.4	1026	1.12	70.9	1034	0.74	72.8
10	(4,2)	1059	0.20	92.8	1061	0.34	76.9	1055	0.67	74.1	1058	0.51	75.6
11	(2,3)	1150	0.16	89.9	1148	0.49	67.8	1148	0.70	68.1	1148	0.60	68.0
12	(6,0)	1174	0.16	81.0	1180	0.31	64.9	1165	0.80	71.1	1173	0.56	68.5
Modal Average Value			0.35	84.73		0.53	72.98		1.00	71.69		0.84	72.36

Mode Number	Case 3 ($\Gamma=.5$)			Case 6 ($\Gamma=.75$)			Case 4 ($\Gamma=1$)		
	$m = 563g$			$m = 588g$			$m = 601g$		
	ω_r (Hz)	$\eta_{r\%}$	p/F	ω_r (Hz)	$\eta_{r\%}$	p/F	ω_r (Hz)	$\eta_{r\%}$	p/F
1	358	1.12	75.3	354	N/A	72.3	345	2.77	74.0
2	405	1.43	71.0	410	2.74	69.6	401	3.46	69.0
3	459	1.50	74.1	463	1.40	71.1	456	2.57	70.8
4	579	1.08	74.8	576	2.18	69.6	571	1.95	72.4
5	633	0.97	65.2	636	2.54	62.7	628	2.07	62.5
6	803	1.18	70.9	791	2.03	N/A	796	1.62	65.5
7	920	0.73	67.5	928	2.06	N/A	916	2.18	N/A
8	975	0.73	72.9	976	N/A	N/A	981	N/A	67.7
9	1051	1.46	66.2	1054	N/A	68.4	1030	N/A	70.1
10	1061	0.97	74.0	1070	1.43	73.3	1055	1.86	72.4
11	1145	1.03	71.9	1154	N/A	N/A	1143	N/A	66.3
12	1178	0.76	67.0	1181	N/A	66.1	1183	N/A	68.4
		1.08	71.53		2.05	69.69		2.31	69.58

Symbols:

G	Area Ratio (Damped Coverage/Undamped Coverage)
p/F	Acoustic Response Function, dB re 20 micro Pa/N
h_r	Modal Loss Factor
ω_r	Natural Frequency at the r^{th} mode
m	Mass
N/A	Mode Heavily Damped



Conclusion:

In this particular application, QuietCoat 118 provided an average of 15dB of acoustic response reduction with 100% coverage versus the undamped plate, and provided greater than 10dB of reduction with 25% coverage.