Vibration analysis of railway track and Quiet Stone

Test report for Sound Absorption UK Ltd

University of Salford
Salford
M5 4WT

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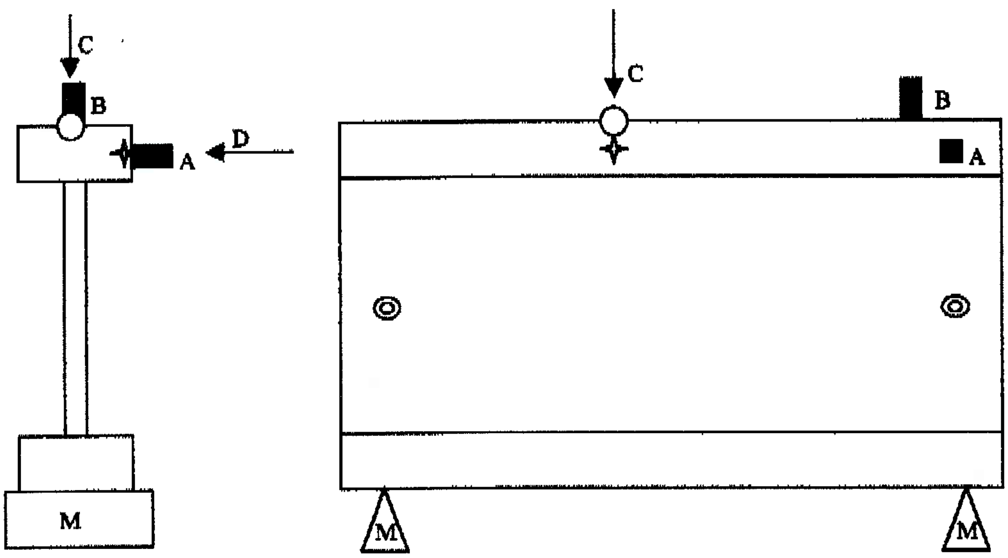
Summary

The performance of anti-vibration material on a short section of railway track was tested. The damping of the modes was measured using an accelerometer and then visually inspected. The findings were:

- That Quiet Stone adds damping to the vibration modes of the track, and has a damping performance close to urethane damping material.
- Hard clamping of the Quiet Stone is more effective than light clamping.
- Full height Quiet Stone has better performance than half height Quiet Stone at high frequencies (>4kHz), and similar performance at low frequencies (<4kHz).
- Internal steel stiffening rods made little difference to the performance of the Quiet Stone.

Test methodology

The railway track was hit with a B&K force hammer with a metal tip. The vibration of the track was measured using a 16g B&K accelerometer. The force was separately applied in two directions, to the top of the rail and to the side of the rail, referred to as transverse and lateral measurements respectively. These two directions were chosen to excite the modes of most concern in railway noise. Figure 1 shows the mounting positions:



Drawing not to scale. The track was about 0.5m long.

A	–	Lateral mounted accelerometer position
B	–	Transverse mounted accelerometer position
C	–	Direction of applied force (hammer blow) for transverse measurement
D	–	Direction of applied force (hammer blow) for lateral measurement
○	–	Location of applied force for transverse measurement
✢	–	Location of applied force for lateral measurement
M	-	Mounts
◎	-	Clamping positions for Quiet Stone (using G-clamps).

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The displacement from the accelerometer was measured and averaged for 8 excitations. The displacement calculated and the displacement spectra plotted. This allows the amount of damping in the different arrangements to be compared visually. It would be possible to carry out a full modal analysis and gain loss factors or other numerical values for the damping of each mode, but it was felt that visual inspection would yield the information needed.

Salford University could carry out a full modal analysis, but this would be time consuming and probably would not yield anything more useful than the visual inspection. Especially as the numerical values obtained through a full modal analysis could not be used in future design analysis as the mounting conditions and length of the railway were not application realistic.

In addition, a measurement of the radiated energy for the untreated railway made using a ¼" microphone about 5cm from the rail.

Test conditions

Table 1 shows the 15 different conditions tested

Table 1

Title/Code	Description	Lateral	Transverse
Microphone	A measurement of the radiated energy	✓	X
Undamped	Railway without any treatment	✓	X
Urethane	Railway treated with urethane	✓	✓
QS_VLC_FH	Quiet Stone, very lightly clamped (held on with tape), full height of Quiet Stone	✓	✓
QS_LC_FH	Quiet Stone, lightly clamped (just held on by G-clamps, lightly tightened), full height of Quiet Stone	✓	✓
QS_CL_FH	Quiet Stone, clamped as hard as possible, full height of Quiet Stone	✓	✓

	Quiet Stone		
QS_CL_HH	Quiet Stone, clamped as hard as possible, half height of Quiet Stone	✓	✓
SS_CL_FH	Quiet Stone with steel inserts, clamped as hard as possible, full height of Quiet Stone	✓	✓
SS_CL_HH	Quiet Stone with steel inserts, clamped as hard as possible, half height of Quiet Stone	✓	✓

* The positions of the accelerometer and force excitation were slightly different from those shown on the previous page in this case

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Figures 4 and 5 shows the effect of clamping strength on performance. As would be expected, the harder the clamping, the better the performance.

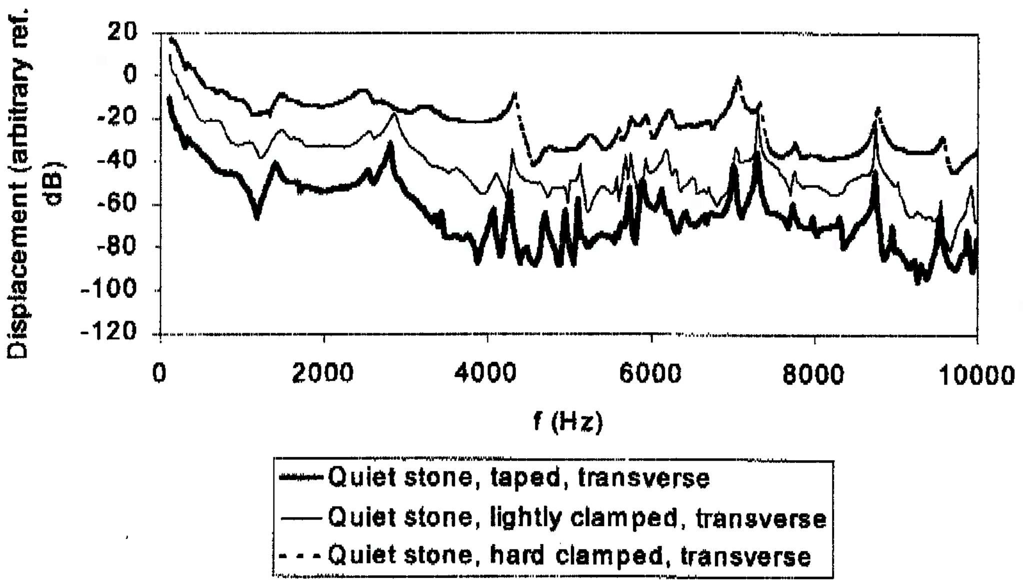

Figure 4 (lines displaced vertically from each other to make lines clearer)

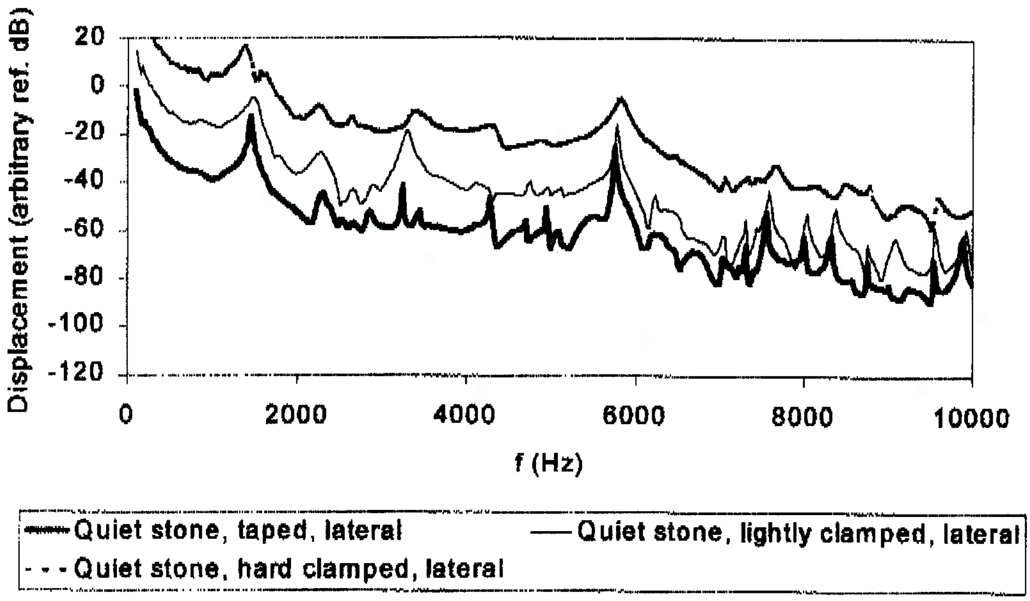

Figure 5 (lines displaced vertically from each other to make lines clearer)

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Figure 6 shows the effect of using only half height Quiet Stone compared to full height Quiet Stone. The performance of the half height Quiet Stone is similar at lower frequencies (<4000Hz), but at higher frequencies the modes are less well damped.

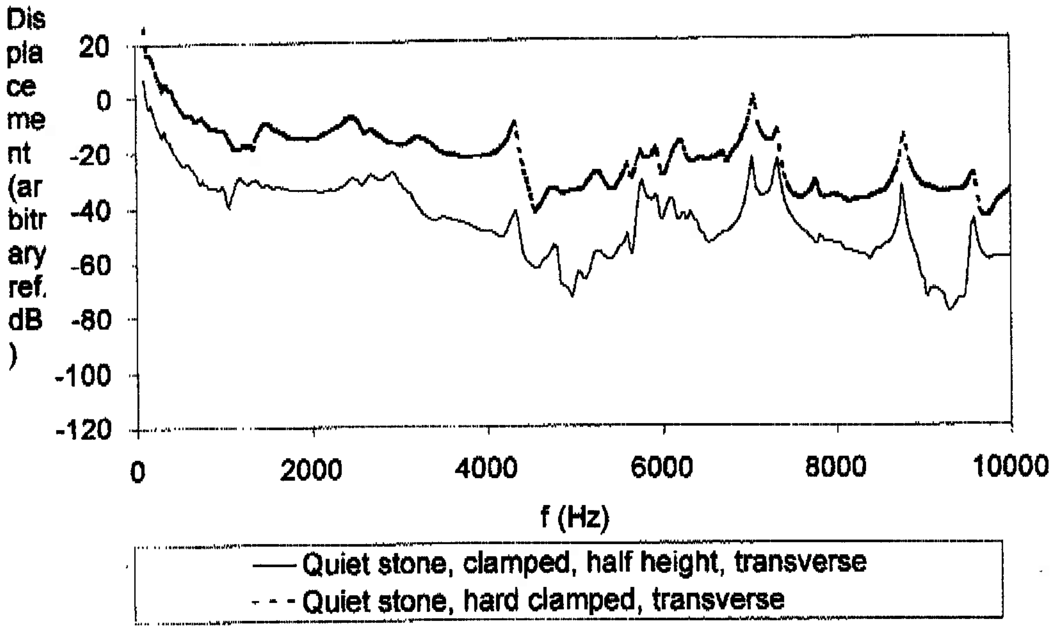

Figure 6, Full and half height Quiet stone compared, transverse (lines displaced for clarity)

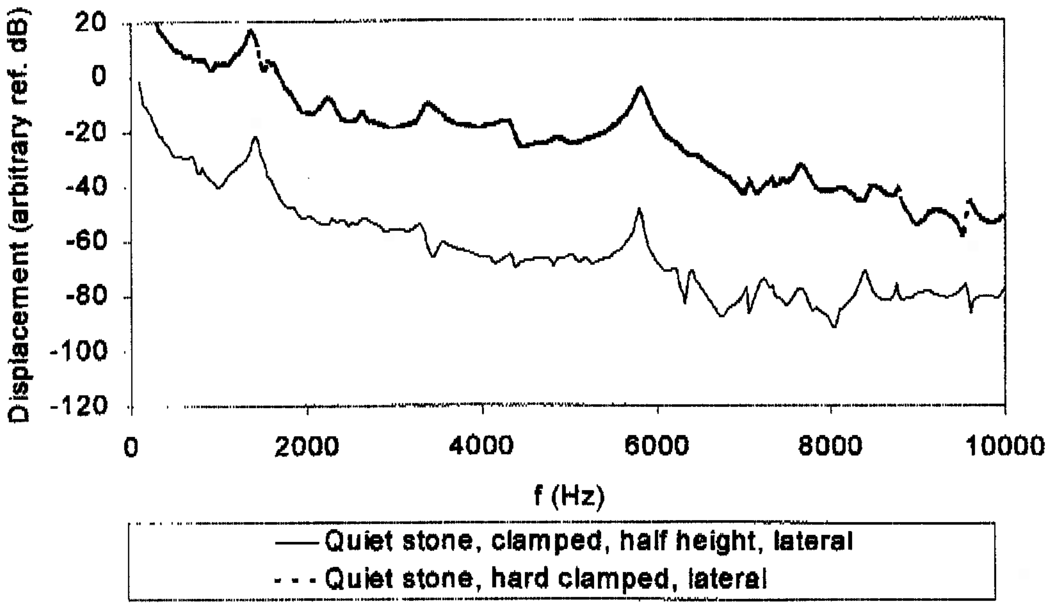

Figure 7, Full and half height Quiet stone compared, lateral (lines displaced for clarity)

The use of steel inserts was tested as shown in Figures 8 and 9. The performance is very similar with and without the steel inserts.

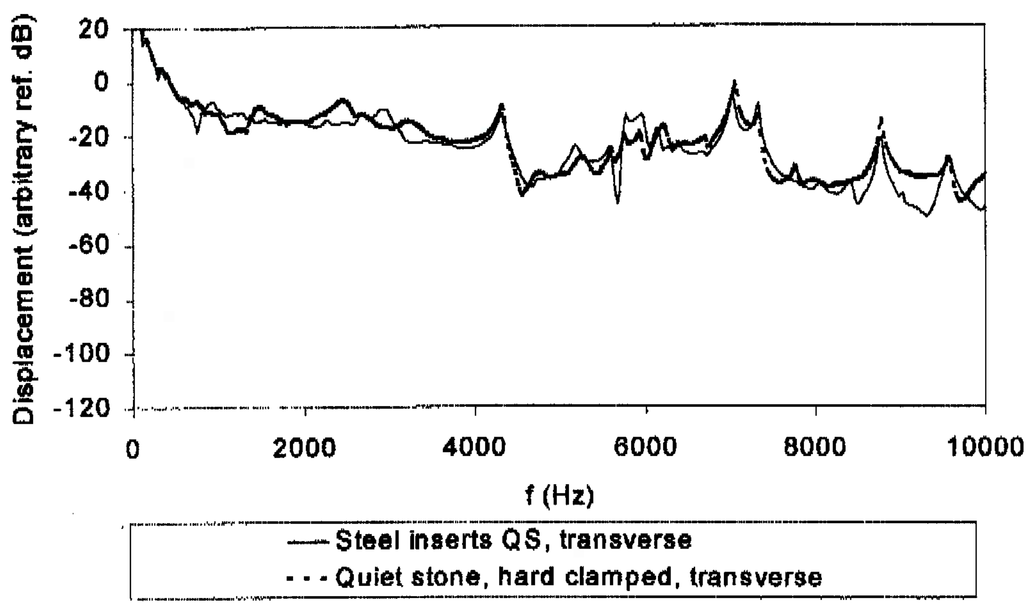

Figure 8. Quiet stone with and without steel inserts

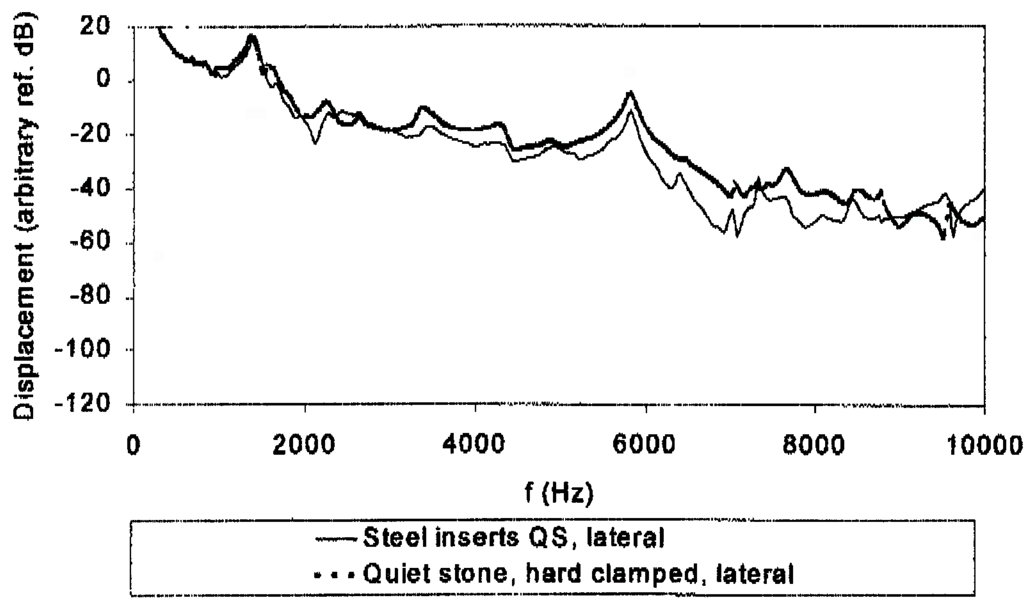

Figure 9. Quiet stone with and without steel inserts