Proceedings of The Institute of Acoustics

THE USE OF LEAD CLAD STEEL IN NOISE CONTROL

G. Kerry

University of Salford

Introduction

Although lead is often cited as being an ideal material for acoustic control, possessing high surface mass, low stiffness and inherent damping, it is rarely used in practice. Some of its mechanical properties, in particular creep, have tended to limit its applications. On the other hand steel is a material often found in acoustic hardware since it combines excellent structural properties with a reasonably high density. Its high inherent bending stiffness and low damping do not enhance its performance.

A lead/steel composite has recently been developed in the form of 'Almex' Lead Clad Steel. It is a sheet material obtained by cold roll bonding lead to a 1 mm thick ternecoated steel without the use of adhesives. The overall thickness of the composite is 1.75 mm and its surface mass about 17 kg/m^2.

A study has been made of the properties and applications of such a material in the noise control field.

Transmission loss and panel constructions

The basic acoustic properties of the sheet material are shown in figure 1. The laboratory SRI of a single leaf partition of lead clad steel (A) is compared with the basic 1 mm ternecoated steel (B). The effect of the lead is to increase the sound insulation by 5 dB over the whole frequency range. When compared with a steel partition of equivalent weight (C) (i.e. 2.6 mm thick) the lower stiffness of lead clad steel is shown to advantage.

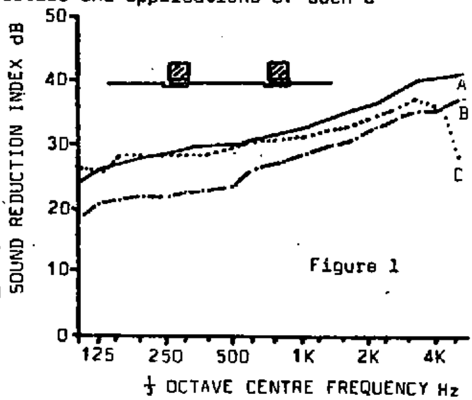

Figure 1

The critical frequency, the onset of coincidence resonance, for lead clad steel occurs at around 15000 Hz, well up the audio frequency range. For equivalent weight steel the figure is around 5000 Hz. Although many common sounds have predominant frequencies below the latter frequency a great deal of industrial noise extends well up the frequency range and hence the superior performance of lead clad steel can be used to advantage.

The increased stiffness of preformed panels causes a lowering of the sound insulation properties. The inherent damping in lead clad steel keeps this reduction to a minimum. In addition lead clad steel can be formed virtually as easily as the basic ternecoat steel. Thus with the same forming machine or press a heavier item can be produced with improved sound insulation properties.

In order to evaluate the material under more practical conditions test panels were erected in a large aperture in the front of a disused cottage some 10 metres back from a main road. The sound insulation, at octave band intervals, was measured and compared with the laboratory results by converting the latter and adjusting for the acoustic conditions on site. A profiled panel is shown in figure 2 where a comparison is made between the field measurement (E) and the prediction D1. Generally a higher sound insulation was measured than predicted. This was attributed to the restricted angle over which sound was incident on the test wall of the cottage.

Further laboratory and field tests were carried out on double leaf panels incorporating either lead clad steel or lead clad steel and plasterboard, using a simple timber stud and a glass fibre infill. Such a system can be used for either noise control enclosures or infill panels in external facades. The results of a field test on a profile panel are shown in figure 3. This clearly demonstrates the effect of restricted field incidence sound. The field performance curve shows superior insulation at low frequencies. The reverse is true at high frequencies when flanking transmission, not encountered in the laboratory begins to dominate.

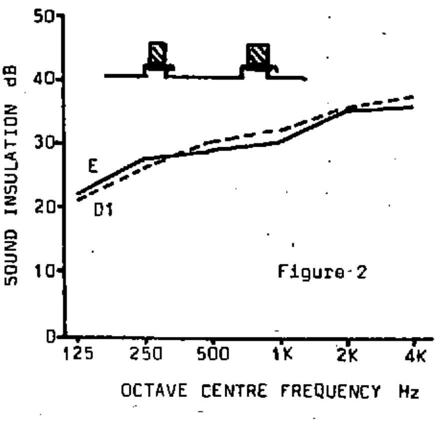

Figure 2

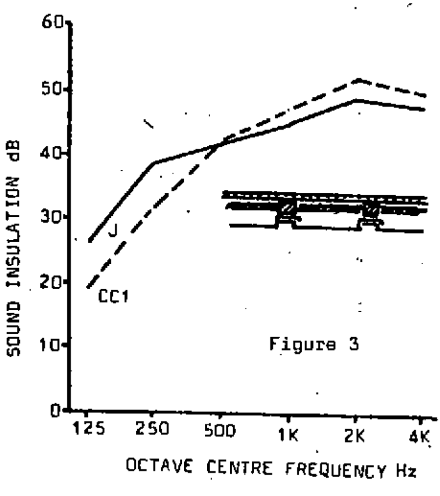

Figure 3

A double leaf partition comprised of one leaf of lead clad steel with the other leaf made from 2 layers of 13 mm plasterboard, a 75 mm timber stud and a 50 mm glass fibre infill can produce an average laboratory SRI of 48 dB. This compares very favourably with a 225 mm brick wall rendered both sides with plaster which generally gives an SRI of 50 dB.

Damping properties

The inherent damping properties of lead clad steel have been briefly mentioned. Some measured values of damping ratio are shown in table 1

THE USE OF LEAD CLAD STEEL IN NOISE CONTROL

TABLE 1

Material	Typical damping ratio at room temperature
1 mm steel	.0005)
2.6 mm steel	.001)in frequency
Lead clad steel	.004)range 10-1000 Hz
Lead	.05)
1.75 mm sound deadened steel	.07)

Clearly lead clad steel has considerably more damping than steel but is not as good as materials incorporating visco-elastic polymers. Lead clad steel does have the advantage that its damping properties remain reasonably constant over a wide temperature range (20-200°C) whereas visco-elastic dampers usually work over a more restricted range.

Noise Control Hardware

Although transmission loss and damping experiments can yield much information into the suitability of a material for noise control structures, it is difficult to assess the behaviour of such structures in practice, especially when impact noise is involved, unless specific items of hardware are manufactured and tested. In an attempt to overcome this, some general experiments were devised and carried out in the 225 m^3 reverberation chamber at Salford. This involved manufacturing 2 metre long channels down which ball bearings were rolled, 0.5 metre cube boxes into which the bearings were dropped and small enclosures into which a random noise source was placed. The resultant noise levels were monitored on a real time analyzer and expressed in terms of Noise Rating levels (NR). Some results are shown in table 2.

TABLE 2

TYPE OF TEST	NR LEVELS dB		
	1 mm steel	2.6 mm steel	Lead clad steel
1. 6 mm ball bearings rolled down 2 m channel	85	82	77
2. 6 mm ball bearings dropped into a container	97	98	91
3. Random noise source in enclosure	65	59	52

In all cases the use of lead clad steel reduced the NR levels by 5 to 7 dB over the equivalent weight steel.

A practical example of the use of lead clad steel has been demonstrated by Sound Attenuators Ltd. By manufacturing a ventilation duct terminal unit in lead clad steel instead of the usual galvanised steel the noise level in a room with a reverberation time of 1 second and subjected to 6 air changes/hour was reduced from NC35 to NC25, a very worthwhile reduction.

THE USE OF LEAD CLAD STEEL IN NOISE CONTROL

Conclusions

Lead clad steel possesses the following properties; (a) High mass/unit area (b) A high critical frequency (c) Relatively high damping (d) Can be formed relatively easily and generally with greater precision than equivalent weight steel (e) Aesthetic appeal when weathered, leaving a maintenance free surface which needs no protection.

The last three properties give lead clad steel a definite advantage over steel in many noise control applications.