Proceedings of the Institute of Acoustics

WHAT HAPPENS TO THE SOUND INSULATION OF A PARTY FLOOR WHEN LOADED?

M.A. Stewart and D.J. MacKenzie
Department of Building Engineering and Surveying
Heriot-Watt University, Edinburgh.

INTRODUCTION

Most impact sound insulation tests carried out on party floors are on newly installed floors. What happens to the insulation when an occupant moves in and the floor is loaded up with furniture, washing machines etc? Research has been carried out at Heriot-Watt University on timber floating floors (ie chipboard on battens) supported by a concrete structural floor. The floating floor is separated from the concrete floor by a resilient layer.

Tests were carried out with a tapping machine on the floating floor using resilient materials in 3 different states:-

1) Unused resilient materials.
2) Resilient materials that had been left loaded for 6 months.
3) Unused resilient materials that has been soaked to simulate an overflowing bath, washing machine etc.

In each case the floor was tested with loads ranging from 0 - 160 kg/m².
The resilient materials used were i) Resilient battens. ii) Closed cell polyethylene foams (5mm thick) iii) Fibre glass quilts (13 and 25mm thick).
All materials are currently used in the construction industry for impact sound insulation of floating floors although closed cell foams tend to be used more under floating screeds than timber floating floors. Figure 1 shows the experimental set up.

PRELIMINARY TESTS

All the tests were carried out on 1m² of floating floor. This was due to the practical difficulties of lifting the floating floor every time the resilient material needed to be changed. However this raised 2 important questions:-

1) Will the impact sound insulation of 1m² of flooring be the same as a full size floor.
2) Will noise generated within the source room effect the impact sound measurements in the receiving room (ie due to the airborne

sound impinging on the exposed concrete).

To answer the first question Figure 2 compares 2 frequency spectra of the standardised sound pressure level (L'nT) in the receiving room. 1 is for a full size floating floor and the other is for 1m². Although there are differences they are not significant. There is a slight improvement in L'nT,w in the 1m² case which implies that the battens further from the tapping machine in the full size floor are transmitting sound.

To answer question 2, tests were carried out to find the level difference of the floor. 2 tests were done; in 1 case a loudspeaker was used as sound source and in the other a tapping machine on the chipboard. With the tapping machine sound is travelling along the impact and airborne paths, with the loudspeaker sound can only travel along airborne paths (direct or flanking). By subtracting the level difference when the loudspeaker was used from the level difference when the tapping machine was the sound source the value of the sound pressure level in the receiving room for impact sound only can be calculated. This can then be compared with the measured value. If there is any significant difference then airborne sound is effecting the measurements. Figure 3 shows the measured and calculated L'nT values in the receiving room for unloaded resilient battens. Measurements were made over the frequency range 50 Hz - 3150 Hz. There is a difference at mid frequencies which caused a 1.2 dB reduction in the L'nT,w in the calculated case. Therefore airborne sound was having an effect on the results. Further tests were carried out with different resilient materials and results averaged to show the relationship between measured and calculated L'nT,w's (see Table 1).

Measured L'nT,w (dB)	Measured L'nT,w - Calculated L'nT,w (dB)
50 - 52	2.4
52 - 54	1.0
54 - 56	1.2
56 - 58	1.1
58 - 60	1.0

Table 1 Differences between Measured L'nT,w's and Calculated Values without Airborne Transmission

Therefore for the test floor, any L'nT,w measured below 52 dB will be effected by airborne sound. Above 52 dB the problem was much less significant.

RESULTS

1) Unused Materials

Figure 4 shows the L'nT,w/load relationship for a 25mm quilt, 13 mm quilt, closed cell foam and resilient battens.
The change of L'nT,w with load is quite significant for all materials. Table 2 shows the worsening effect over the load range 0 - 80 kg/m² which is the range that most domestic loads can be expected to be within.

Material	Plain battens	Resilient battens	Closed Cell foam	25mm Quilt	13mm Quilt
L'nT,w (dB)	2.69	2.46	1.35	2.94	3.11

Therefore although quilts appear to be the better impact insulating materials foams do not worsen quite as much as quilts when loads are added (within the test range).

2) Resilient Materials After 6 Months Loading

The same types of materials above were tested in exactly the same way only this time the materials had been left under a load of 200 kg/m² for 6 months. This load was chosen as the highest load that could reasonably be expected on a domestic floor. Figure 5 shows the L'nT,w/load for unused materials and materials left loaded for 6 months. It can be seen that 6 months loading gives a further worsening effect. Table 3 shows the average increase in L'nT,w for each material.

Material	Resilient battens	Closed cell foam	25mm Quilt	13mm Quilt
L'nT,w (dB)	1.59	1.48	1.25	1.94

Table 3 Difference in L'nT,w between Unused Materials and Materials Left Loaded for 6 Months

It is difficult to assess from this data which material loses its insulating ability the most. 6 months loading has a similar worsening effect on each material.

3) Confidence Intervals

The above results would lose any real significance if the standard deviation was high. Measurements were made in 6,8 or 10 positions and the average results calculated.

Table 4 gives the 95% confidence interval of the L'nT,w for resilient battens and 25 mm quilt.

	Resilient battens		25 mm Quilt	
Load (kg)	Unused	6 months loading	Unused	6 months loading
0	1.57	2.09	1.47	1.47
20	1.50	1.87	1.37	1.73
40	1.82	1.84	1.42	1.86
80	1.76	1.82	1.74	1.61
160	1.74	1.86	1.83	1.90
Mean	1.68	1.90	1.57	1.71

Table 4 95% Confidence Intervals for Resilient Battens and 25 mm Quilts (dB)

The 95% confidence intervals are close to the difference in L'nT,w between unused and 6 month loaded materials. However it is unlikely that the differences in Table 2 are purely due to measurement error as the results would be more random.

4) Tests on Soaked Resilient Materials

Impact sound insulation tests were carried out on previously unused resilient materials that had been soaked with a fire hose to show the effect of an overflowing bath or washing machine. Figure 6 compares the L'nT,w/load relationship for 2 materials.

The average differences in L'nT,w between unused and soaked materials are shown in Table 4:

Material	13mm Quilt	25mm Quilt	Closed cell foam	Resilient Battens
Increase in L'nT,w	0.51	-0.13	0.48	0.63

Table 4 Difference in L nT,w between Unused and Soaked Resilient Materials

There is generally a slight worsening effect although it is not as sifnificant as when the materials were left loaded for 6 months. However the effect may worsen with time as the author thinks that soaked materials are more likely to creep.

SOUND INSULATION OF A PARTY FLOOR

CONCLUSIONS

The results show quite clearly that the impact sound insulation of floating floors can be expected to get worse once residents have moved in and the floor is loaded with their furniture and appliances. Research by the BRE (1) showed that typical floor loads for a flat have an average value of 0.4 kN/m^2 (40 kg/m^2). Therefore a worsening in L'nT,w of up to 1 dB can be expected immediately after loading with further reductions with time. This raises the question about floors which just pass the regulations when new. If tests were carried out a few months later after occupancy they would be likely to fail.

Should the regulations be made more stringent to ensure that after a floor is loaded by the occupier it is still within the regulations on impact sound insulation?

ACKNOWLEDGEMENTS

The author gratefully acknowledges the assistance provided by the Science and Engineering Research Council for funding.

REFERENCES

(1) Floor Loadings in Domestic Buildings - The results of a survey. G.R. Mitchell and R.W. Woodgate. (Building Research Establishment Current Paper 2/77).

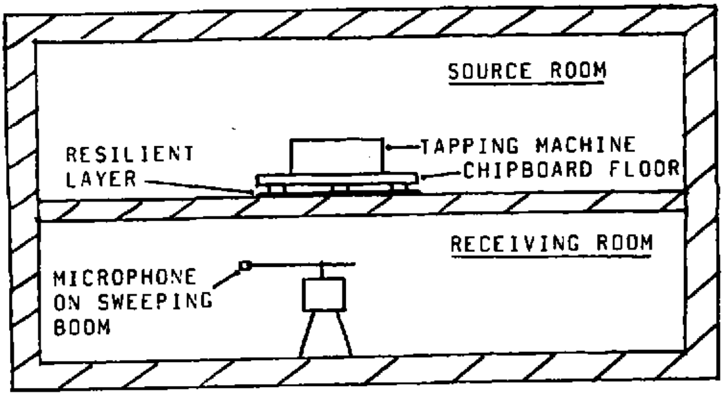

FIGURE 1 THE TEST CHAMBER

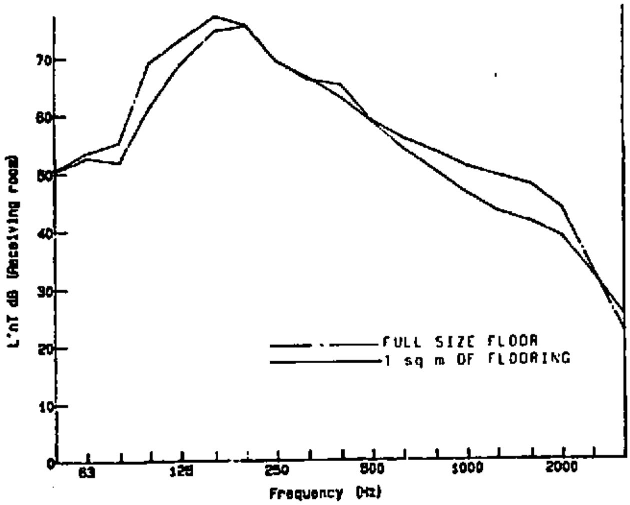

FIGURE 2 STANDARDISED SOUND PRESSURE LEVEL (L'nT) IN THE RECEIVING ROOM. TAPPING MACHINE ON RESILIENT BATTENS.

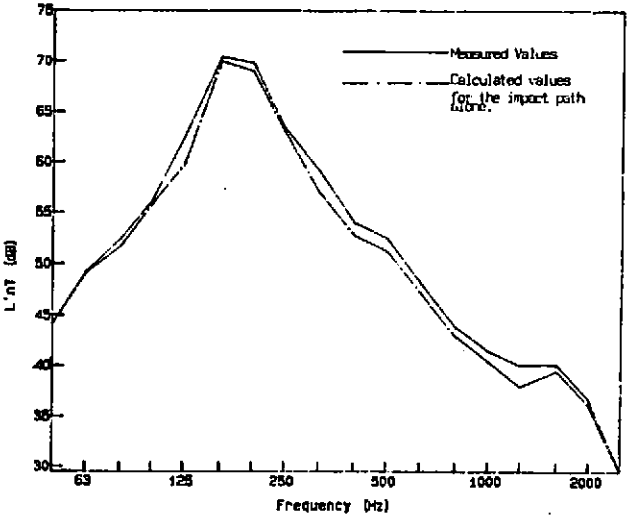

FIGURE 3 LnT VALUES IN THE RECEIVING ROOM FOR RESILIENT BATTENS (unloaded)

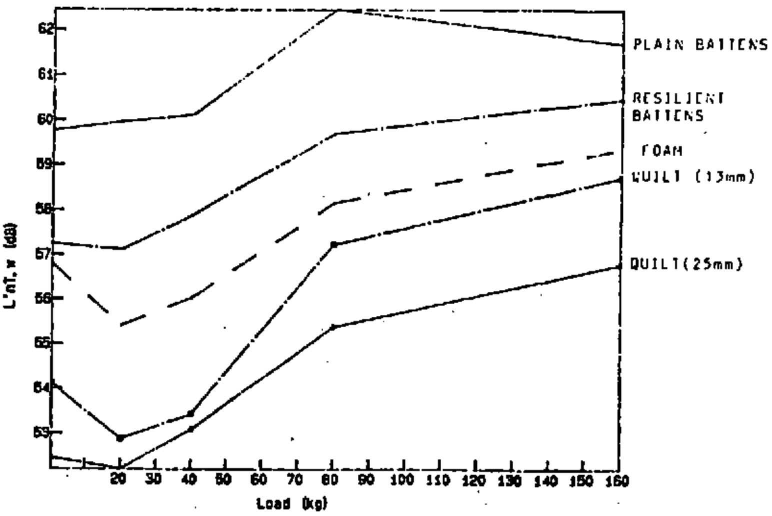

FIGURE 4 L'nT,w/LOAD FOR DIFFERENT RESILIENT MATERIALS

SOUND INSULATION OF A PARTY FLOOR

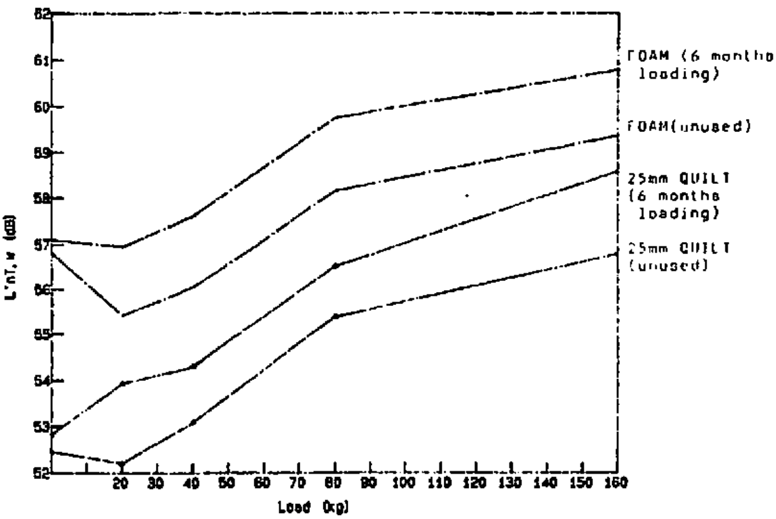

FIGURE 5 L'nT,w/LOAD FOR 25mm FIBRE GLASS QUILT AND CLOSED CELL FOAM

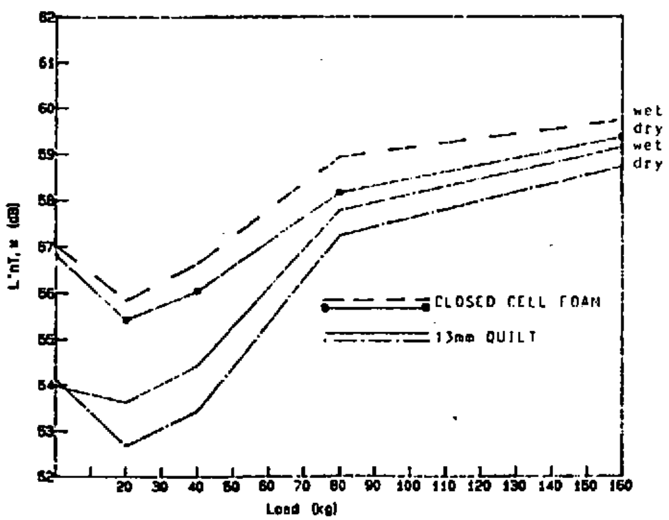

FIGURE 6 L'nT,w/LOAD FOR DRY AND WET RESILIENT MATERIALS