Australian Government
Forest and Wood Products Research and Development Corporation

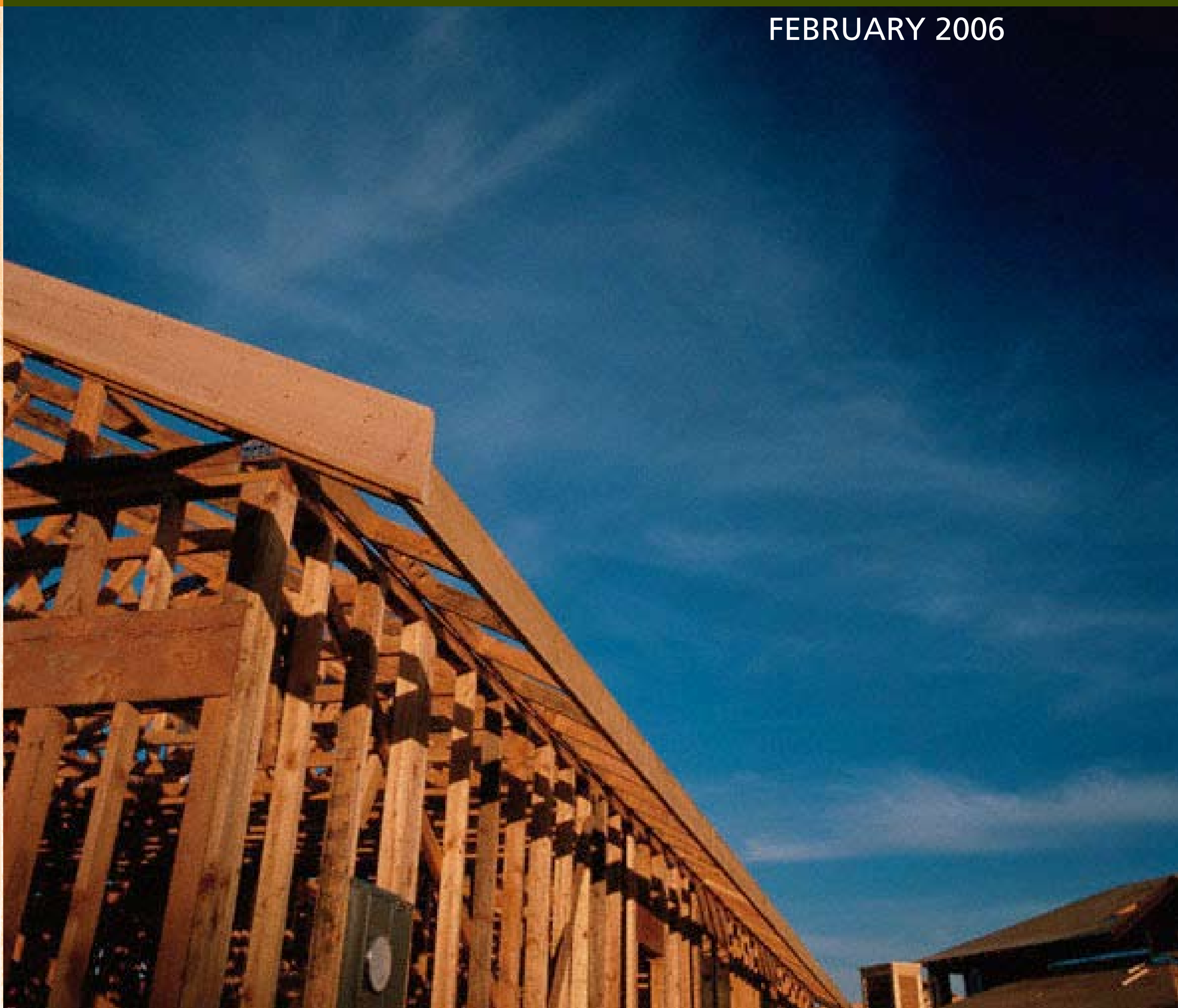
MARKET KNOWLEDGE & DEVELOPMENT

PROJECT NUMBER: PN04.2005

Maximising impact sound resistance of timber framed floor/ceiling systems

Volume 3

FEBRUARY 2006



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Maximising impact sound resistance of timber framed floor/ceiling systems
Volume 3

Prepared for the

Forest and Wood Products Research and Development Corporation

by

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The FWPRDC is jointly funded by the Australian forest and wood products industry and the Australian Government.

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7. LOW-FREQUENCY MEASUREMENT RESULTS

7.1 INTRODUCTION

This research is primarily concerned with examining the weakest area of timber floor impact sound insulation performance: low-frequency impact sound. It is difficult to measure low-frequency sound performance of a floor using traditional methods of measuring the sound pressure in a receiving room and normalising for the effect of the room. This is simply because the effect of the room is uncertain at such low frequencies and hence is difficult to factor out.

With the above in mind, and because we would like to examine the performance of the floors in detail, it was decided to measure the vibration response of the floor when driven or excited with a known force. This allows the effect of the room to be removed, and if we measure the vibration of the floor over its surface, also allows us to examine how the floor is reacting to the applied forces. This detail of measurement assists greatly in modelling and generally seeing what is happening in the floors.

In this section we describe the experimental procedure used to generate the low-frequency vibration measurements. Plots of the average surface velocity of the floors' upper surfaces and ceilings will then be presented, as well as plots of predicted sound pressures in a room below.

7.2 EXPERIMENTAL SETUP

The floors were built in the concrete block test chamber.

On each floor an electrodynamic shaker was used to provide a vertical force on the floor upper surface. The shaker was connected to the floor through a wire stinger and a reference force transducer. The function of the stinger is to ensure that only vertical forces are transmitted in the floor, while the force transducer enables us to known how much force is being sent into the floor. The shaker body was mounted on a beam which straddled the floor and rested on supports which sat on the concrete collar surrounding the floor. Vibration isolation of the beam from the concrete collar was provided by very resilient pads made of polyester fibre infill. The shaker was driven with pseudorandom signal with a bandwidth from 10Hz to 500Hz, for a duration of 2 seconds (to get a frequency resolution of 0.5Hz).

The shaker/force transducer setup used to achieve this is shown in Figure 7-1 and Figure 7-2.

Figure 7-1. View of the shaker attached to a floor to send vibrations into the floor.

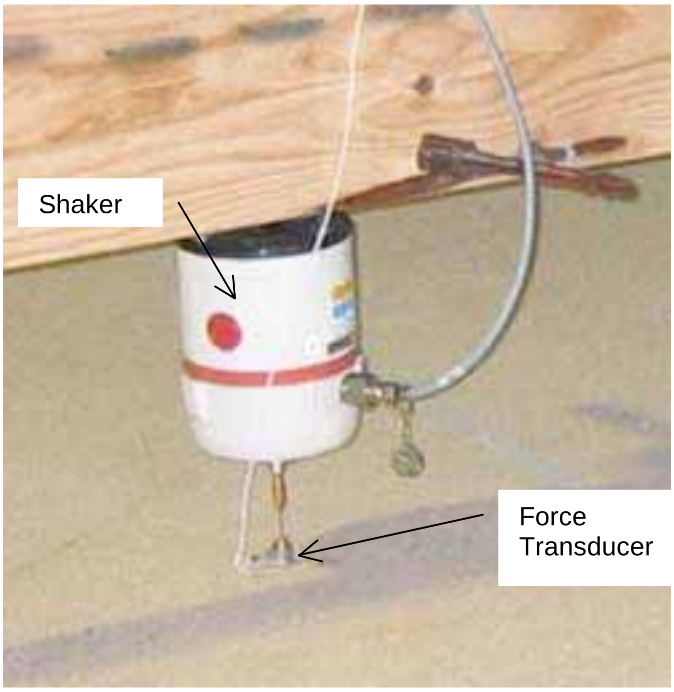


Figure 7-2 Close-up of shaker and force transducer used to vibrate the floor

A scanning laser vibrometer (Polytec PSV 300) was used to measure the velocity of the floor and ceiling normal to the surface. A grid with a spatial resolution of 10-14cm was used to obtain a map of the surface velocity of the floor and ceiling relative to the input force; both amplitude and phase information was recorded at each frequency. The scanning laser vibrometer used to measure the vibration of the upper surface of the floor is shown in Figure 7-3 and Figure 7-4. The scanning laser vibrometer was also used to measure the vibration of the ceiling surface and this set up is shown in Figure 7-5.

Figure 7-3. Overview of the shaker and the scanning laser vibrometer for measurement of floor vibration response. The scanning laser vibrometer is mounted on a gantry made from I-beams 2.6m above the floor. There are two gantries to enable the whole upper surface of the floor to be scanned.

Figure 7-4. Close-up of the scanning laser vibrometer as supported in the gantry. The laser vibrometer is supported in a trolley, which can roll along the flanges of the I-beams, enabling the laser vibrometer to be moved to different sections of the floor.

Figure 7-5. The scanning laser vibrometer as used to measure the vibration of the ceiling in response to the shaker force.

7.3 EXPERIMENTAL TECHNIQUE

For each floor, the shaker was connected to the upper surface through a force transducer as illustrated above. The position on the floor was selected so that the low-frequency modes would be excited. Only one position on each floor was chosen. It is often useful to select two or more positions on a structure to ensure a sufficient number of modes are excited, and to act as a check for results. However, in this case, it would have taken too long to do two complete vibration response scans of each floor.

Once the shaker was connected to the floor the scanning laser vibrometer was positioned over the floor upper surface to measure the surface velocity of the floor upper in the direction normal to the surface of the floor. The scanning laser vibrometer was supported in a mobile cradle and mounted on two gantries over the floor so that it point down to the floor and scan the surface. For each can the area that could be measured was about 1.8m by 1.8m, hence eight positions were required to scan the whole surface of the floor. The scanning laser vibrometer measurement equipment was also connected to the force transducer so that the recorded surface vibration is normalised with respect to the force applied. The signal sent to the shaker was a pseudorandom noise filtered by a low-pass filter (500Hz corner frequency) with a period of 2 seconds (±30 s), which matched with the sampling time of the laser vibrometer software. This ensured minimal spectral leakage and a frequency resolution of 0.5Hz.

After measuring the upper surface, the scanning laser vibrometer was placed in its cradle on the floor under the ceiling of the floor to be tested, pointing up to the ceiling. It was then used to scan the surface of the ceiling. This was repeated in different positions to cover the whole ceiling.

After the scans of the floor vibration were made, the results of the measurements of surface vibration over the floor were extracted from the Polytec scanning software into a form easily readable by other software. The program used to do this was specially written for the project. The data was then compiled by software specially written for this project to enable overall surface velocity of the floor upper and ceiling to be plotted as well as animated pictures of the response of the floor upper surface and ceiling to be generated.

7.4 EXPERIMENTAL RESULTS OVERVIEW

The data available from the experimental results is enormous: there are about 4000 measured points each containing 1000 vibration frequencies. For the purposes of this report, we will restrict ourselves to examining a frequency range of 10Hz to 200Hz, which contains the low-frequency region we are interested in. For each floor we will look at the overall, average surface velocity response to the applied dynamic force. We will also examine some 3D plots of the surface to illustrate some regions of interest.

We note that there are two sizes of floors:

- floors 3.2m wide, spanning 7m
- floor3 3.2m wide, spanning 5.5m.

Each floor size has the shaker excitation point located at a different place: for 7m spans it is at 2510mm in from the joist ends, and 965mm in from the side of the floor – this is designated position C; for 5.5m spans it is at 1875mm in from the joist ends, and 965mm in from the side of the floor – this is designated position E.
Another floor size was examined, this was only 1.3m long, and the shaker position was position F (440mm in from the joist ends, and 965mm in from the side of the floor). It was

tested without a ceiling, but was not considered further. The results are included for completeness.

7.5 3-DIMENSIONAL VIBRATION PLOTS

Software was written to allow the plotting of 3-dimensional plots of the upper surfaces and ceilings of the floors for every frequency measured. This software also allows animations of the floors to be produced. An example of this for Floor 10 is shown in Figure 5-22. Such 3D plots will be produced to illustrate certain aspects of the floors in the experimental analysis section of the report.

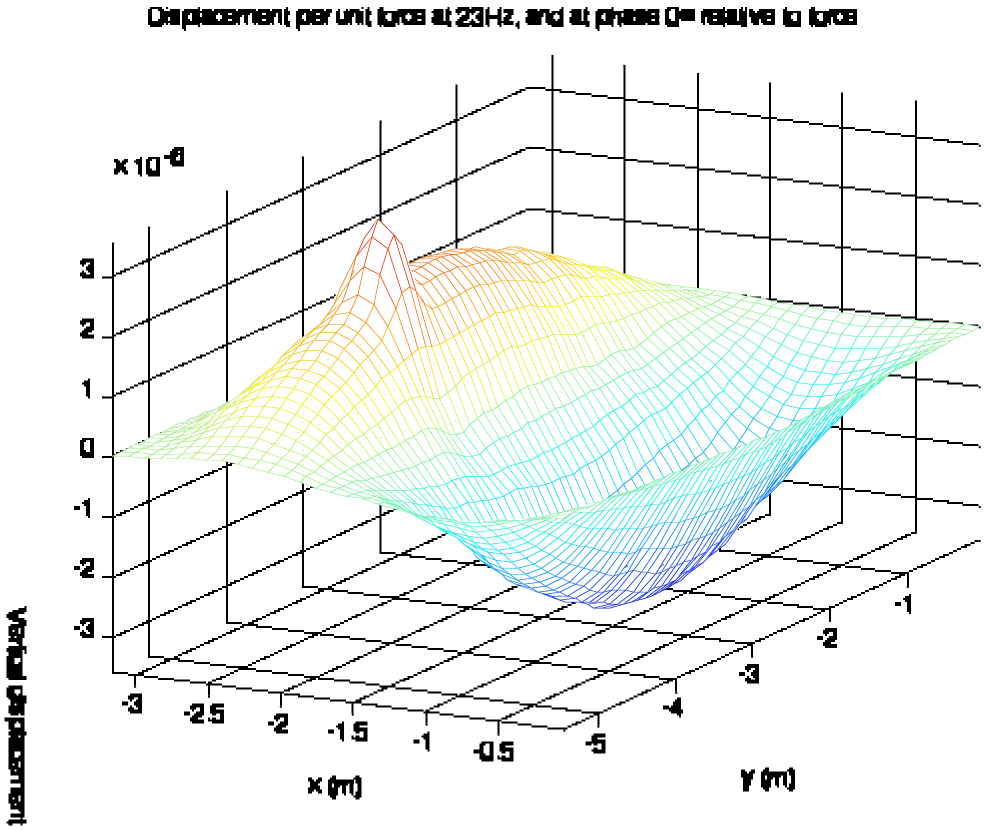


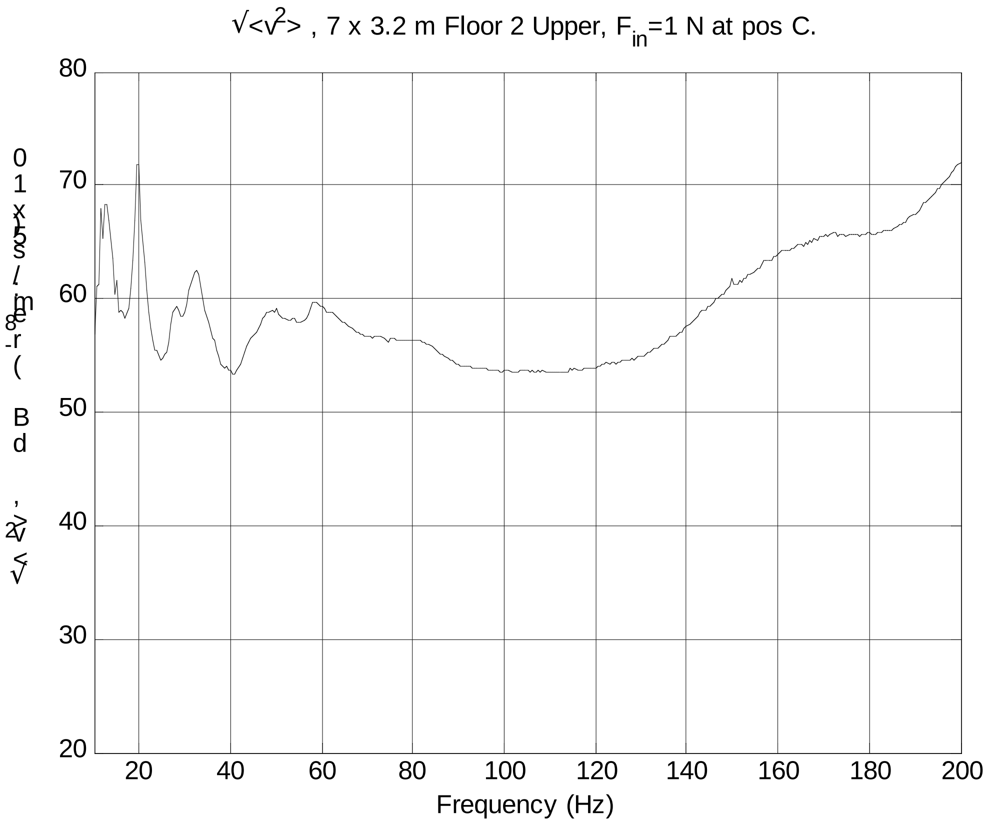
Figure 7-6. Illustration of mode (1,2) of floor 10. Note that the phase with respect to the force is 0 in this illustration.

7.6 AVERAGE SURFACE VELOCITY PLOTS

In this section the data from each measured floor is presented as a root-mean-square average over the entire surface when the force applied to the floor is 1N for each frequency. This way an overall trend can be seen, especially when we are examining different floors. Since different vibrational modes present in the ceiling couple into the room below differently, one other useful thing to look at is the average sound pressure in a room below the ceiling. This is achieved by predicting what effect a rectangular room 2.5m high (with the other dimensions being the same as the floor) would have on the sound produced by the floor. It is assumed that the room has an absorption coefficient of 0.15 [1].

[1] This is concluded to be the approximate case for plasterboard-lined light-framed rooms from work by Maluski and Gibbs (2004).

Floor 2



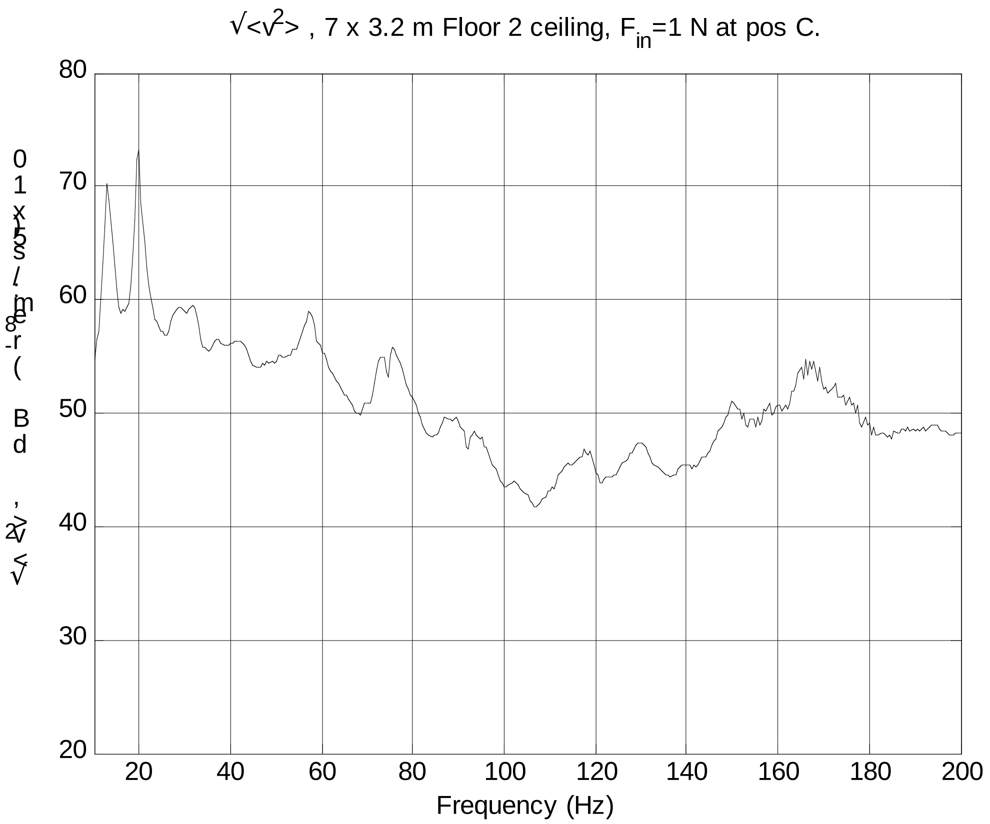


Figure 7-7. Averaged surface velocity plots in dB for Floor 2 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position C and normalised against the amplitude of the applied force (F_{in}) for each frequency.

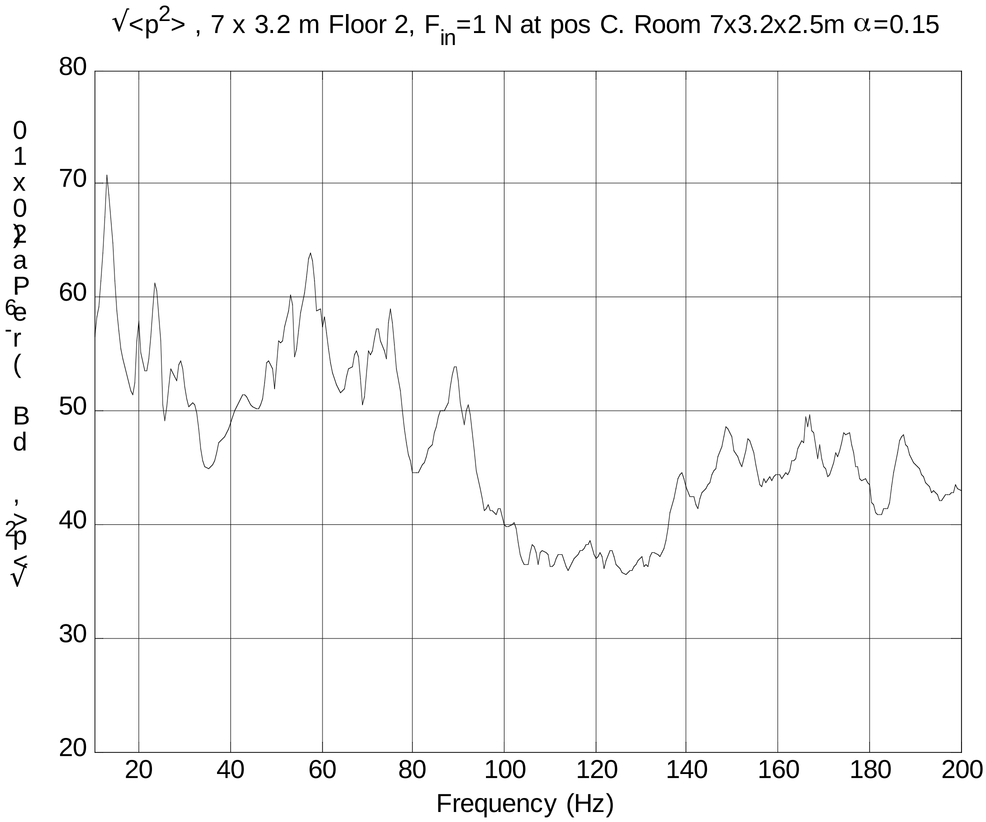
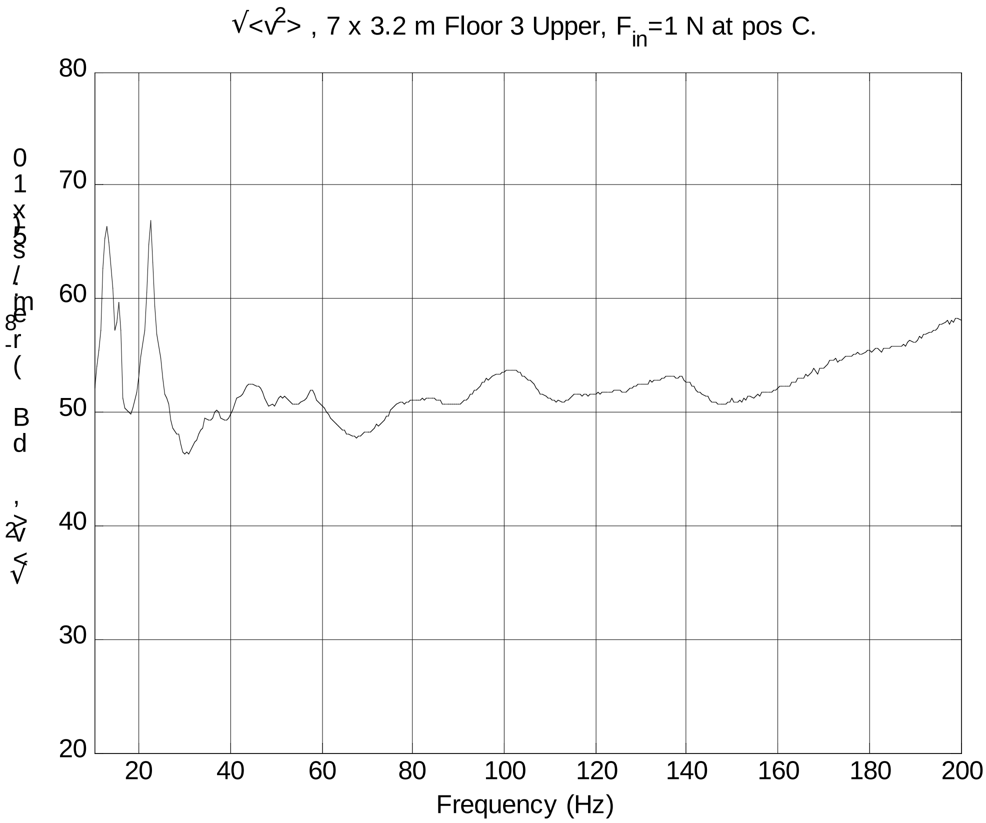


Figure 7-8. Averaged sound pressure in dB for Floor 2 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position C and normalised against the amplitude of the applied force (F_{in}).

Floor 3



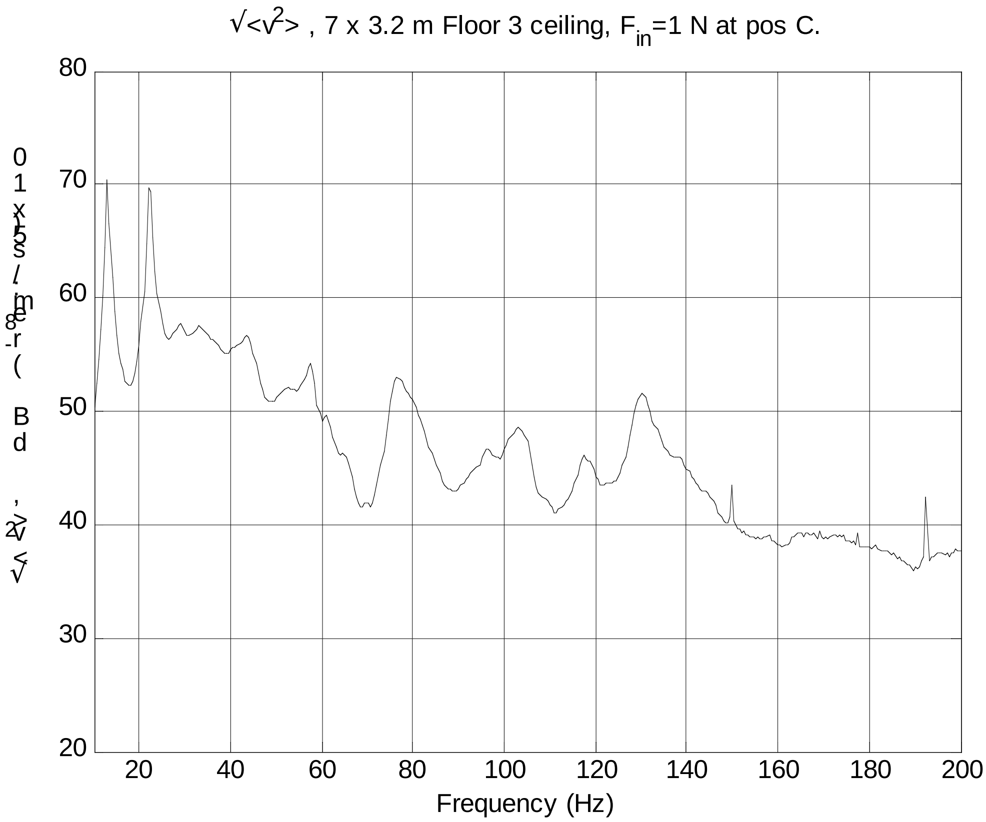


Figure 7-9. Averaged surface velocity plots in dB for Floor 3 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position C and normalised against the amplitude of the applied force (F_{in}) for each frequency.

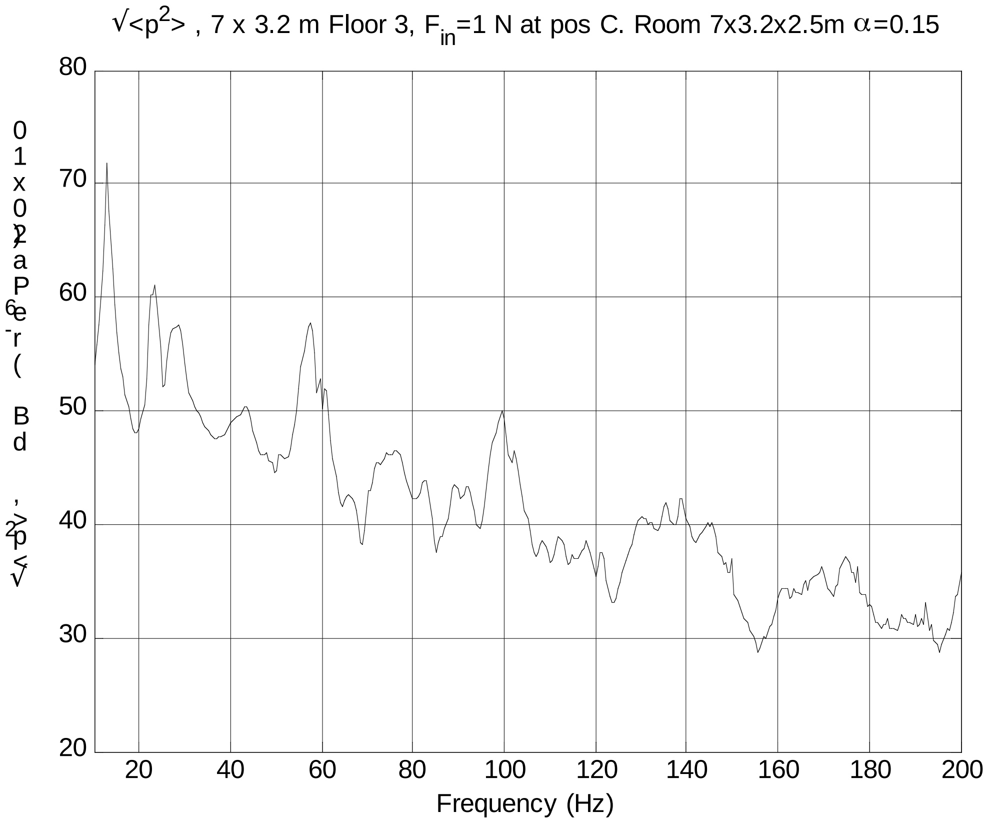
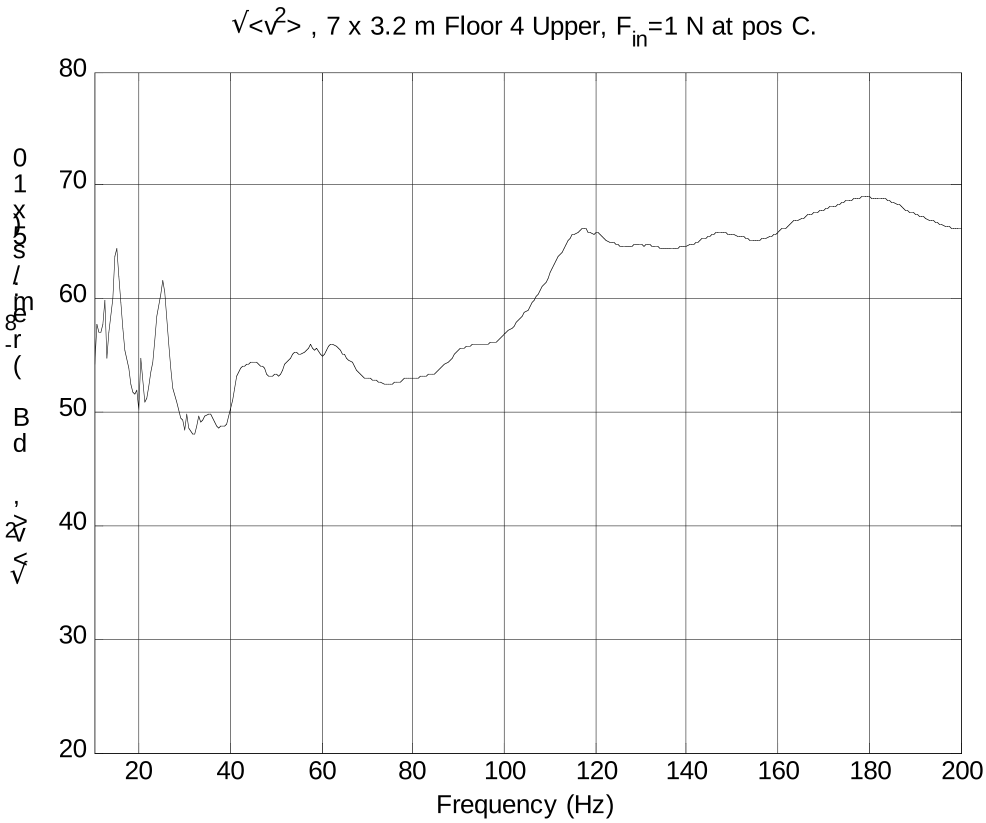


Figure 7-10. Averaged sound pressure in dB for Floor 3 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position C and normalised against the amplitude of the applied force (F_{in}).

Floor 4



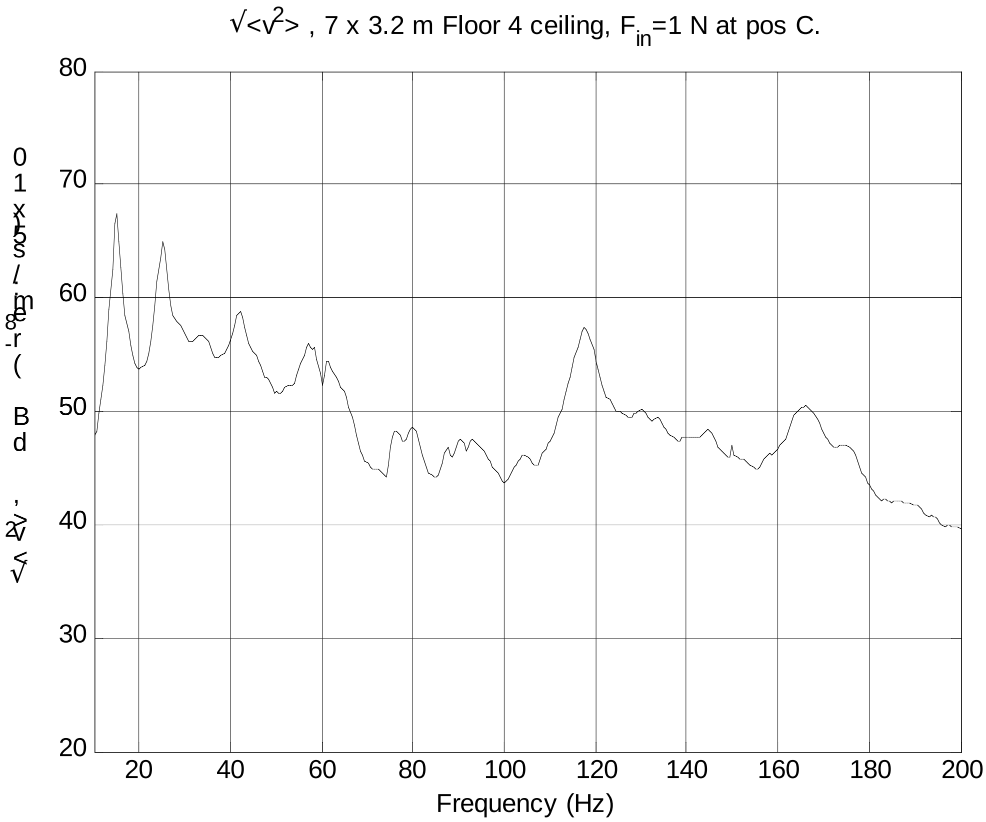


Figure 7-11. Averaged surface velocity plots in dB for Floor 4 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position C and normalised against the amplitude of the applied force (F_{in}) for each frequency.

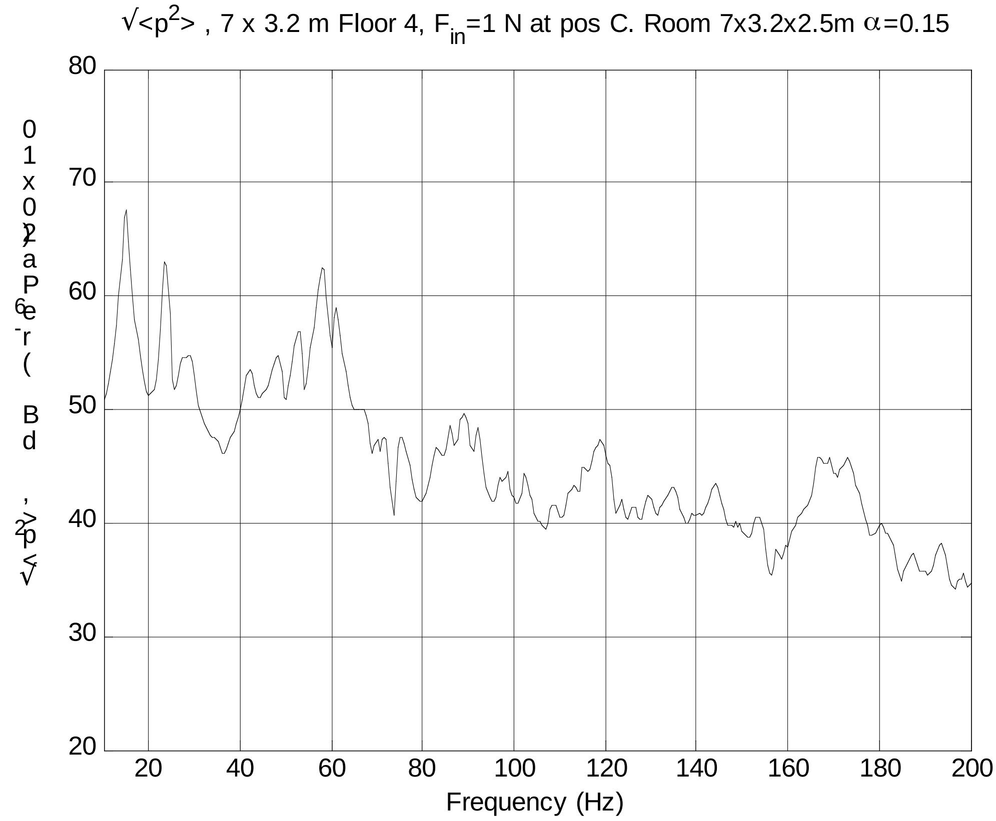
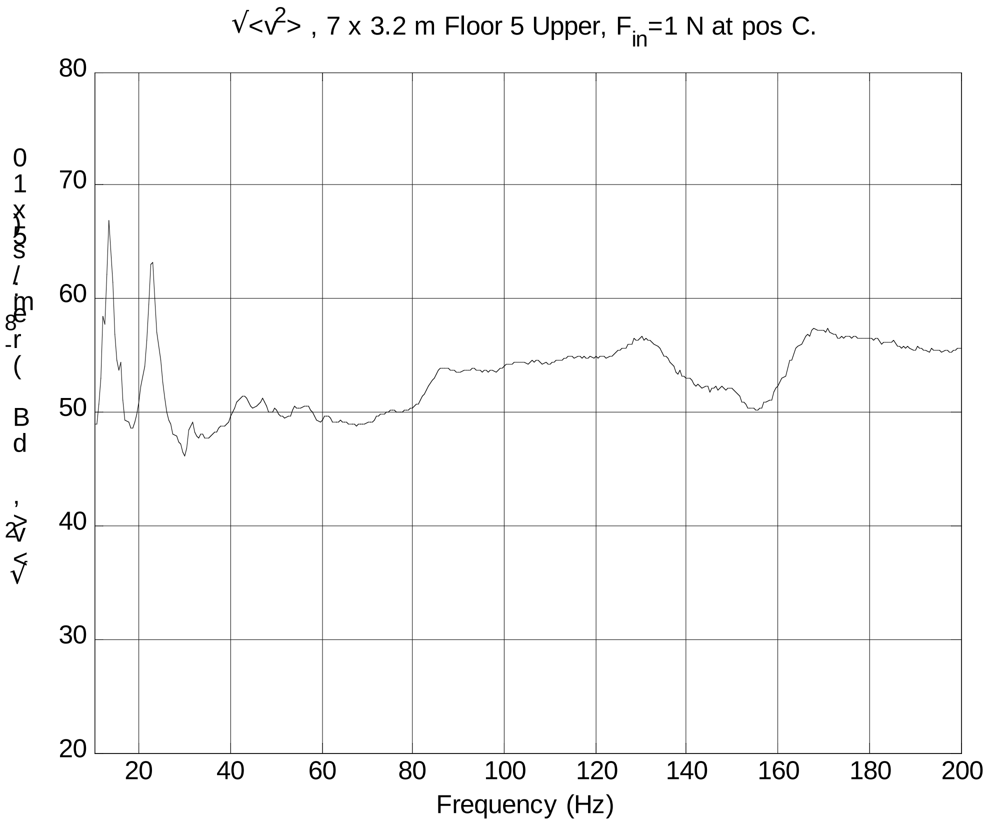


Figure 7-12. Averaged sound pressure in dB for Floor 4 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position C and normalised against the amplitude of the applied force (F_{in}).

Floor 5



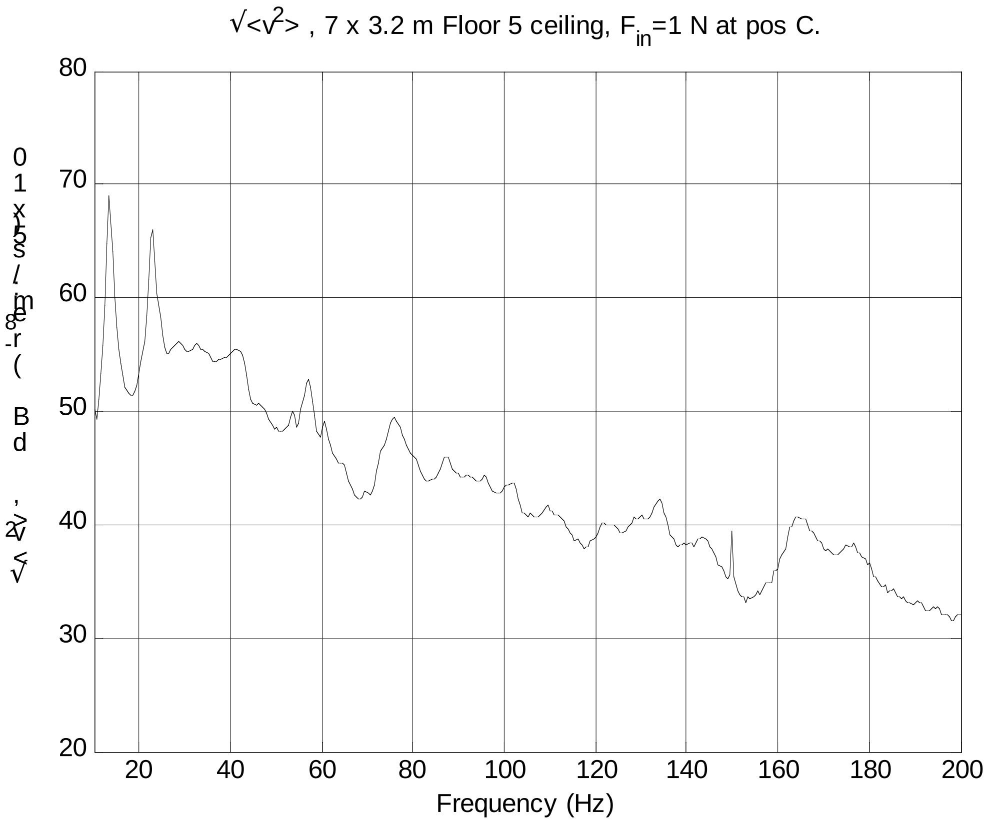


Figure 7-13. Averaged surface velocity plots in dB for Floor 5 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position C and normalised against the amplitude of the applied force (F_{in}) for each frequency.

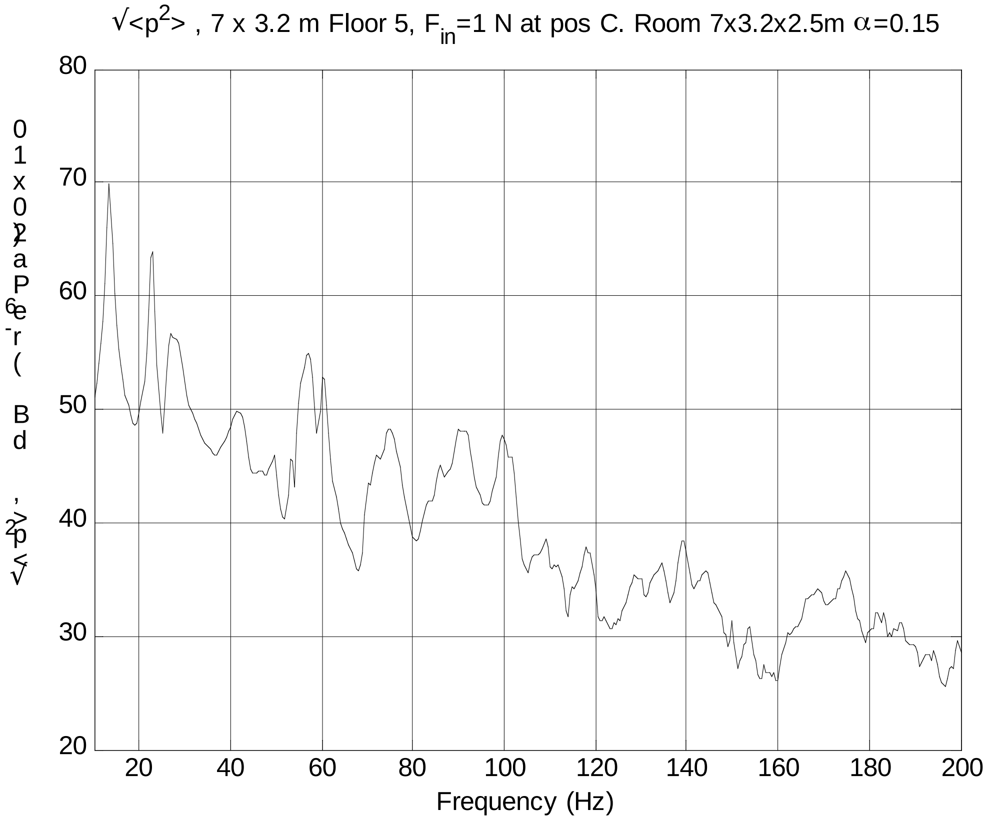
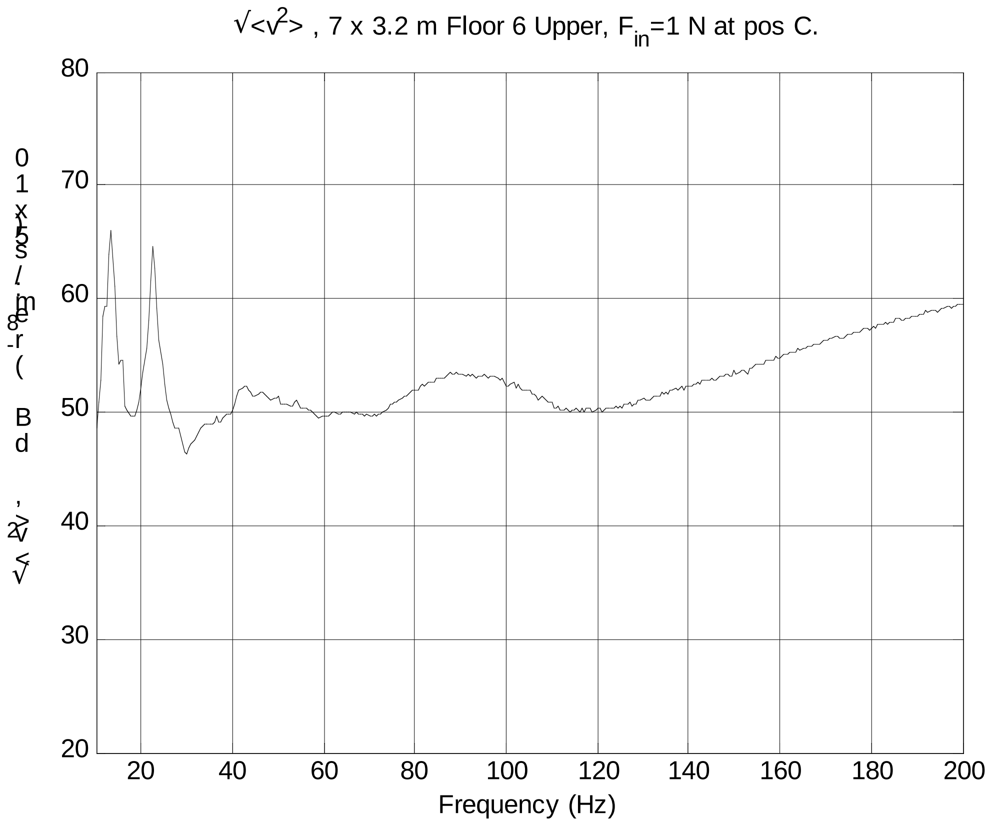


Figure 7-14. Averaged sound pressure in dB for Floor 5 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position C and normalised against the amplitude of the applied force (F_{in}).

Floor 6



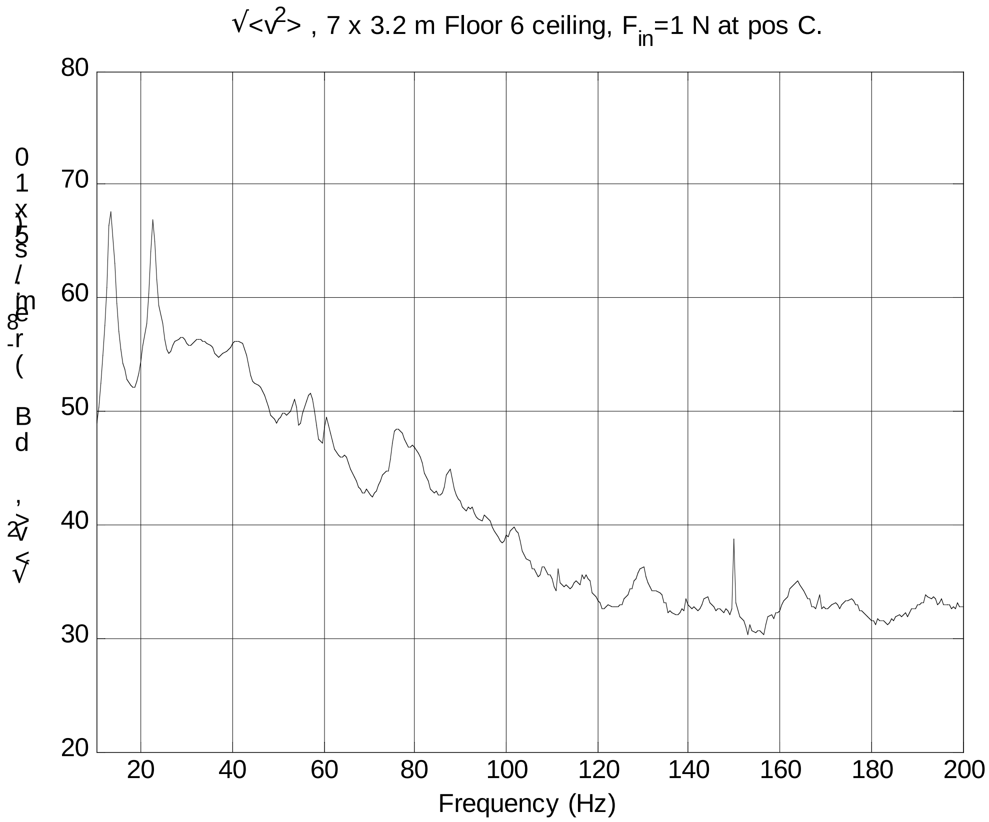


Figure 7-15. Averaged surface velocity plots in dB for Floor 6 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position C and normalised against the amplitude of the applied force (F_{in}) for each frequency.

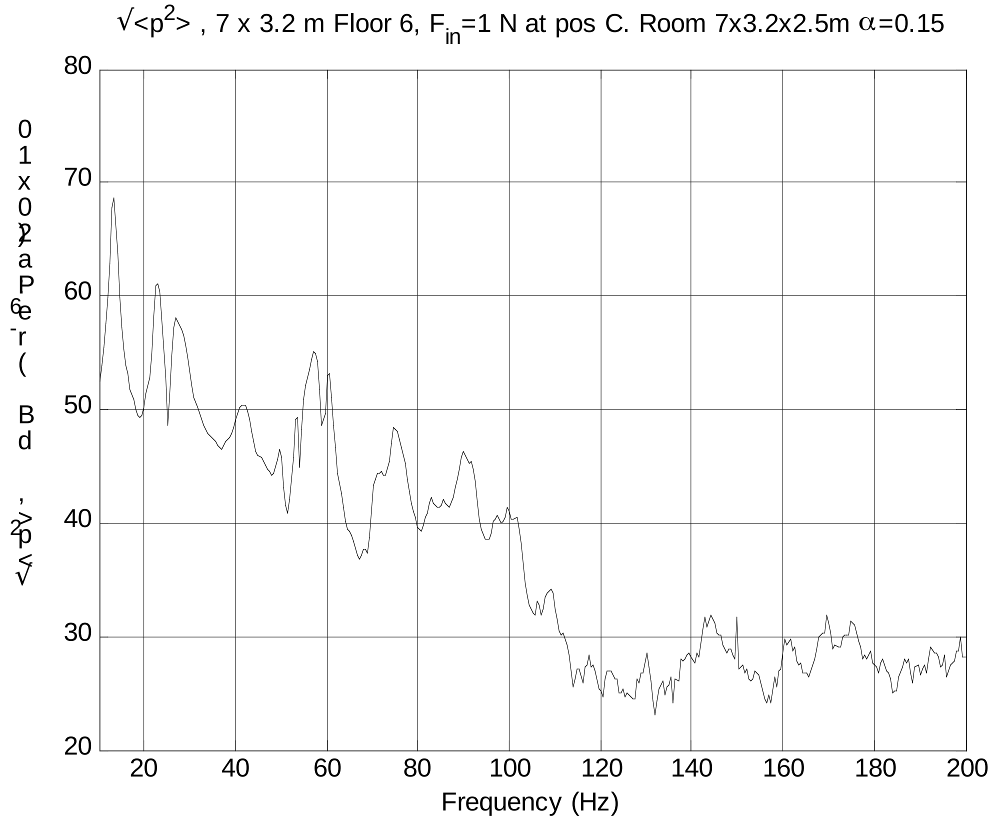
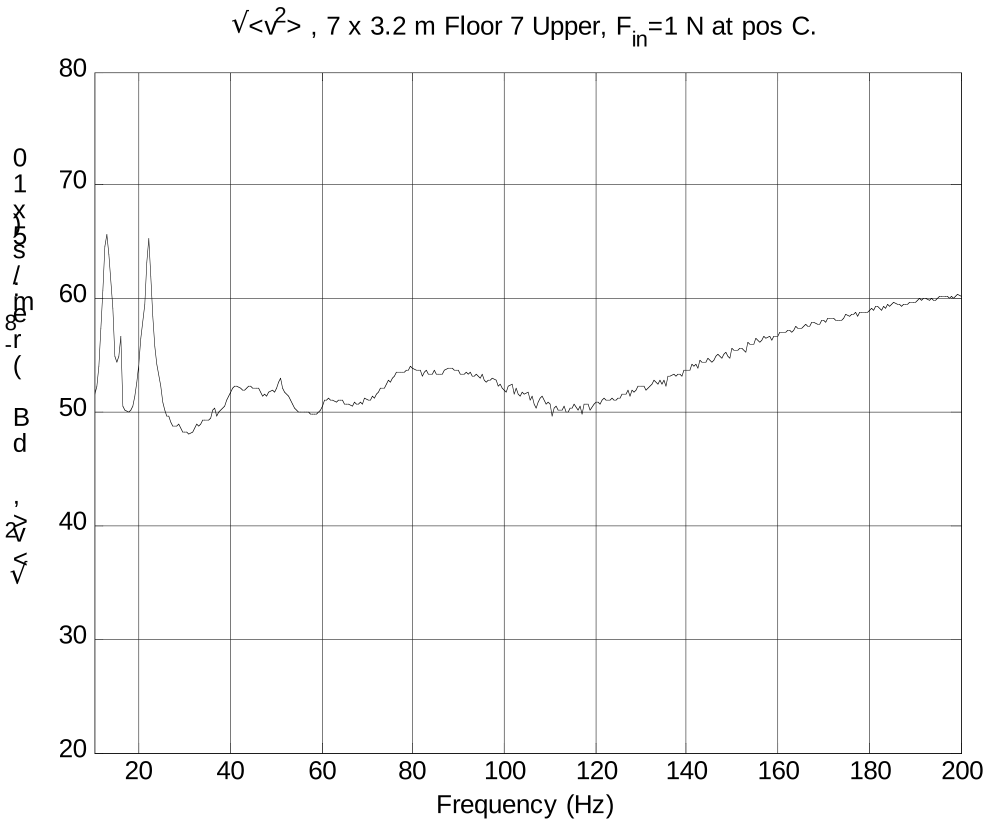


Figure 7-16. Averaged sound pressure in dB for Floor 6 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position C and normalised against the amplitude of the applied force (F_{in}).

Floor 7



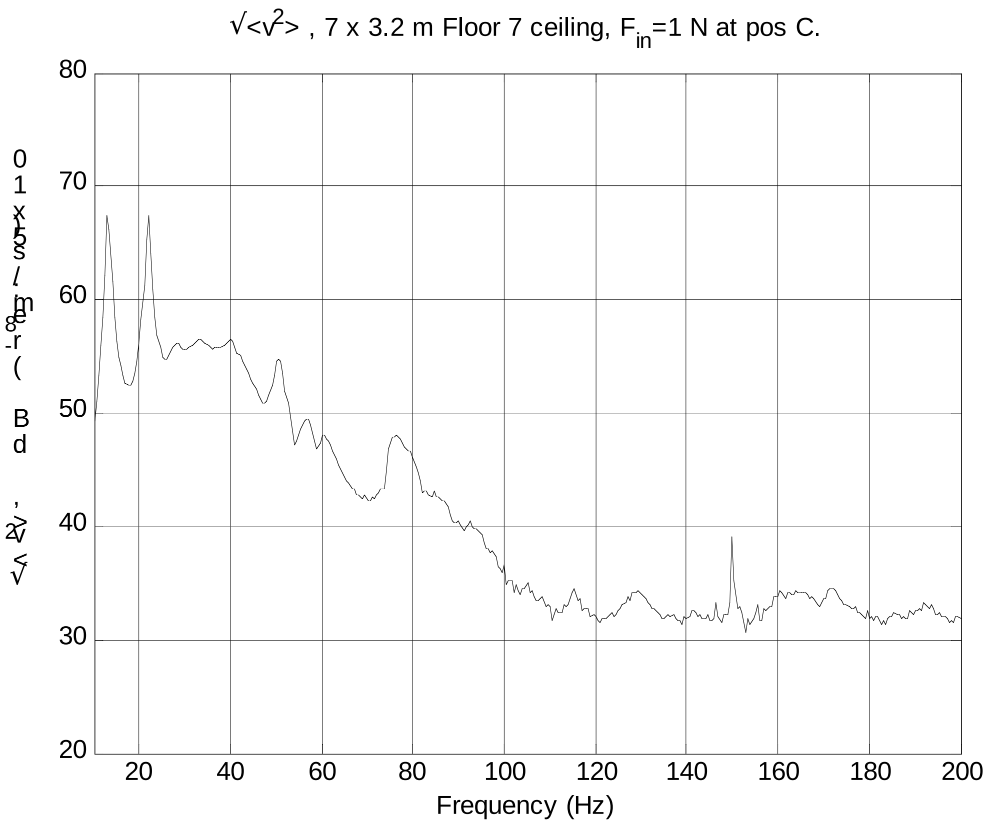


Figure 7-17. Averaged surface velocity plots in dB for Floor 7 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position C and normalised against the amplitude of the applied force (F_{in}) for each frequency.

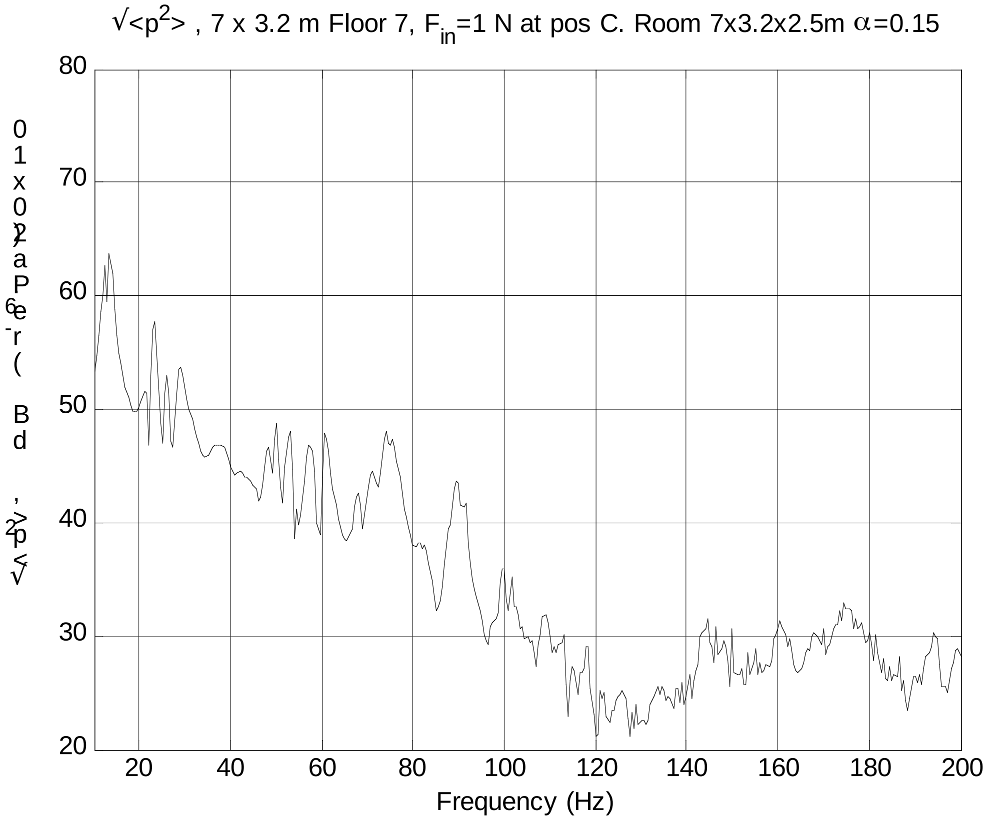
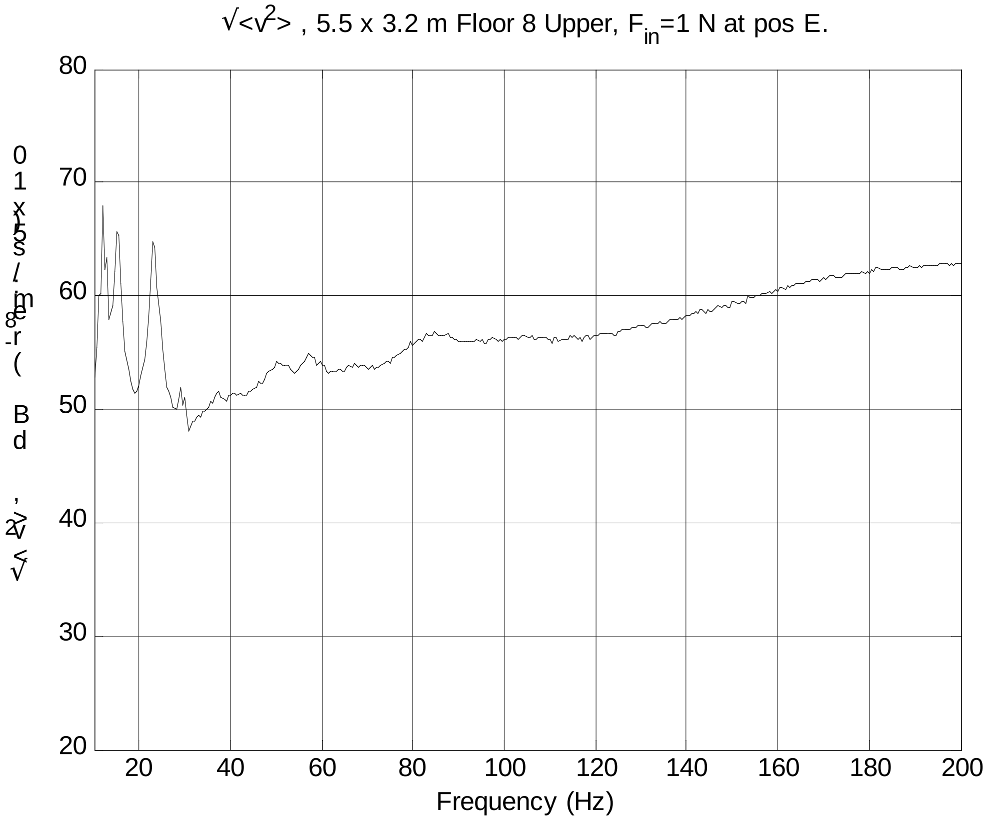


Figure 7-18. Averaged sound pressure in dB for Floor 7 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position C and normalised against the amplitude of the applied force (F_{in}).

Floor 8



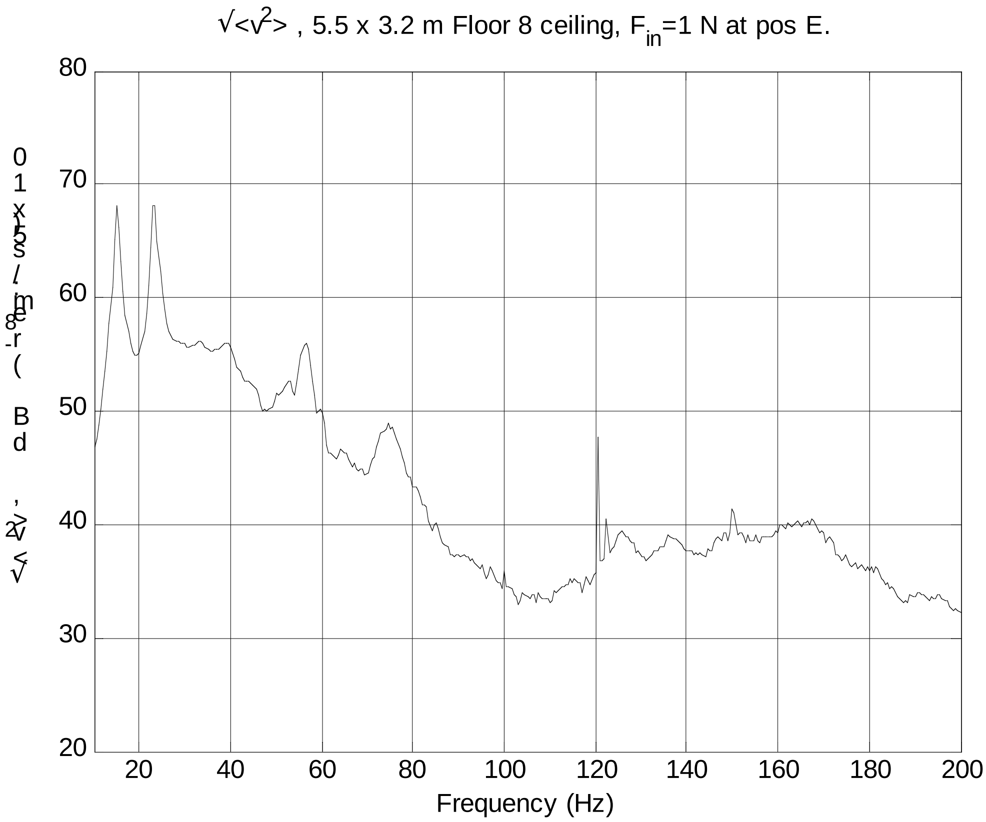


Figure 7-19. Averaged surface velocity plots in dB for Floor 8 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

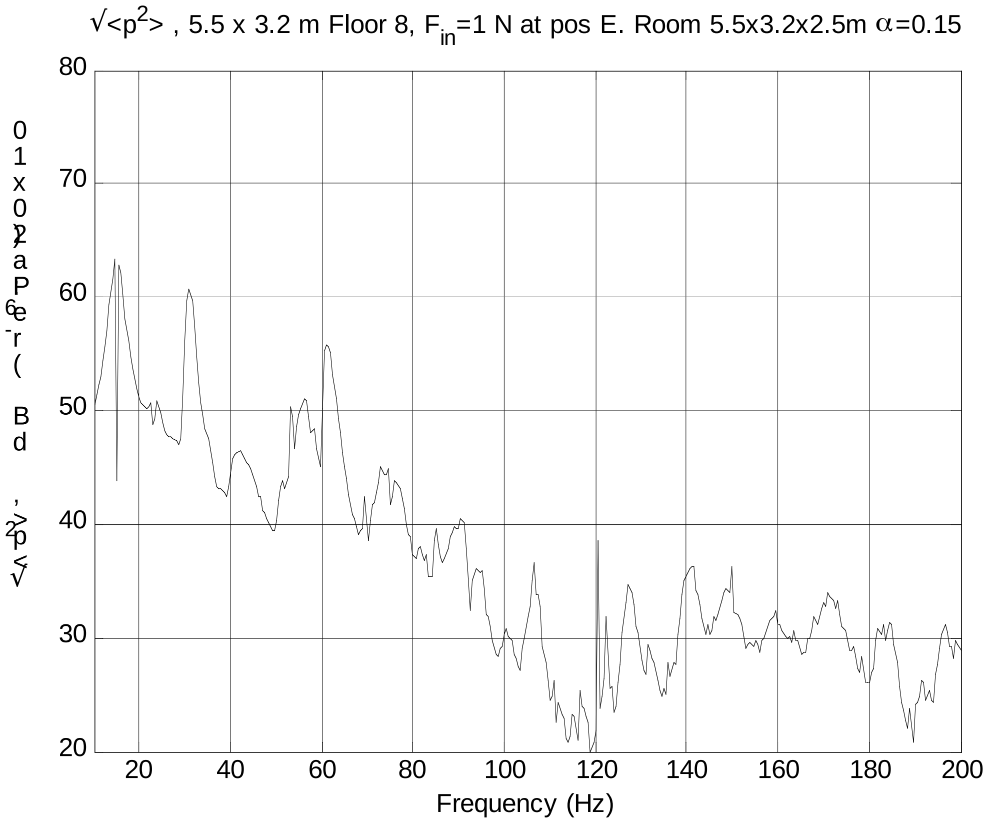
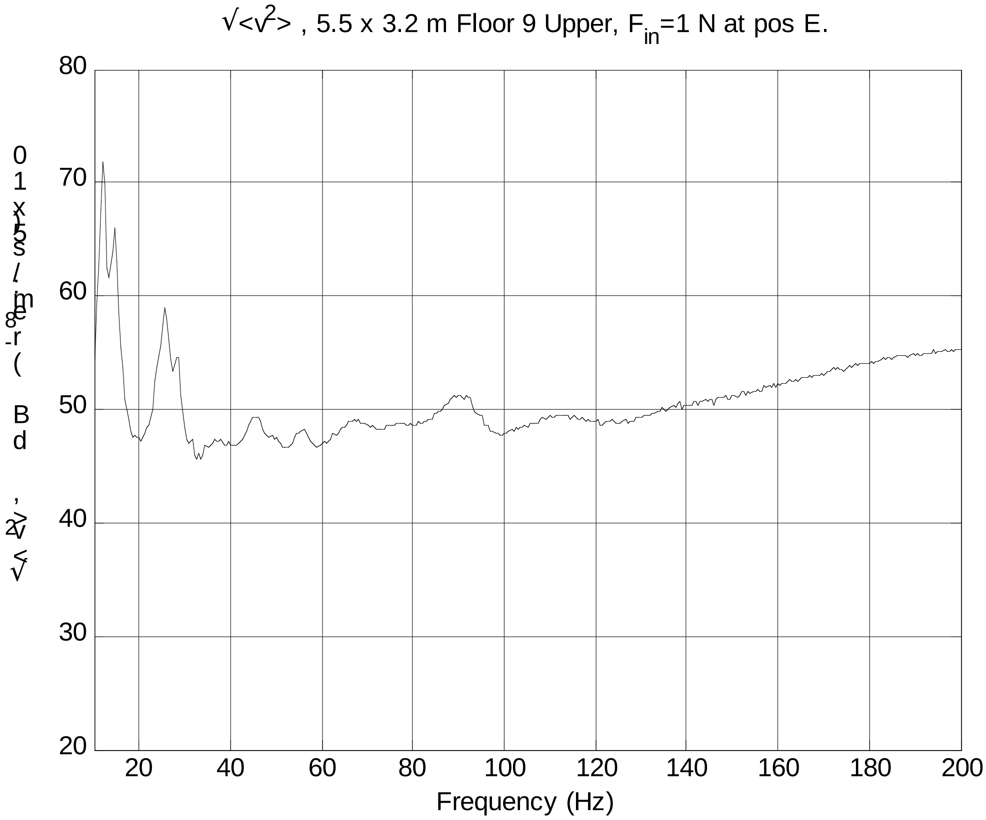


Figure 7-20. Averaged sound pressure in dB for Floor 8 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 9



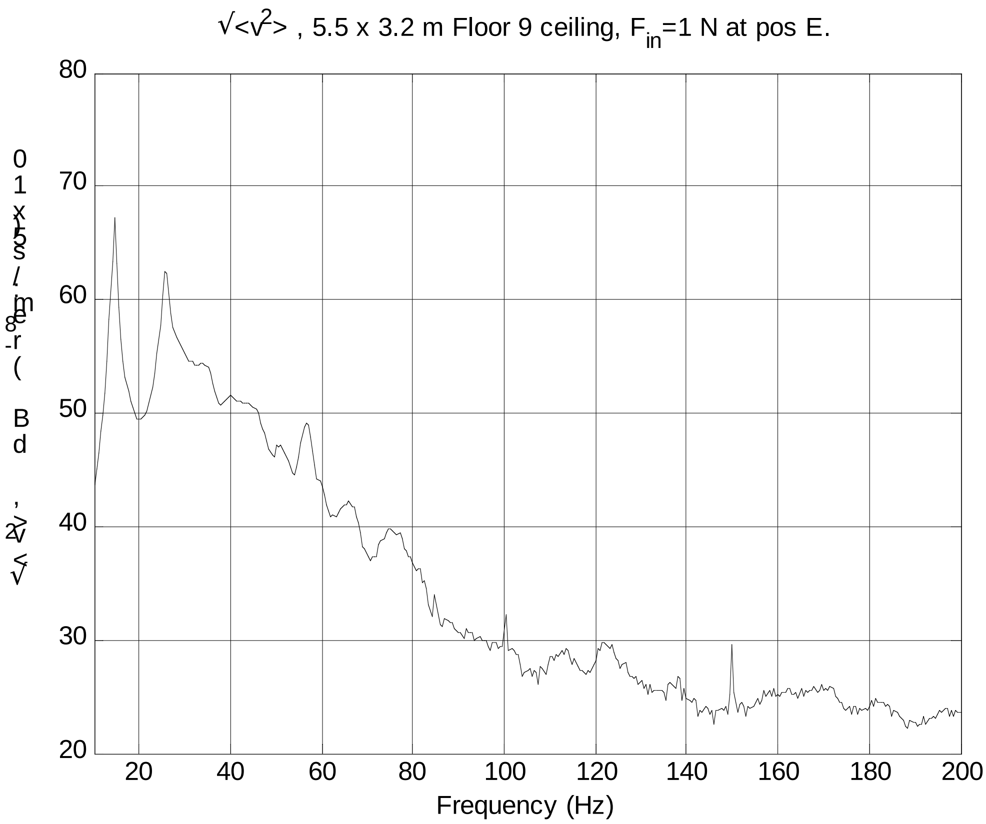


Figure 7-21. Averaged surface velocity plots in dB for Floor 9 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

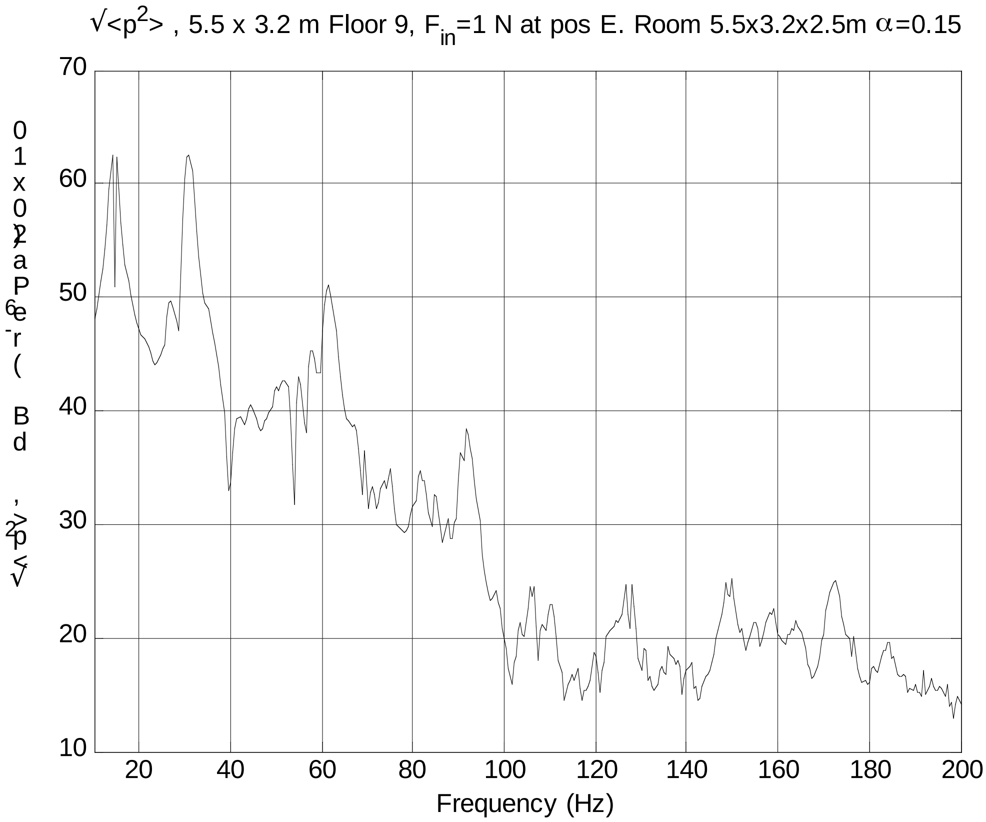


Figure 7-22. Averaged sound pressure in dB for Floor 9 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 10

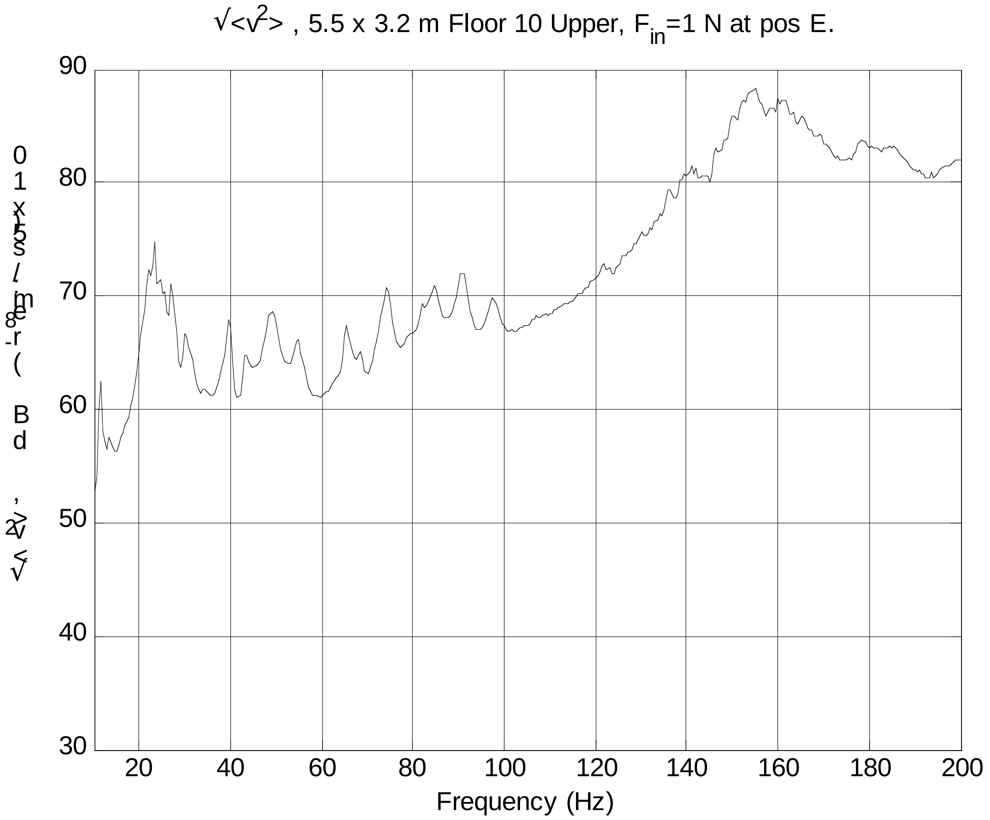


Figure 7-23. Averaged surface velocity plot in dB for Floor 10 as a function of frequency for the upper part of the floor (there is no ceiling). As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

Floor 11

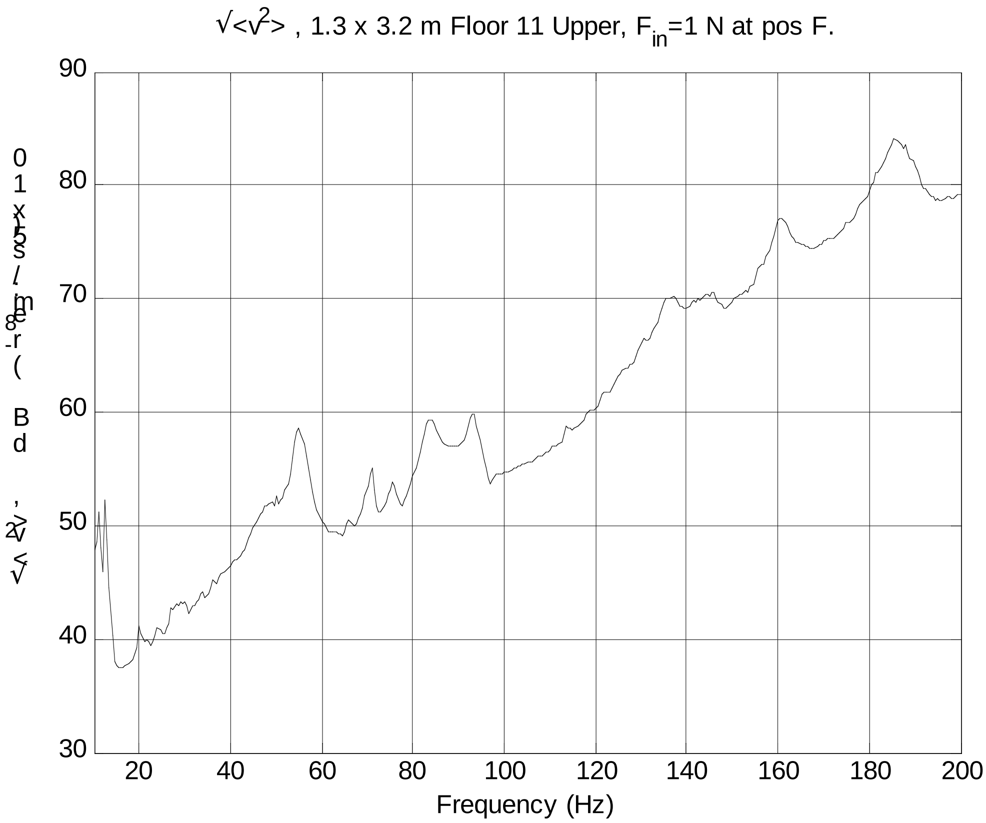


Figure 7-24. Averaged surface velocity plot in dB for Floor 11 as a function of frequency for the upper part of the floor (there is no ceiling). As measured by the scanning laser vibrometer, generated by the force at position F and normalised against the amplitude of the applied force (F_{in}) for each frequency.

Floor 12

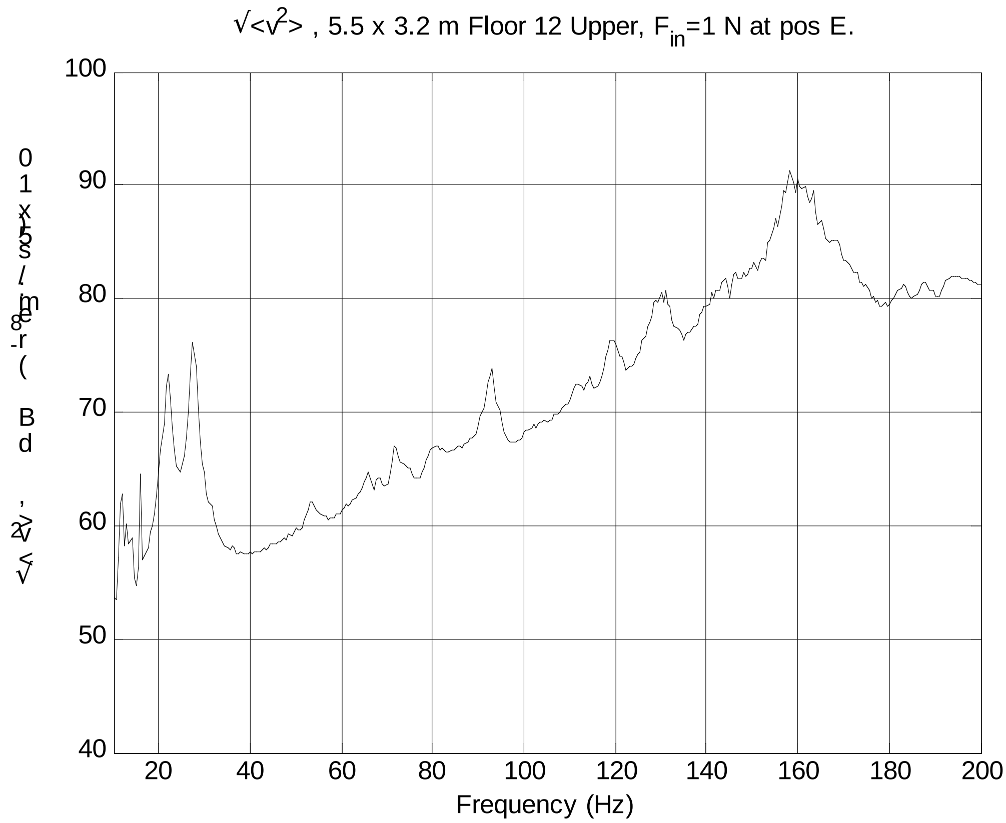


Figure 7-25. Averaged surface velocity plot in dB for Floor 12 as a function of frequency for the upper part of the floor (there is no ceiling). As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

Floor 13

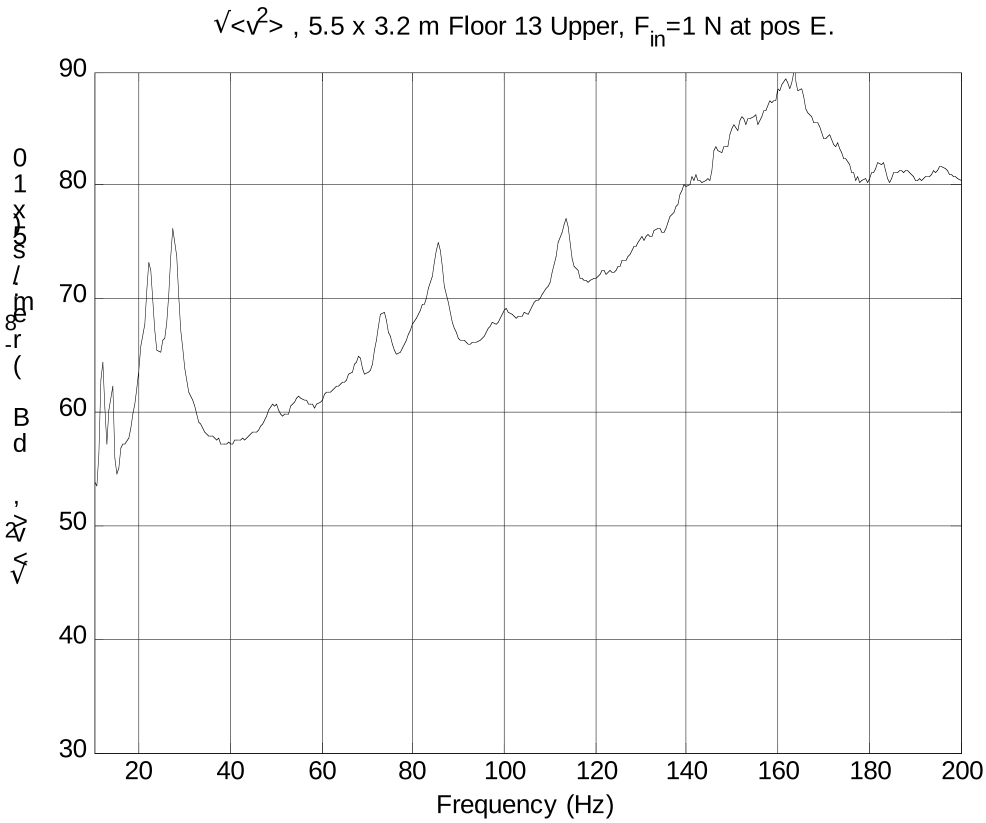
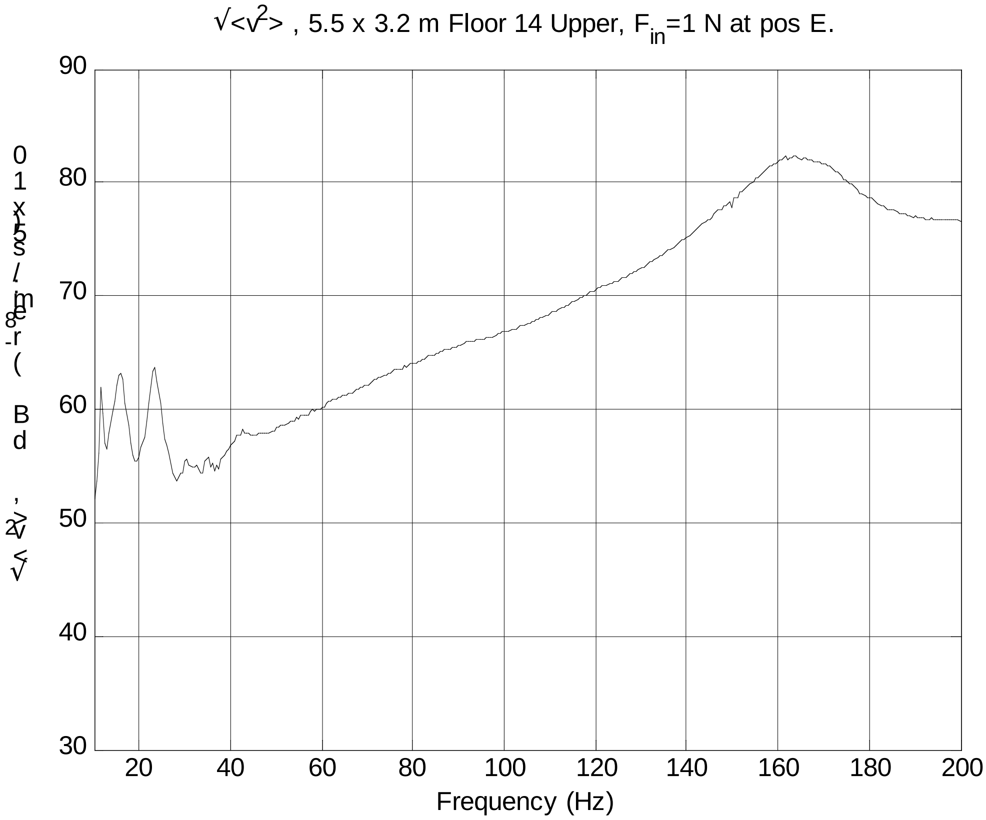


Figure 7-26. Averaged surface velocity plot in dB for Floor 13 as a function of frequency for the upper part of the floor (there is no ceiling). As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

Floor 14



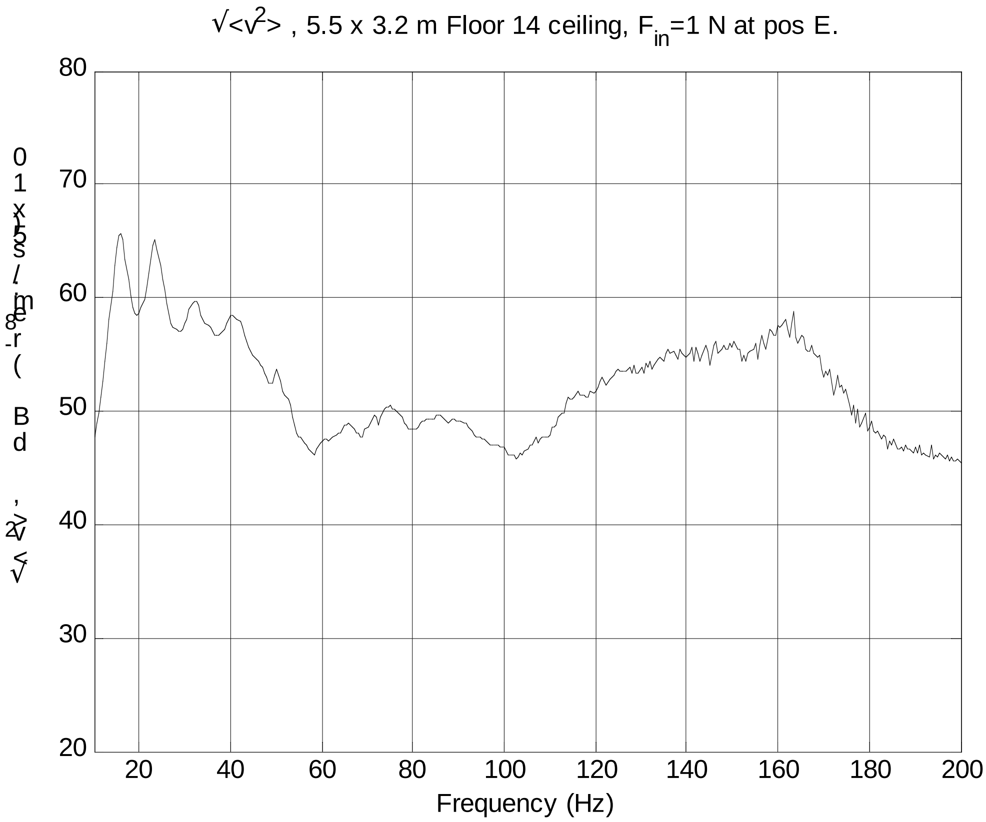


Figure 7-27. Averaged surface velocity plots in dB for Floor 14 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

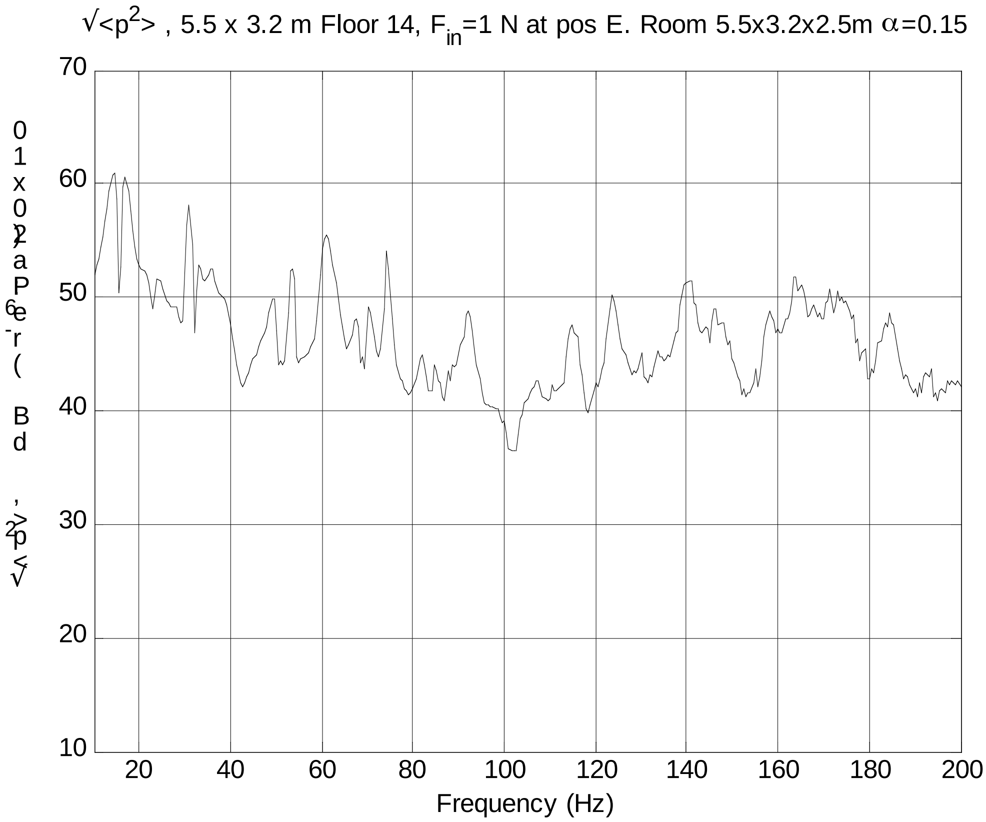


Figure 7-28. Averaged sound pressure in dB for Floor 14 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 15

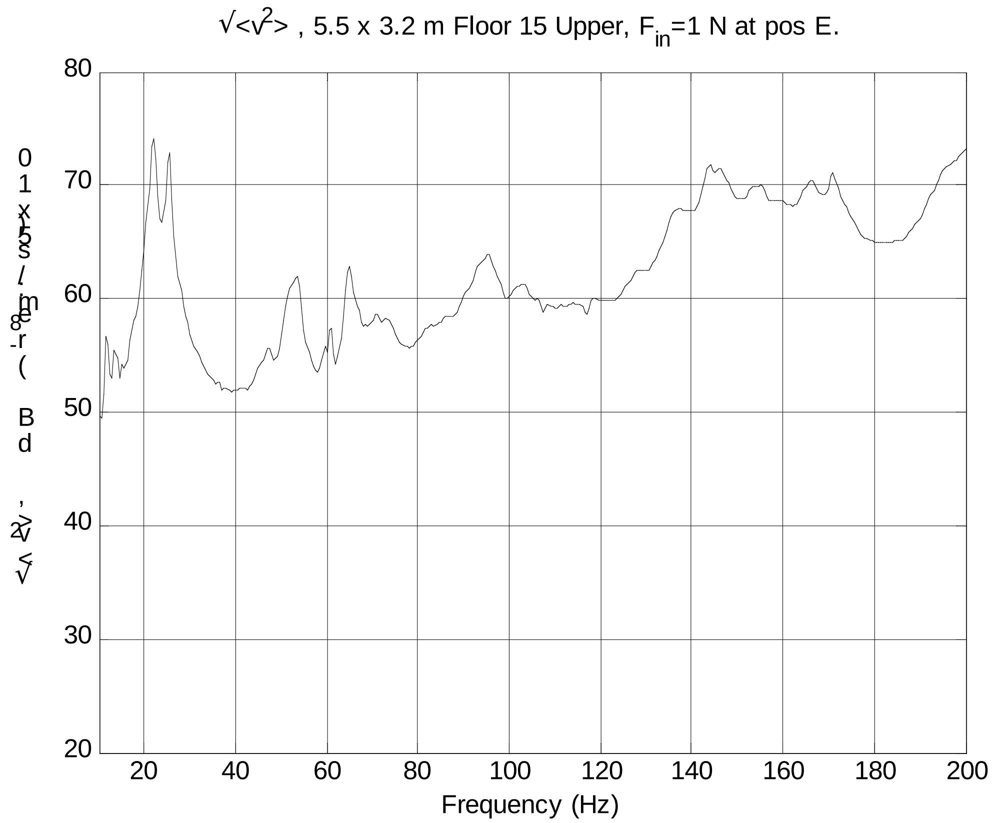
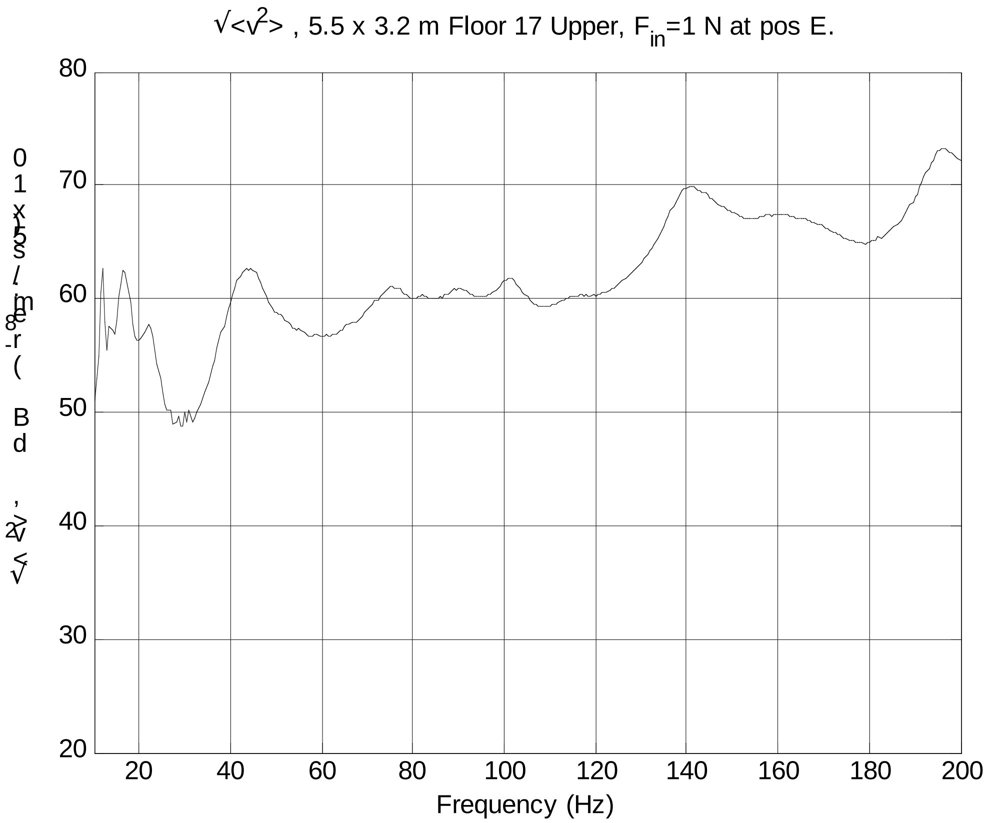


Figure 7-29. Averaged surface velocity plot in dB for Floor 15 as a function of frequency for the upper part of the floor (there is no ceiling). As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

Floor 17



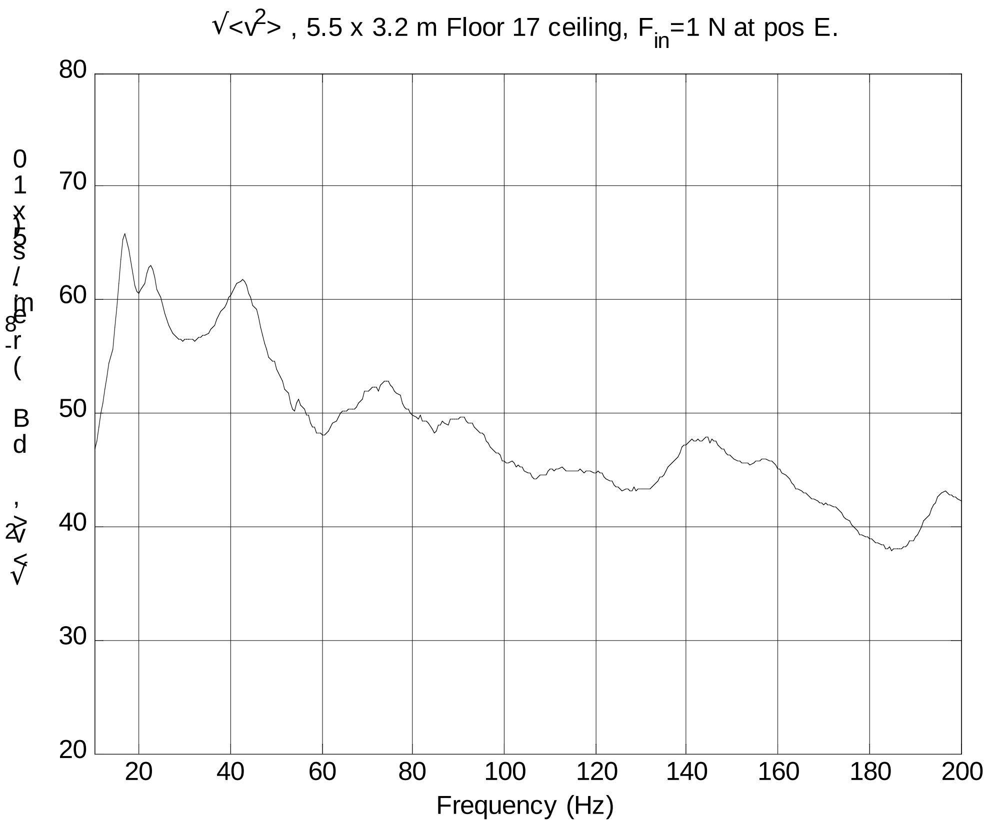


Figure 7-30. Averaged surface velocity plots in dB for Floor 17 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

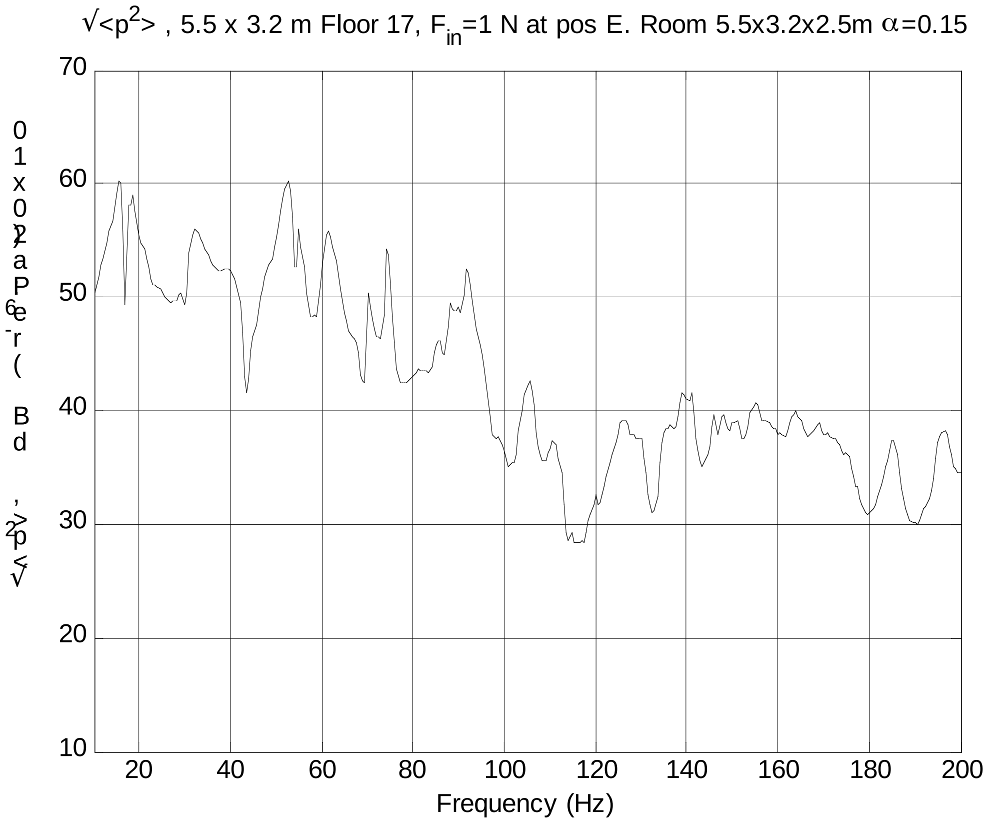
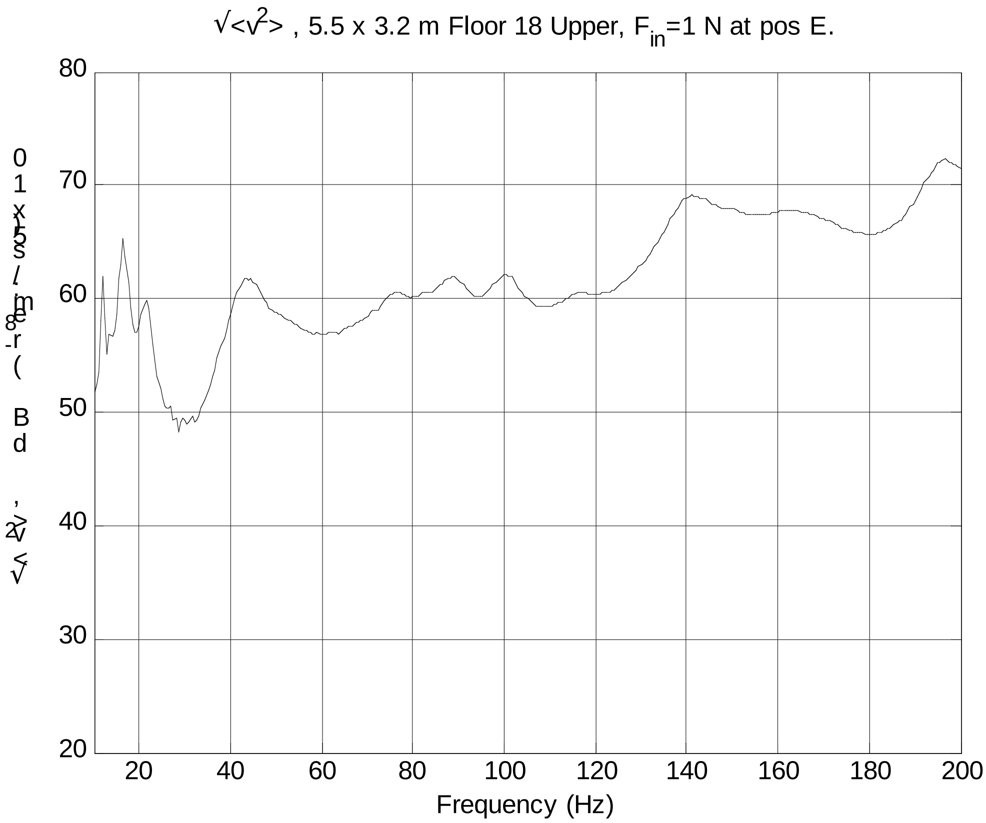


Figure 7-31. Averaged sound pressure in dB for Floor 17 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 18



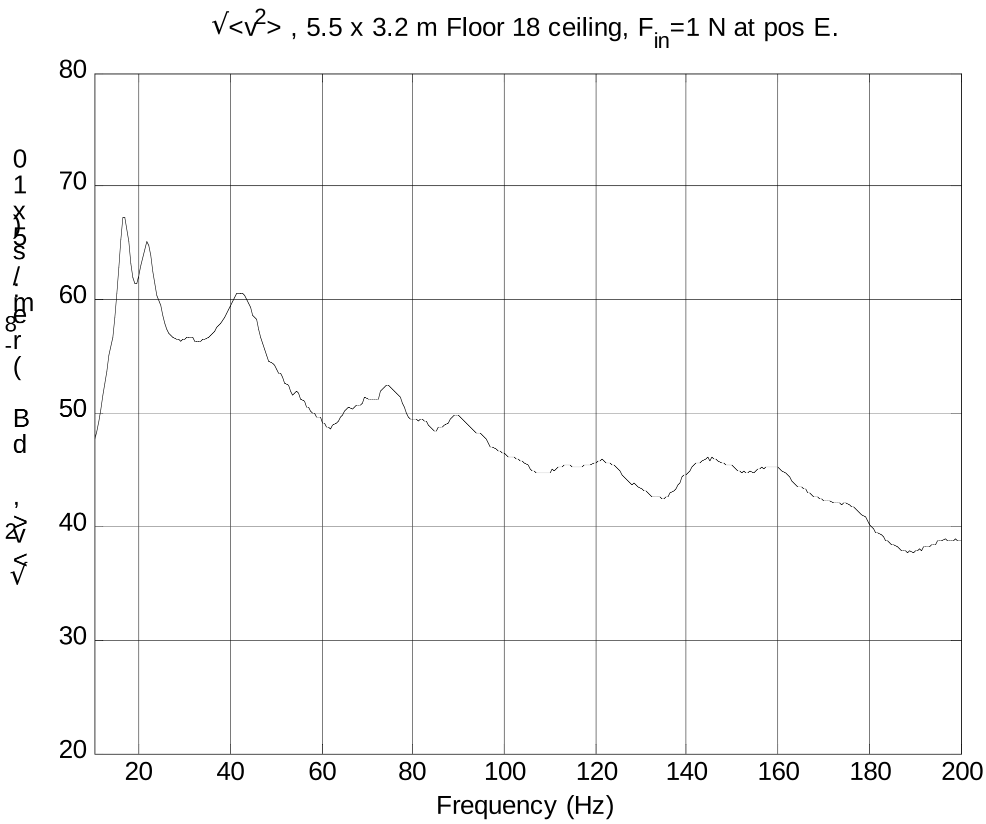


Figure 7-32. Averaged surface velocity plots in dB for Floor 18 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

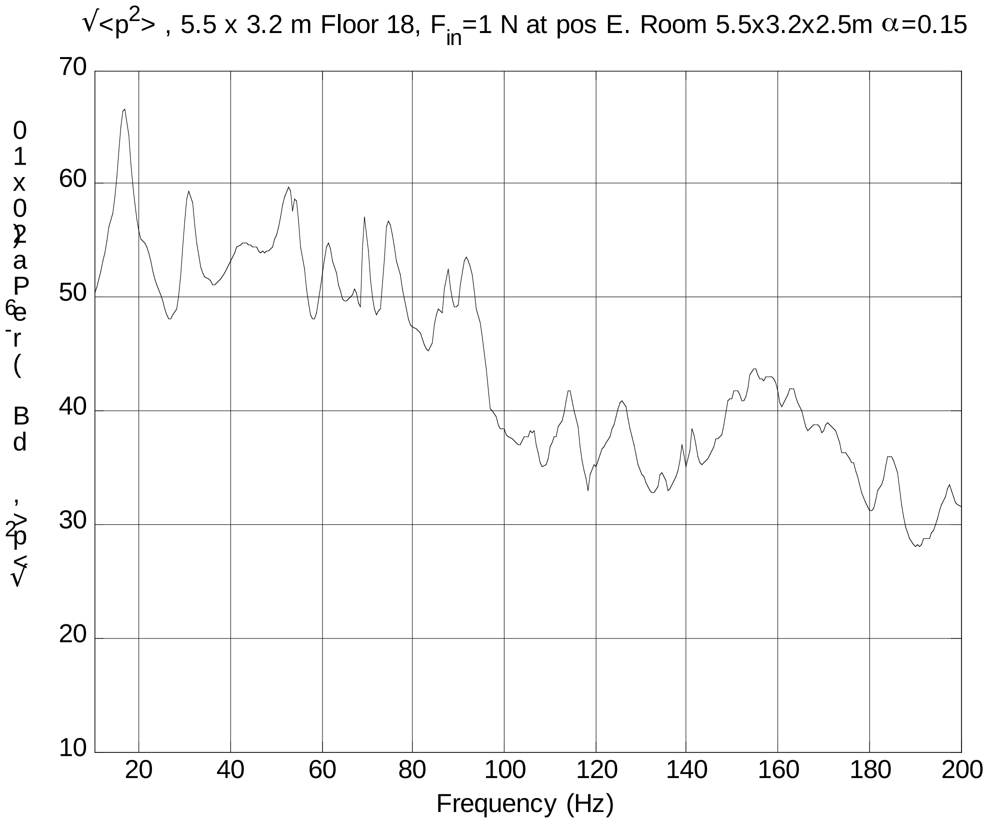
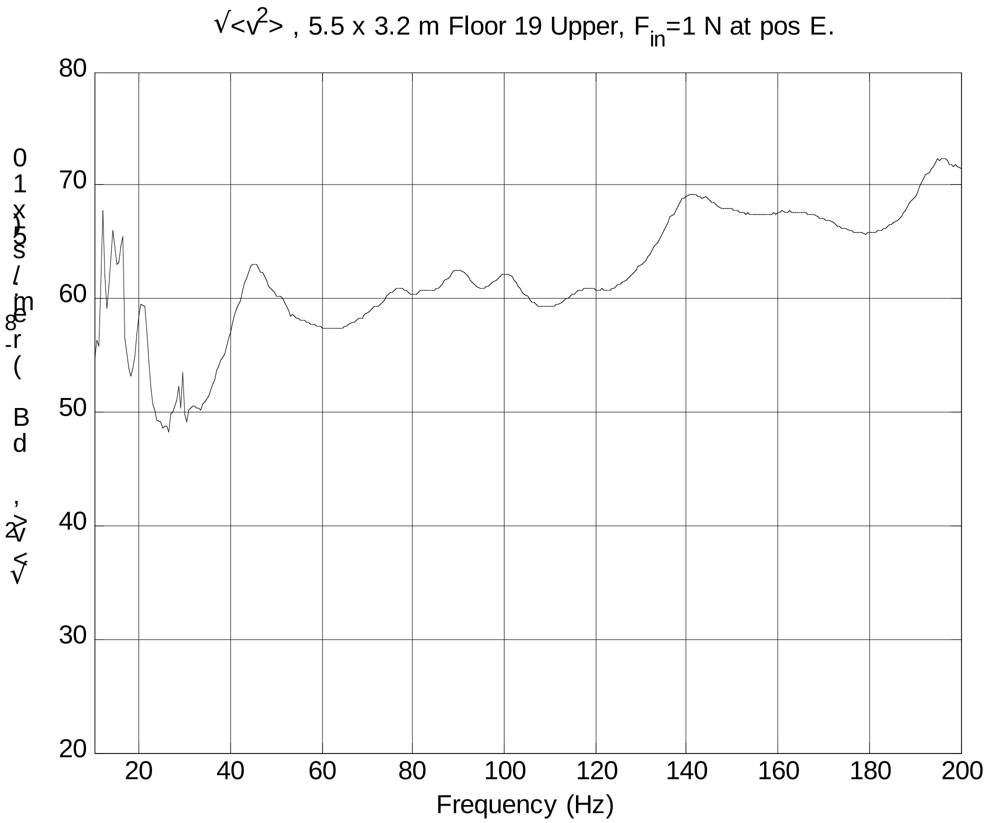


Figure 7-33. Averaged sound pressure in dB for Floor 18 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 19



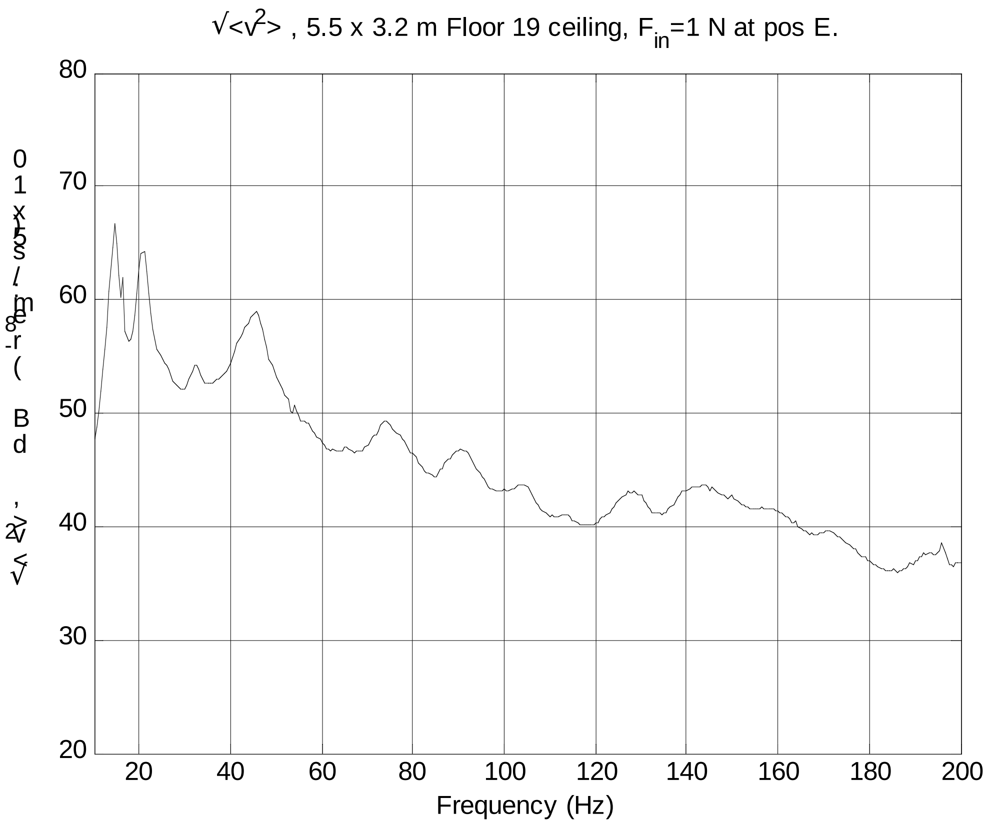


Figure 7-34. Averaged surface velocity plots in dB for Floor 19 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

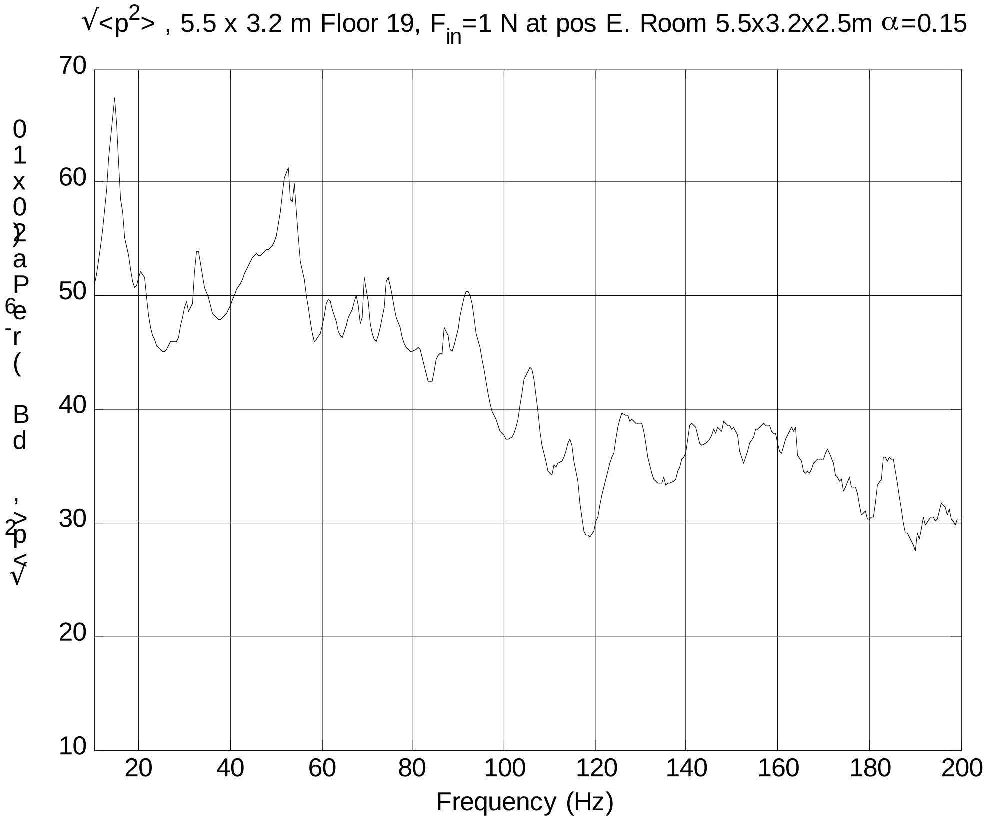
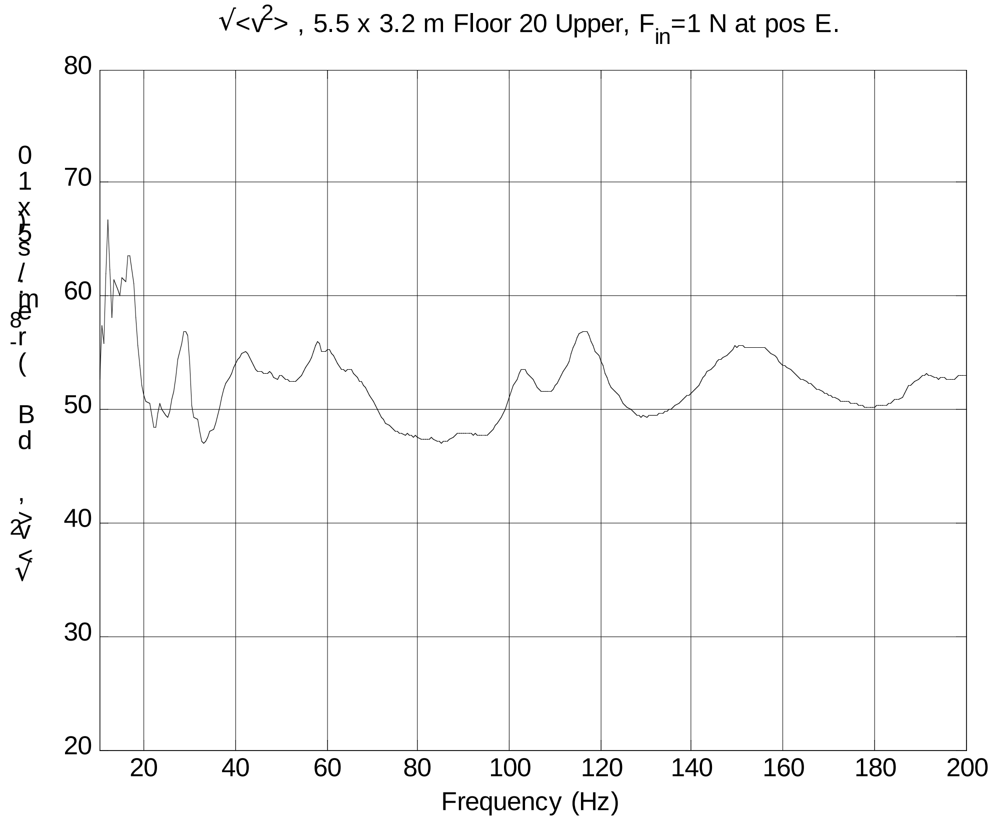


Figure 7-35. Averaged sound pressure in dB for Floor 19 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 20



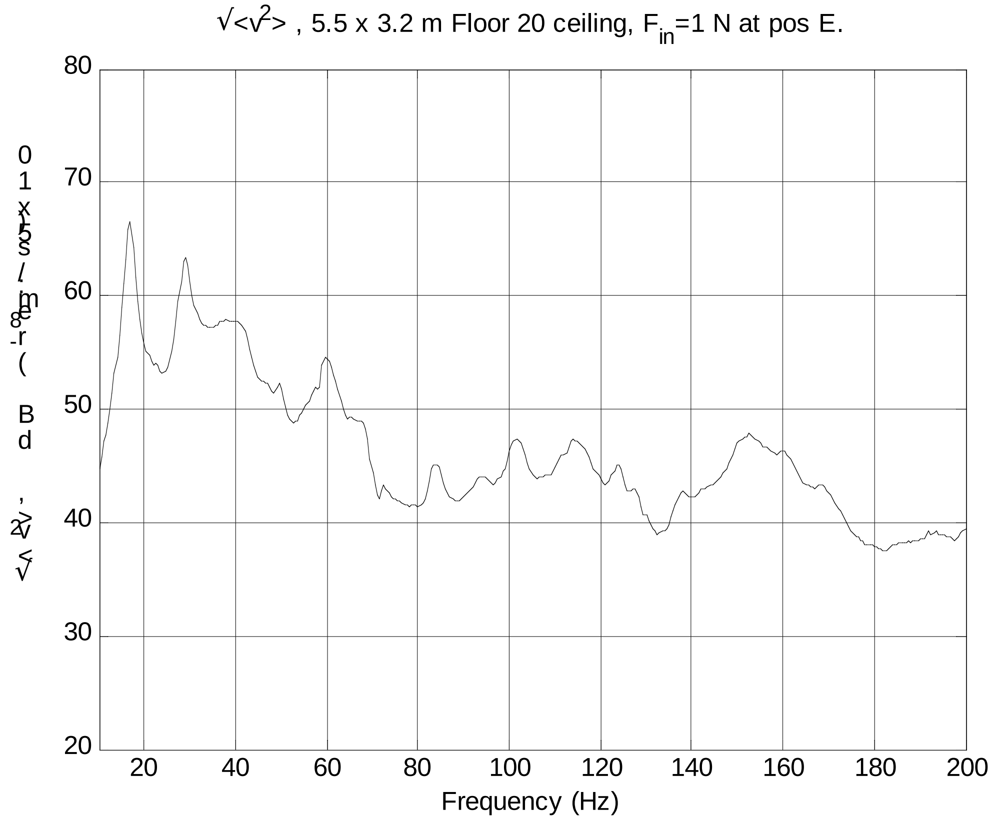


Figure 7-36. Averaged surface velocity plots in dB for Floor 20 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

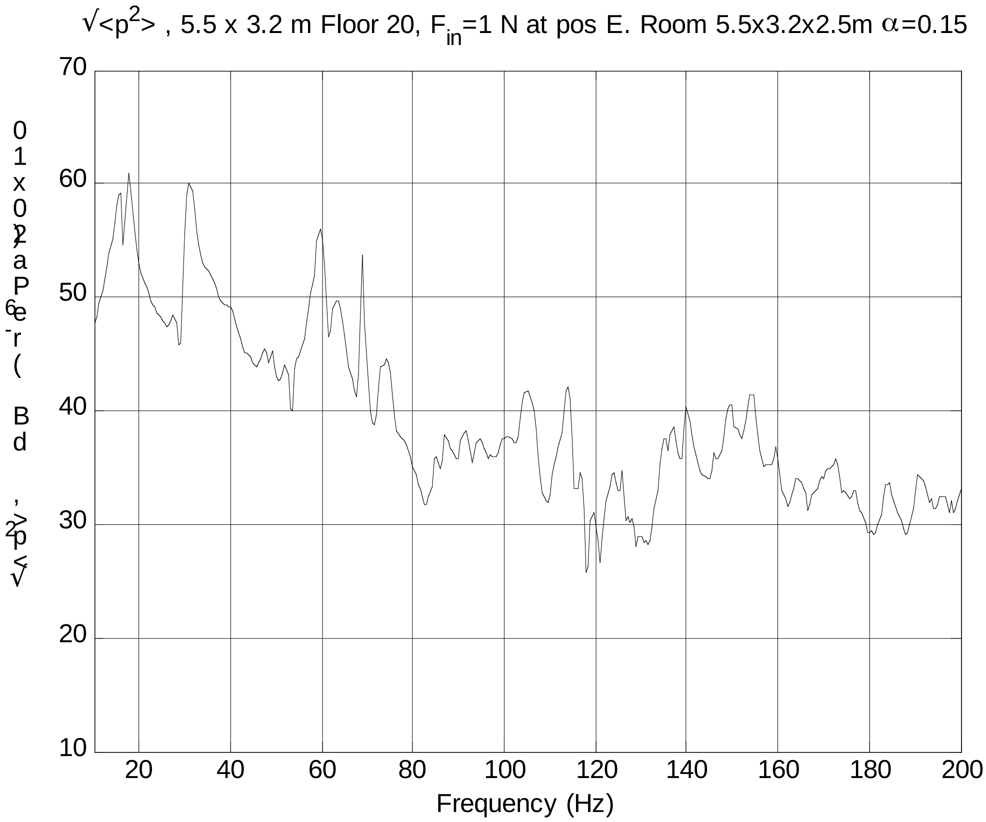
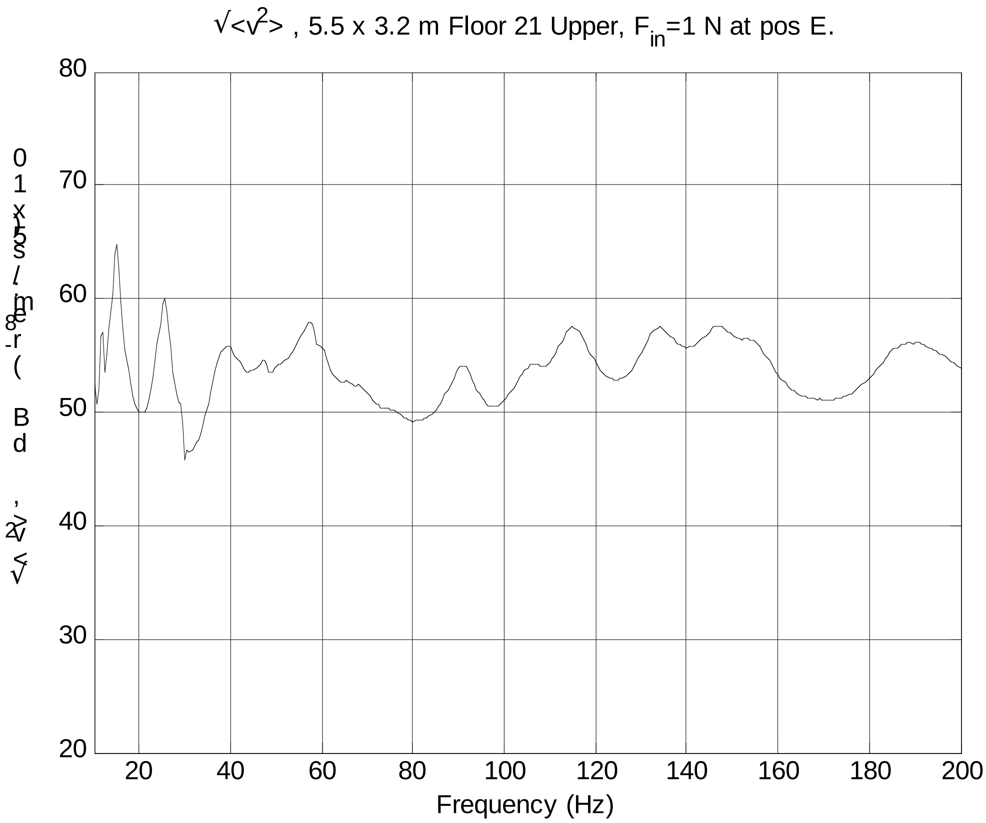


Figure 7-37. Averaged sound pressure in dB for Floor 20 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 21



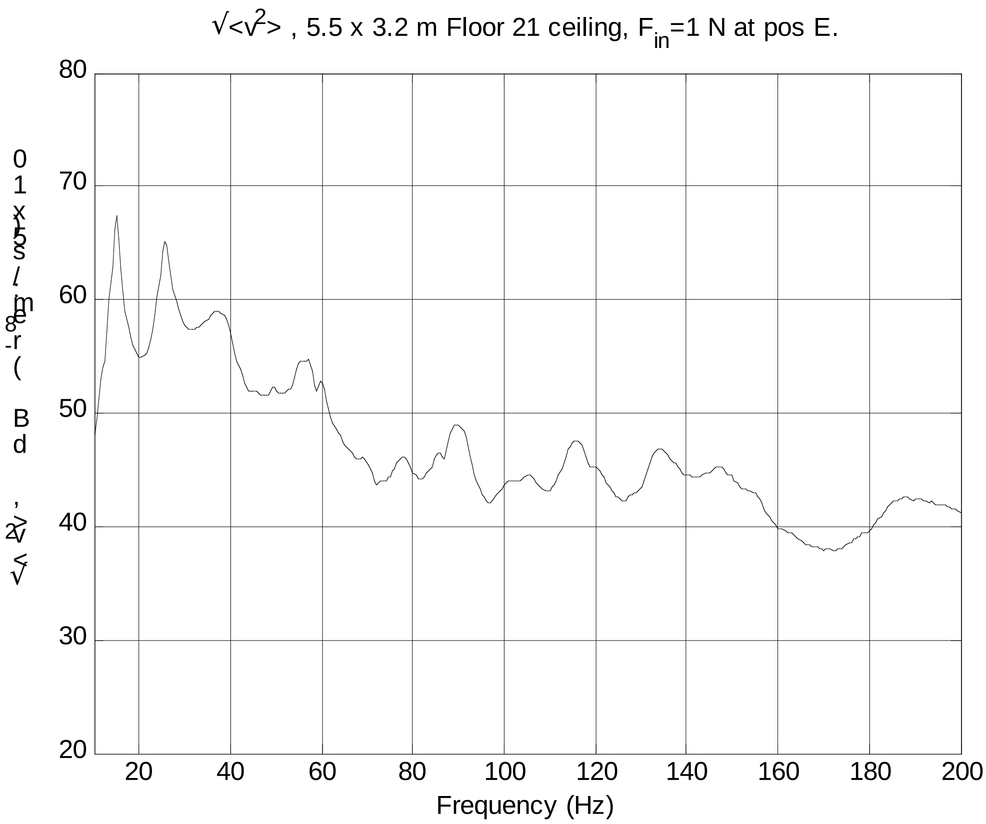


Figure 7-38. Averaged surface velocity plots in dB for Floor 21 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

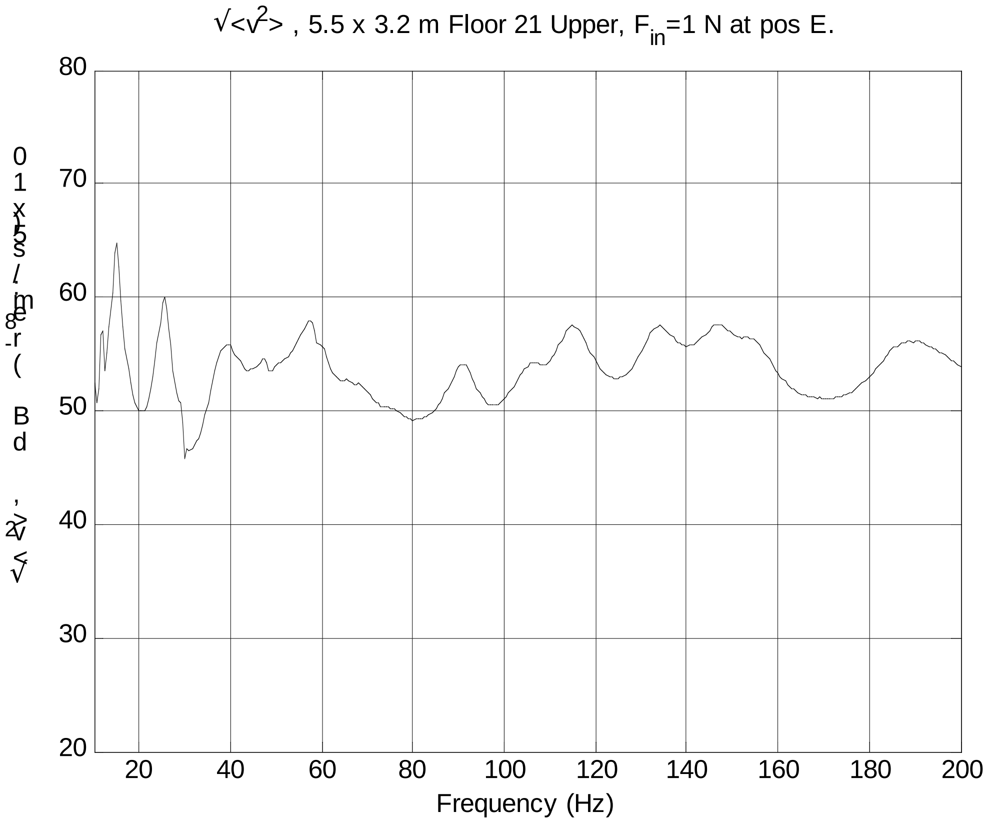
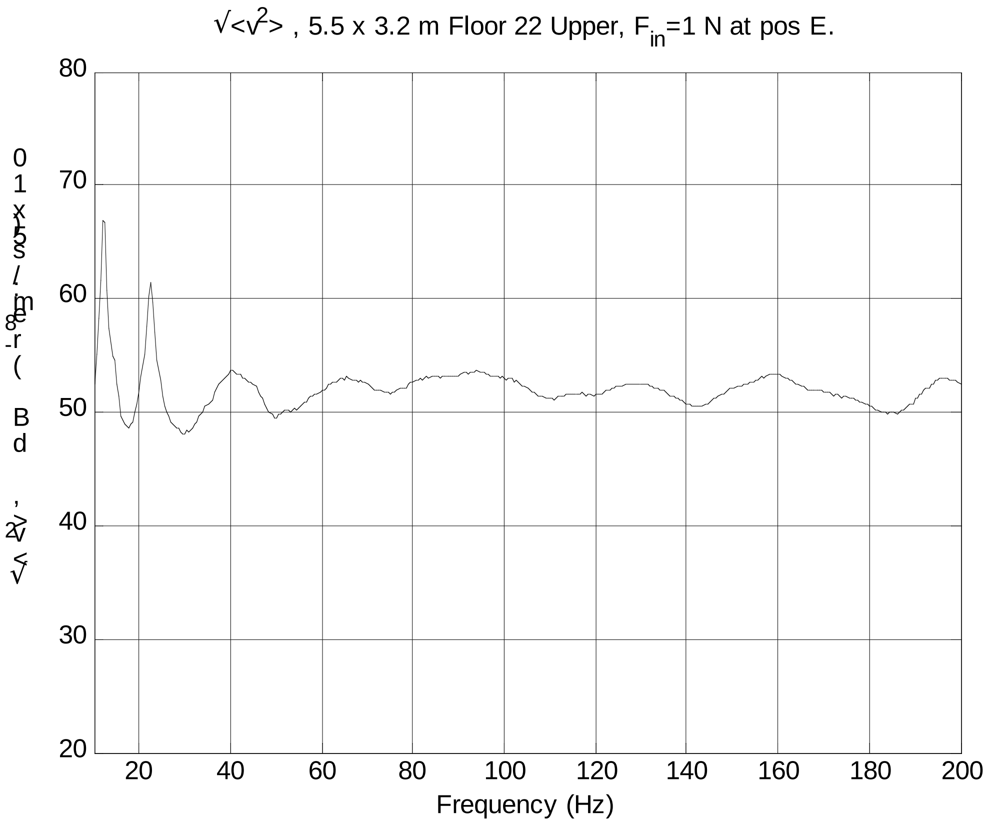


Figure 7-39. Averaged sound pressure in dB for Floor 21 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 22



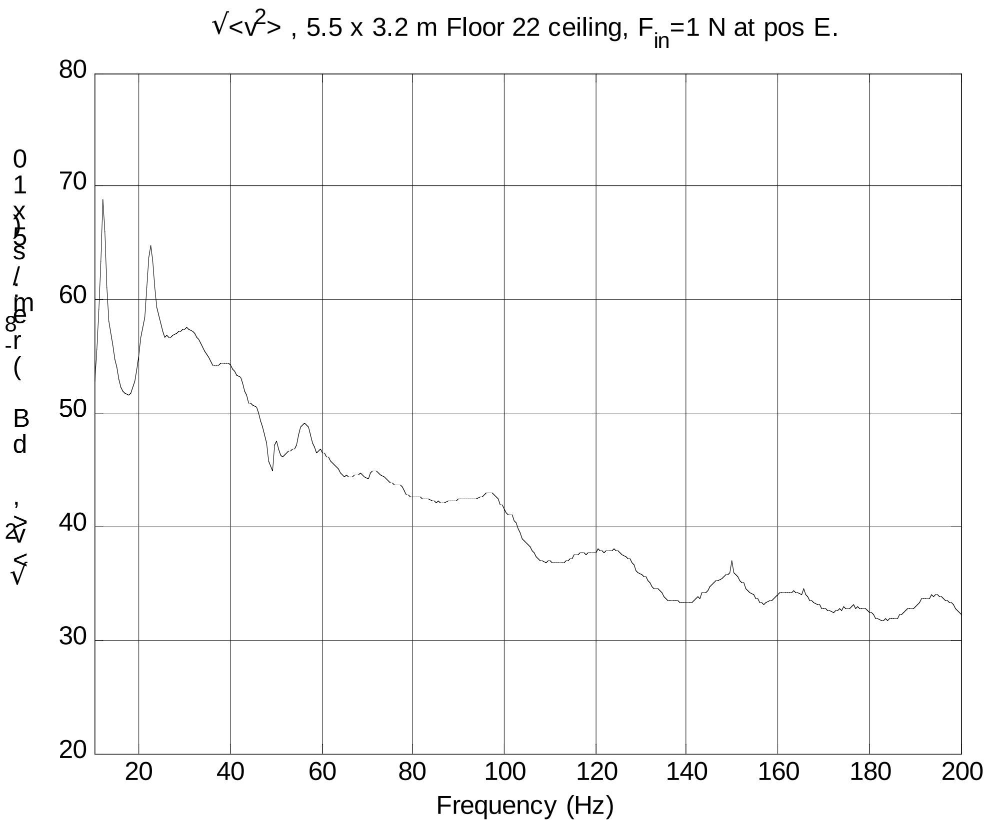


Figure 7-40. Averaged surface velocity plots in dB for Floor 22 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

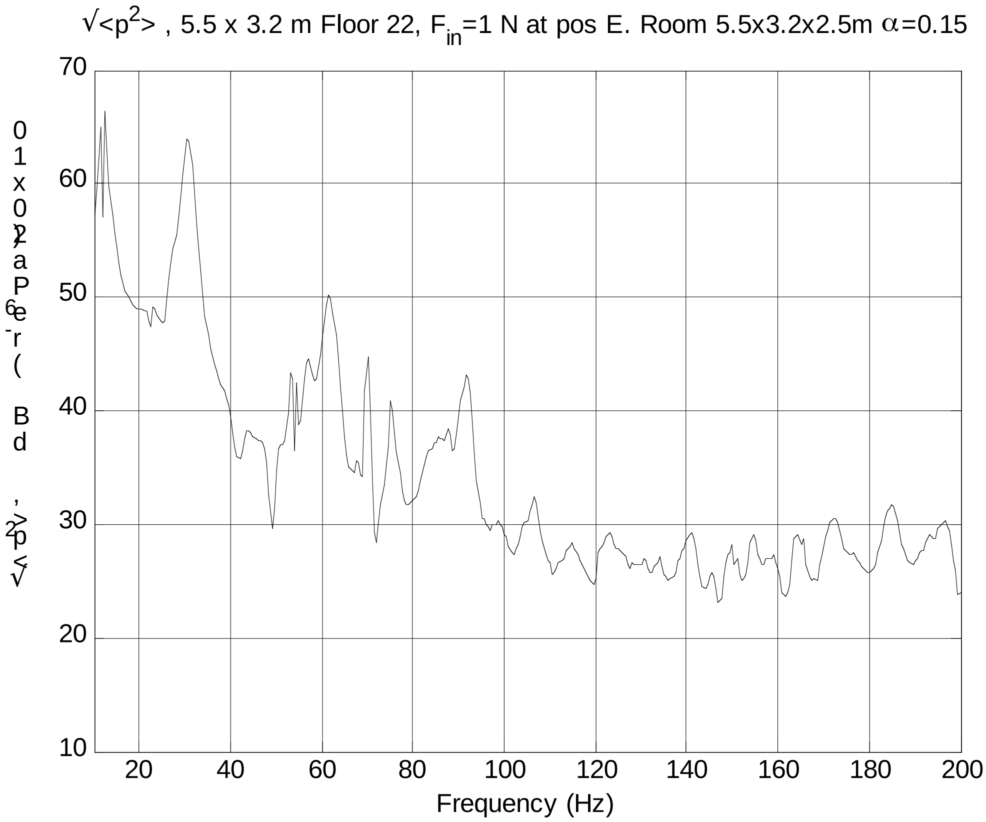


Figure 7-41. Averaged sound pressure in dB for Floor 22 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 23

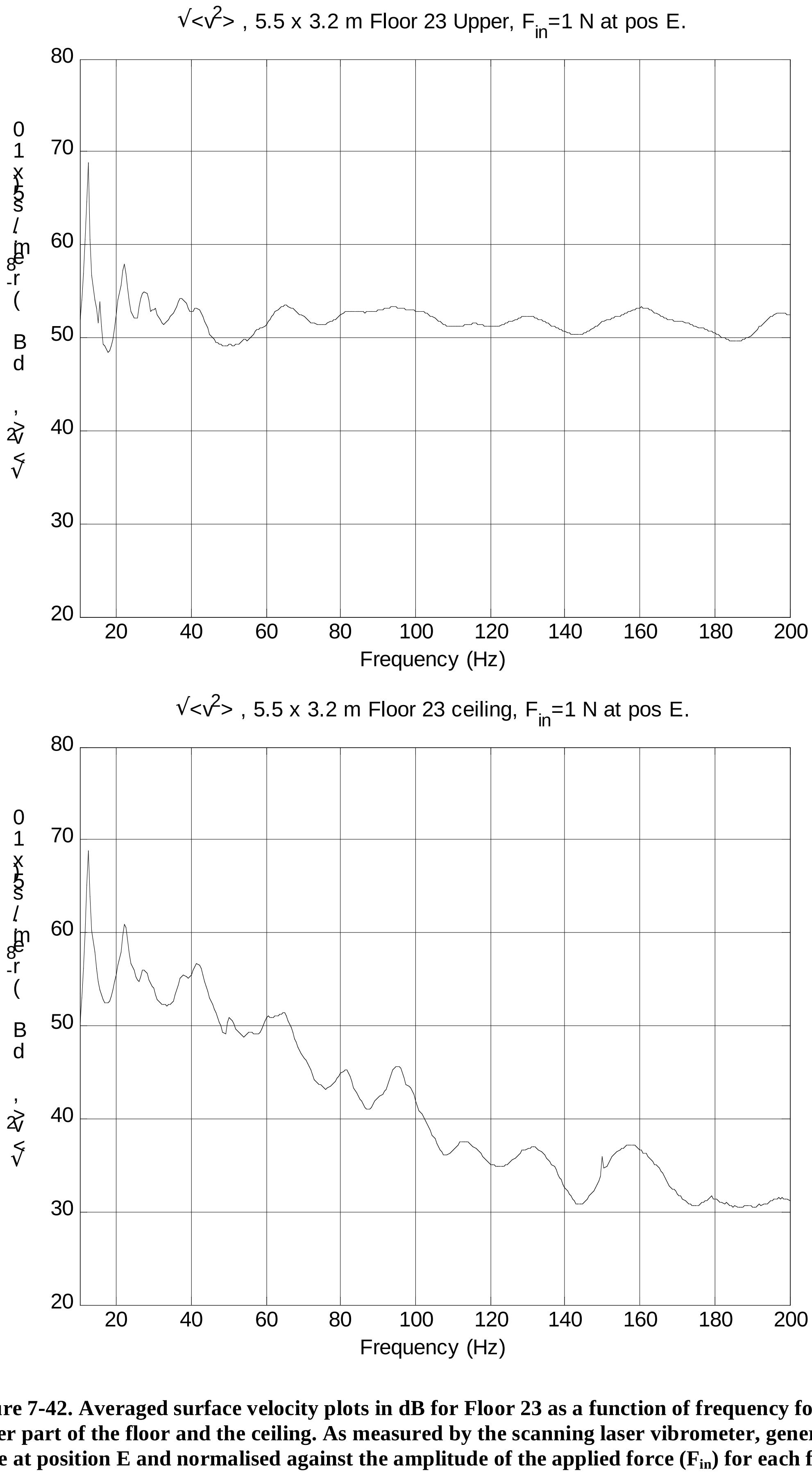


Figure 7-42. Averaged surface velocity plots in dB for Floor 23 as a function of frequency for both the upper part of the floor and the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

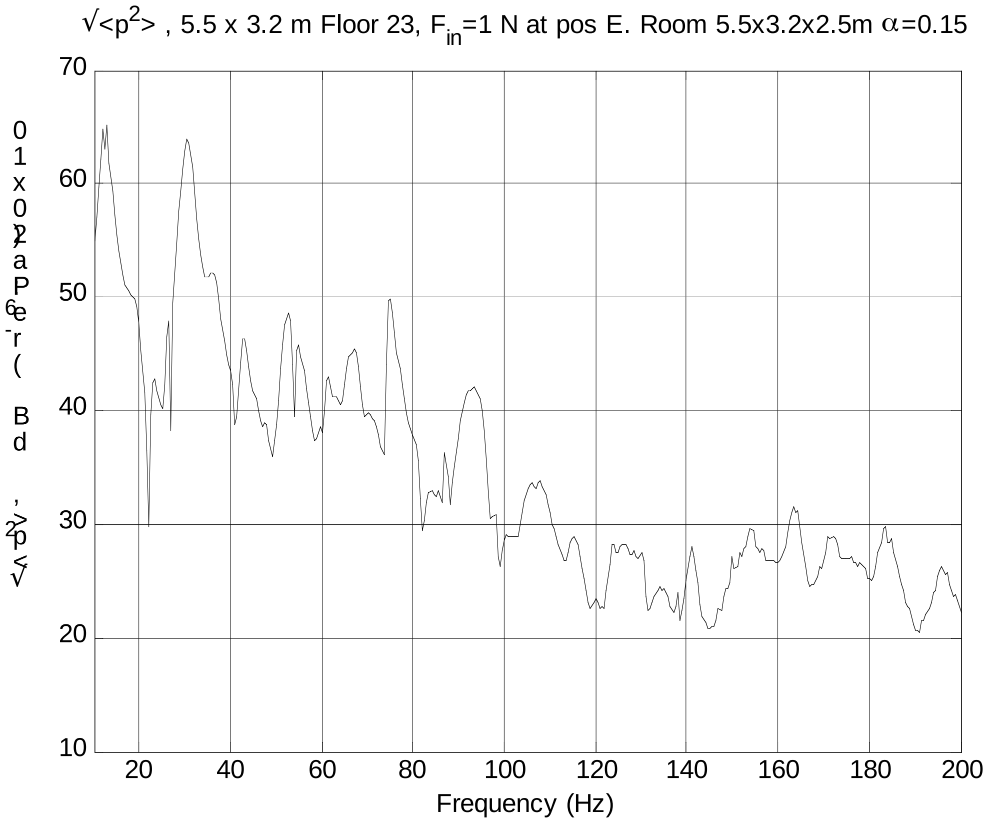


Figure 7-43. Averaged sound pressure in dB for Floor 23 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 24

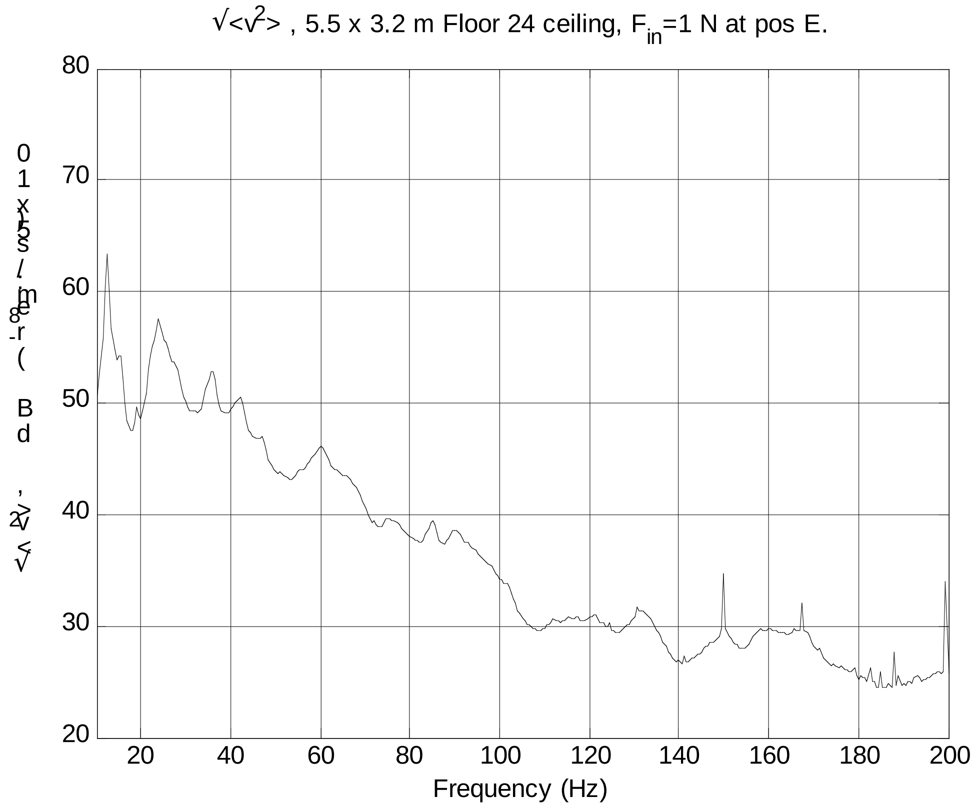


Figure 7-44. Averaged surface velocity plots in dB for Floor 24 as a function of frequency for the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

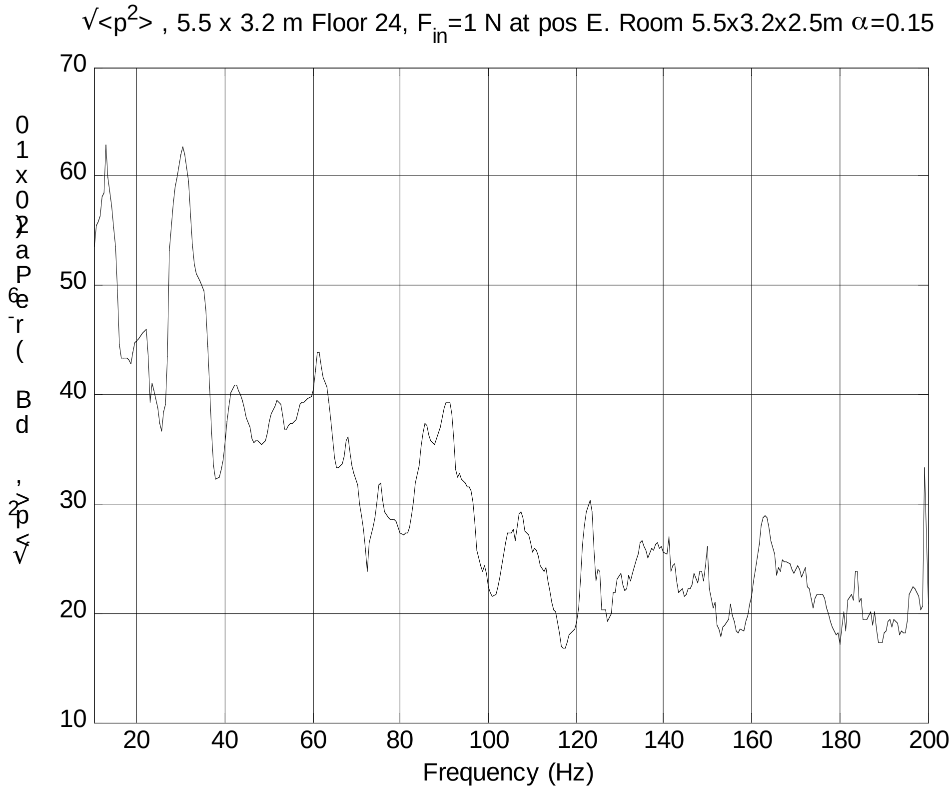


Figure 7-45. Averaged sound pressure in dB for Floor 24 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 25

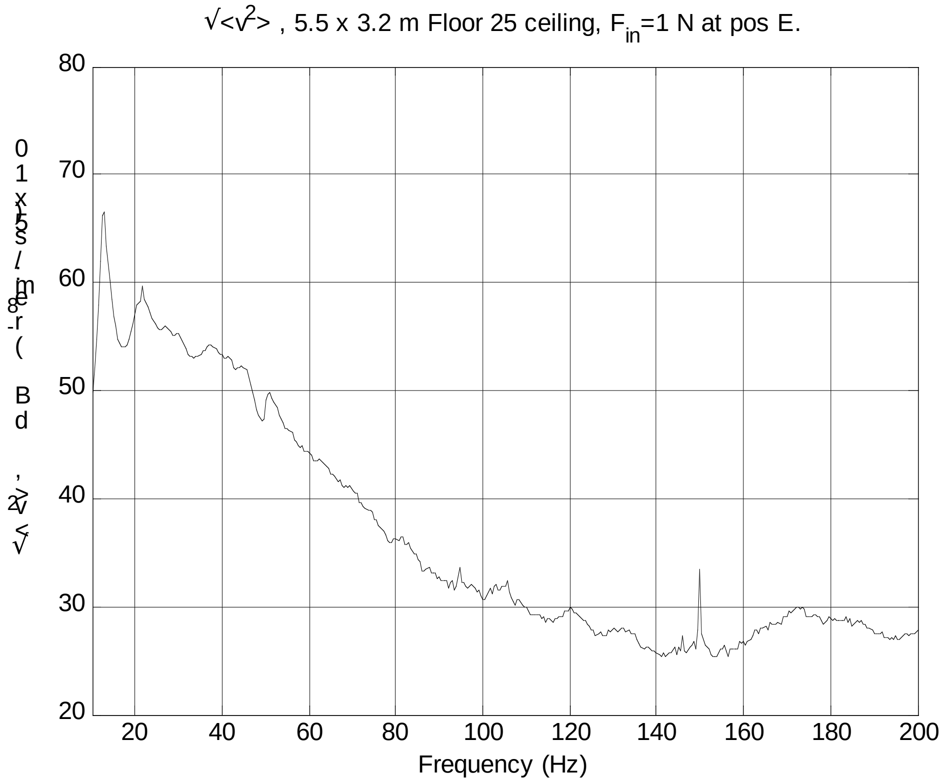


Figure 7-46. Averaged surface velocity plots in dB for Floor 25 as a function of frequency for the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

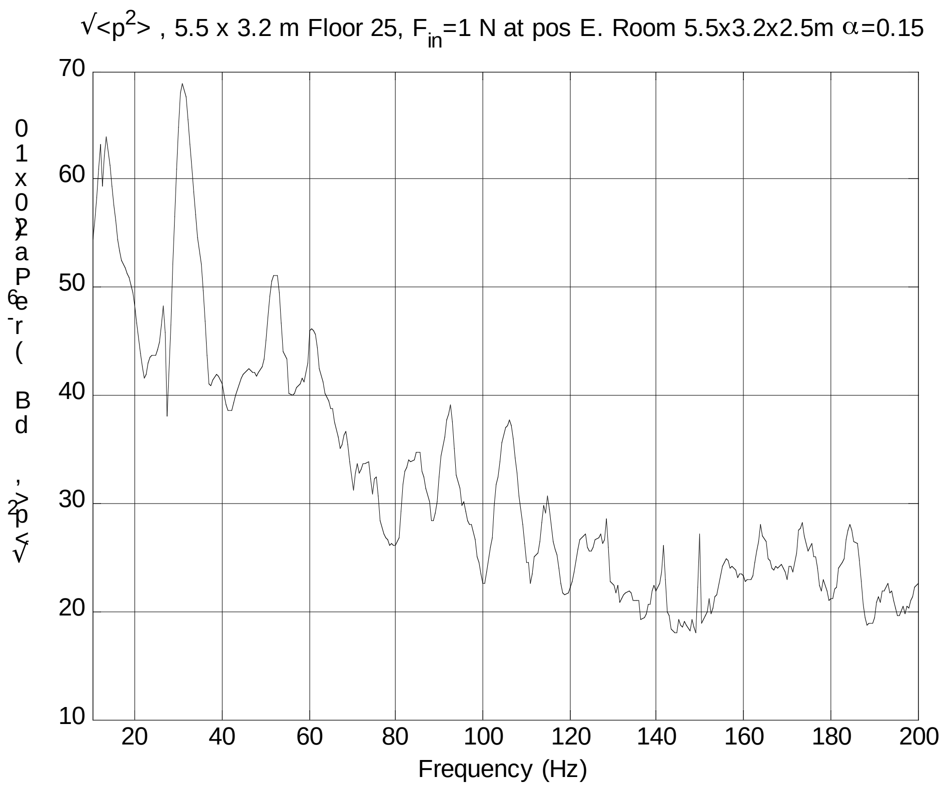


Figure 7-47. Averaged sound pressure in dB for Floor 25 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

Floor 26

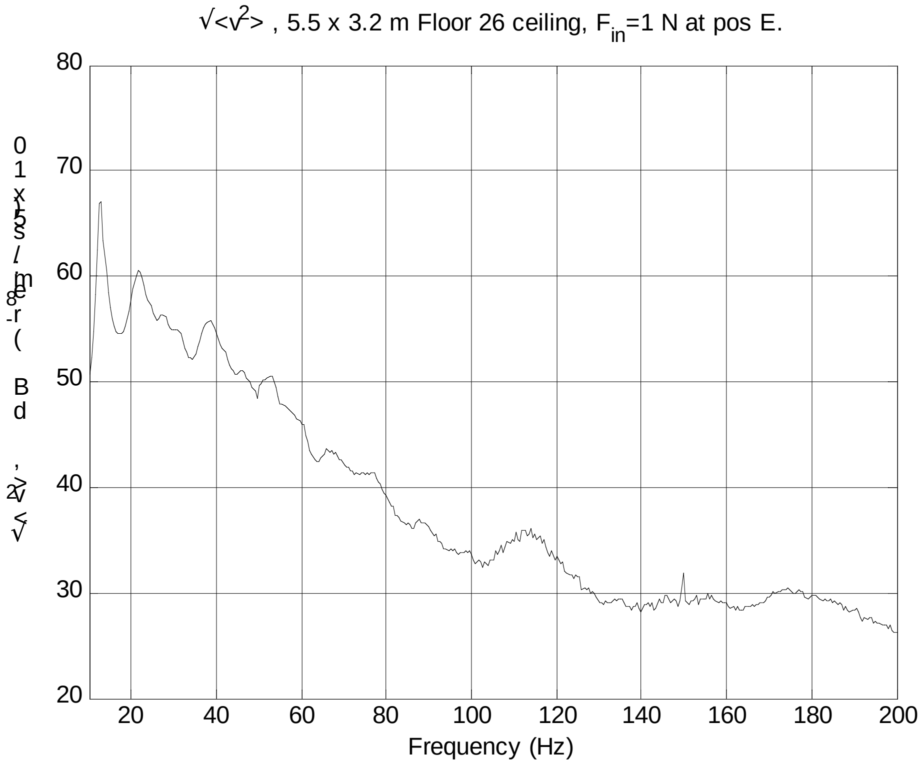


Figure 7-48. Averaged surface velocity plots in dB for Floor 26 as a function of frequency for the ceiling. As measured by the scanning laser vibrometer, generated by the force at position E and normalised against the amplitude of the applied force (F_{in}) for each frequency.

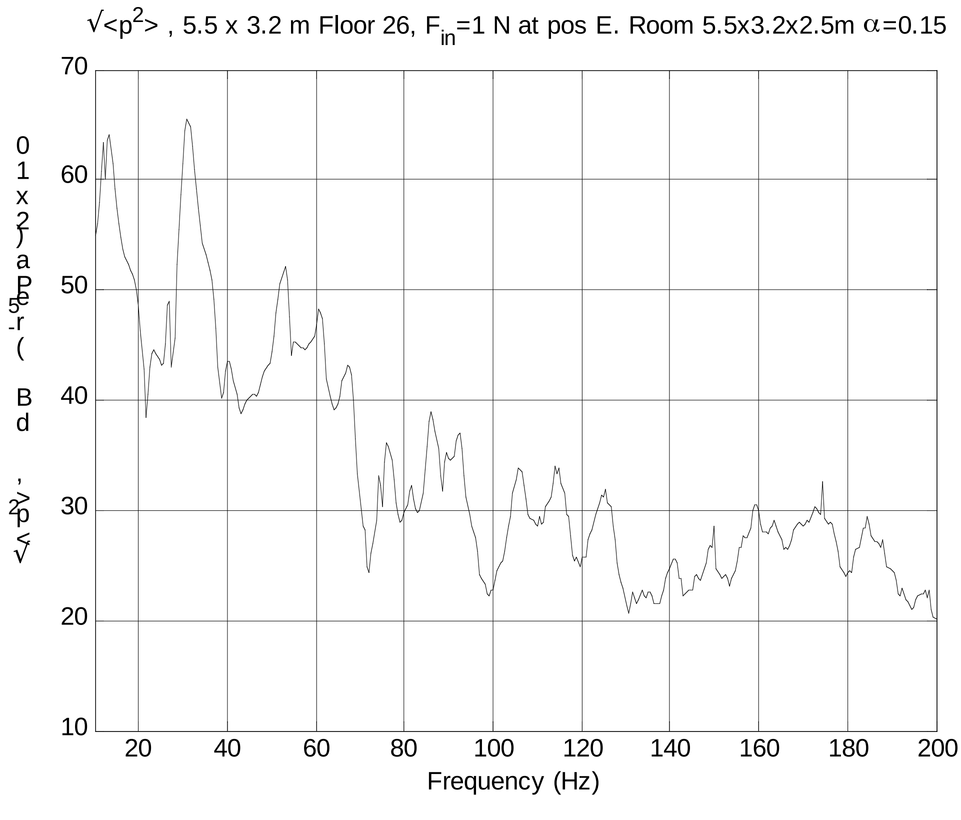


Figure 7-49. Averaged sound pressure in dB for Floor 26 calculated for a room 2.5m high and with a sound absorption coefficient of 0.15 over its surfaces. Generated by the force at position E and normalised against the amplitude of the applied force (F_{in}).

7.7 REFERENCES

Maluski, S., Gibbs, B.M. (2004). “The effect of construction material, contents and room geometry on the sound field in dwellings at low frequencies,” *Applied Acoustics*, 65, pp 31-44.

8. HIGH-FREQUENCY MEASUREMENT RESULTS

In this chapter the high frequency measurements of the floor, as done using the standard tapping machine method, are presented in full. Only test floors with a ceiling were measured in this way: it was felt that measuring floors without ceilings using the tapping machine would not have produced informative results for this project.

8.1 SUMMARY OF THE MEASUREMENT OF IMPACT SOUND INSULATION OF FLOORS

Method

The normalized impact sound pressure levels are obtained in accordance with the recommendations of ISO standard 140-6:1998(E) "Laboratory measurements of impact sound insulation of floors."

The BK3204 tapping machine is placed sequentially in four different positions on the floor. The impact sound pressure level is measured in the receiving room below the floor, using a rotating microphone, in third octave frequency bands. The impact sound pressure levels are normalized against the room absorption. The room absorption is calculated from the reverberation time and room volume. The reverberation time is measured from the decay of a steady state sound field.

Results

The third octave band normalized impact sound pressure levels Ln are presented in both table and graph formats. Sometimes a highly reflective test sample means that the lower frequency normalized impact sound pressure levels cannot be reliably measured; this is indicated by #N/A in the table of results. Additionally, sometimes the airborne transmission of sound through the floor or loud background noise affects the measurements resulting in only an upper threshold being found; this is indicated by a < sign preceding the tabulated results.

Single figure ratings are also presented. The weighted normalized impact sound pressure level $L_{n,w}$, determined according to ISO 717-2, is presented along with a spectrum adaptation term C_I . $L_{n,w}$ is determined by fitting a reference curve to the third octave band normalized impact sound pressure levels L_n from 100Hz to 3150Hz, and gives a single figure determination of the sound levels which are transmitted through the floor from impacts (higher is worse). The spectrum adaptation term C_I is used to suggest the presence of high level peaks in the results over the frequency range 100Hz to 2500Hz, and may be added to $L_{n,w}$. For massive floors with effective coverings C_I will be about zero, for light timber floors C_I will be slightly positive, and for concrete floors with less effective covering C_I will range from –15 dB to 0dB. Another spectrum adaptation term $C_{I,50\text{-}2500}$, which covers the frequency range from 50Hz to 2500Hz, may also be presented if the low frequency levels are available.

The impact insulation class (IIC) determined according ASTM E989 is also presented. This is determined by fitting a reference curve to the third octave band normalized impact sound pressure levels L_n from 100Hz to 3150Hz, but in a slightly different way to ISO 717-2. The impact insulation class measures the insulating abilities of the floor so that higher is better (contrary to $L_{n,w}$).

8.2 THE RESULTS FOR EACH MEASURED FLOOR

Floor 0 – The concrete reference floor

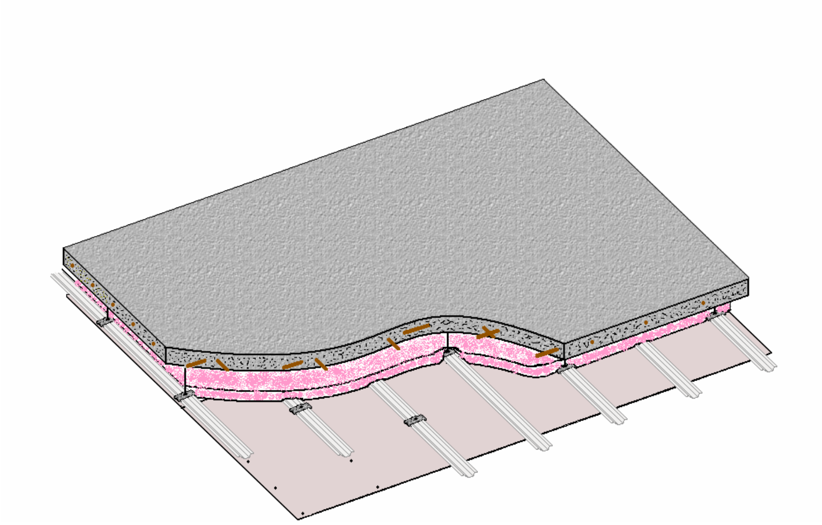
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 14-Sep-05

Description and identification of the test specimen and test arrangement: Client: FWPRDC

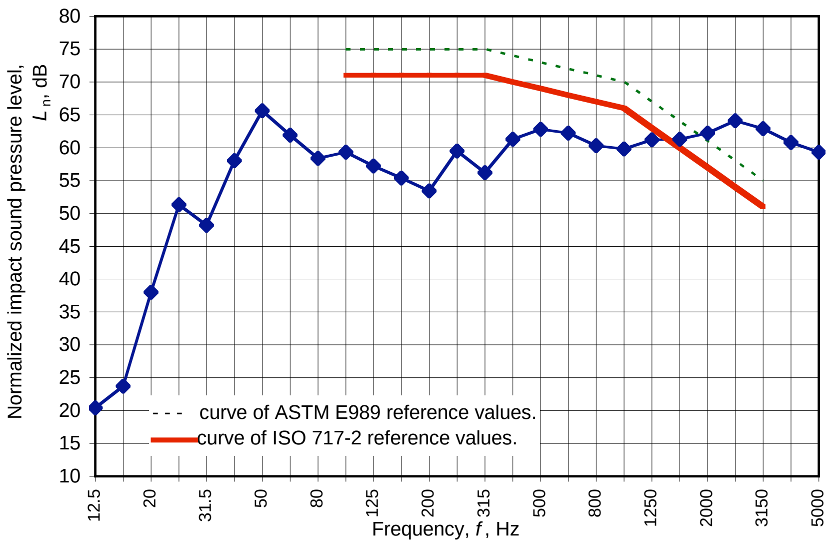
A concrete based floor/ceiling system comprising: 150mm reinforced concrete floor with a suspended ceiling comprising: 200mm long 6mm Ø threaded rods fixed to steel plates glued to the underside of the concrete slab at 600mm x 600mm centres, *Rondo®* ceiling clips are screwed to the threaded rods and 35mm *GIB® Rondo® furring channels* are held in the clips. The *furring channels* are screw-fixed at either end to *J channels* screw-fixed to the 25mm x 245mm timber perimeter plate. 1 lining of 13mm *GIB® Standard* plasterboard is screw-fixed at 300mm centres to the furring channels, the 230mm ceiling cavity is lined with 1 layer of 75mm *Pink Batts™ R1.8* fibreglass insulation. The joints and perimeter are sealed with *GIB Soundseal®*.

Italics are clients wording



Frequency f Hz	L_n 1/3 Octave dB
12.5	< 20.4
16	< 23.7
20	< 38
25	51.3
31.5	48.2
40	58.0
50	65.6
63	61.9
80	58.4
100	**59.3**
125	**57.2**
160	**55.4**
200	**53.4**
250	**59.5**
315	**56.2**
400	**61.3**
500	**62.8**
630	**62.2**
800	**60.3**
1000	**59.8**
1250	**61.2**
1600	**61.3**
2000	**62.2**
2500	**64.1**
3150	**62.9**
4000	60.8
5000	59.3

Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.



Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 69 (-12) dB $C_{I,50\text{-}2500}$ = -10 dB

Rating according to ASTM E989:

Impact Insulation Class = 37 dB

No. of test report: **Floor 0 Bare** Name of test institute: University of Auckland Acoustics Testing Service.

Floor 2

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 29-Dec-04

Description and identification of the test specimen and test arrangement: Client: FWPRDC

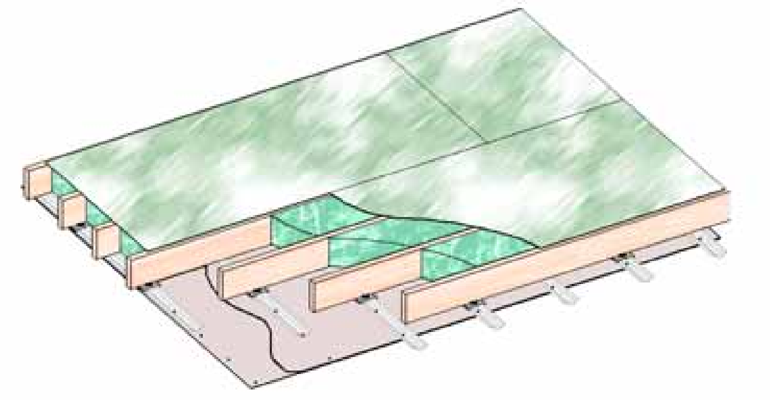
A light weight timber floor/ceiling system comprising: Butt jointed 15mm plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres. The 7m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres and the steel perimeter *J channel* fixed to the timber plates, the furring channels are fixed to the LVL joists with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

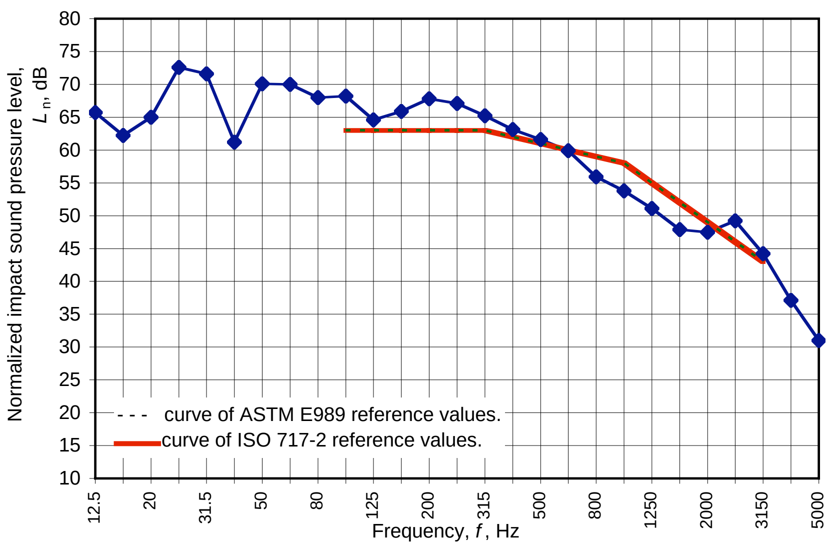
Italics are clients wording

* *LVL* Laminated Veneer Lumber

** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	65.7
16	62.2
20	65.0
25	72.6
31.5	71.6
40	61.2
50	70.1
63	70.0
80	68.0
100	**68.2**
125	**64.6**
160	**65.9**
200	**67.8**
250	**67.1**
315	**65.2**
400	**63.1**
500	**61.6**
630	**59.9**
800	**55.9**
1000	**53.8**
1250	**51.1**
1600	**47.9**
2000	**47.5**
2500	**49.2**
3150	**44.2**
4000	37.1
5000	31.0





Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 61 (-1) dB $C_{I,50\text{-}2500}$ = 2 dB

Rating according to ASTM E989:

Impact Insulation Class = 49 dB

No. of test report: **Bare floor 2** Name of test institute: University of Auckland Acoustics Testing Service.

Floor 3

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 17-Jan-05
Client: FWPRDC

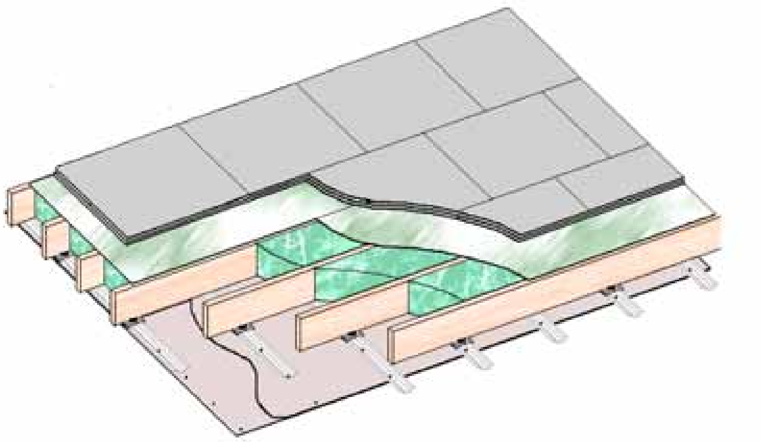
Description and identification of the test specimen and test arrangement:

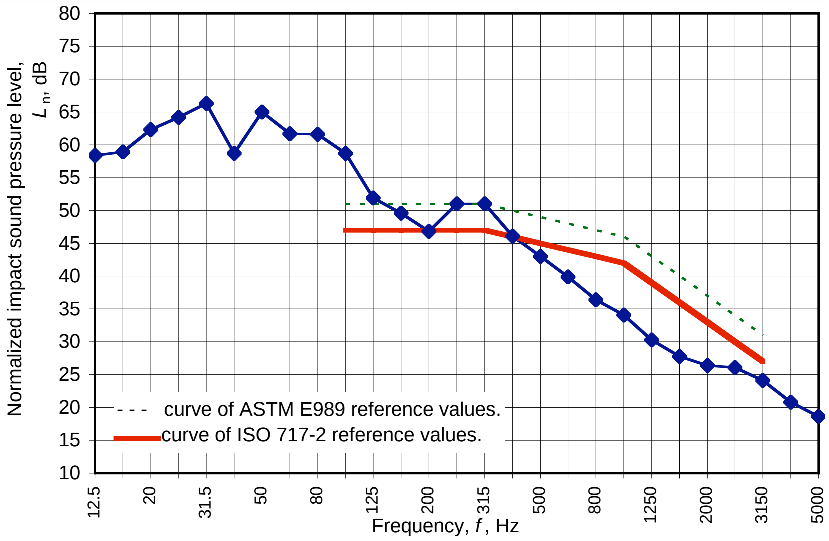
A light weight timber floor/ceiling system comprising: 3 layers of 13mm *GIB® Soundbarrier™* sheets 900mm x 1200mm, each layer fixed with 40mm square head screws at 150mm centres to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres. The 7m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo®* furring channels at 600mm centres and the steel perimeter J channel fixed to the timber plates, the furring channels are fixed to the *LVL** joists with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	58.4
16	58.9
20	62.3
25	64.2
31.5	66.3
40	58.7
50	65.0
63	61.7
80	61.6
100	**58.7**
125	**51.9**
160	**49.6**
200	**46.8**
250	**51.0**
315	**51.0**
400	**46.1**
500	**43.0**
630	**39.9**
800	**36.4**
1000	**34.1**
1250	**30.3**
1600	**27.8**
2000	**26.4**
2500	**26.1**
3150	**24.1**
4000	20.8
5000	18.6

Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.





Rating according to ISO 717-2:	
$L_{n,w}$ (C_I) = 45 (1) dB	$C_{I,50\text{-}2500}$ = 9 dB
Rating according to ASTM E989:	
Impact Insulation Class = 61 dB	

No. of test report: **Bare floor 3**
Name of test institute: University of Auckland Acoustics Testing Service.

Floor 4

Normalized Impact sound pressure levels according to ISO 140-6

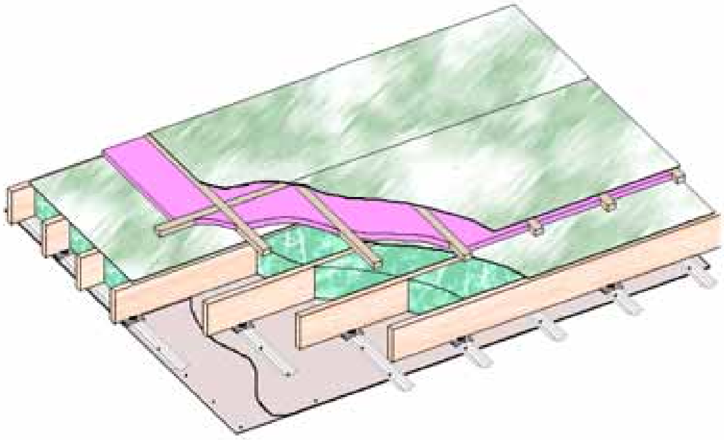
Date of test: 04-Mar-05

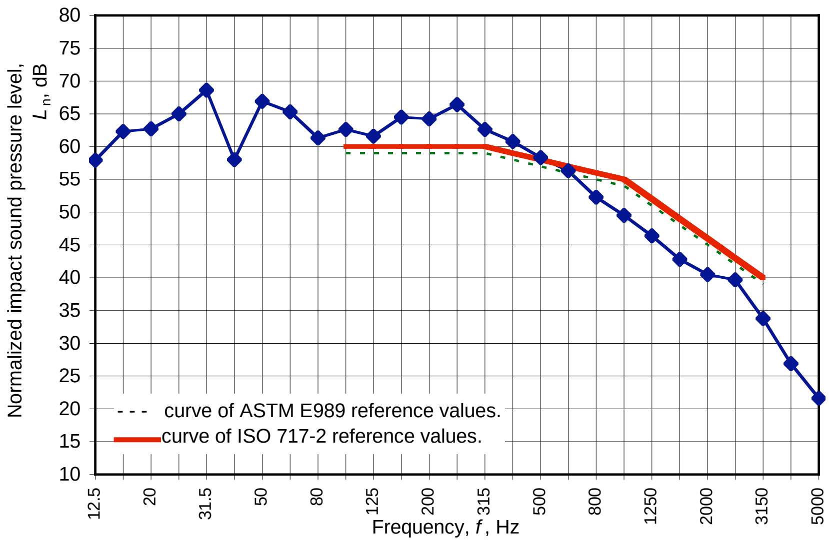
Description and identification of the test specimen and test arrangement: Client: FWPRDC

A light weight timber floor/ceiling system comprising: 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 70mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres, the cavity between the 2 layers of Plywood is lined with 1 layer of *Pink Batts R1.8* fibreglass insulation. The 7m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo®* furring channels at 600mm centres and the steel perimeter J channel fixed to the timber plates, the furring channels are fixed to the *LVL** joists with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Bold Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	57.9
16	62.3
20	62.7
25	65.0
31.5	68.6
40	58.0
50	66.9
63	65.3
80	61.3
100	**62.6**
125	**61.6**
160	**64.5**
200	**64.2**
250	**66.4**
315	**62.6**
400	**60.8**
500	**58.3**
630	**56.3**
800	**52.3**
1000	**49.5**
1250	**46.4**
1600	**42.8**
2000	**40.5**
2500	**39.7**
3150	**33.8**
4000	26.9
5000	21.6





Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 58 (-1) dB $C_{I,50\text{-}2500}$ = 1 dB

Rating according to ASTM E989:

Impact Insulation Class = 53 dB

No. of test report: **Bare floor 4**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 5

Normalized Impact sound pressure levels according to ISO 140-6

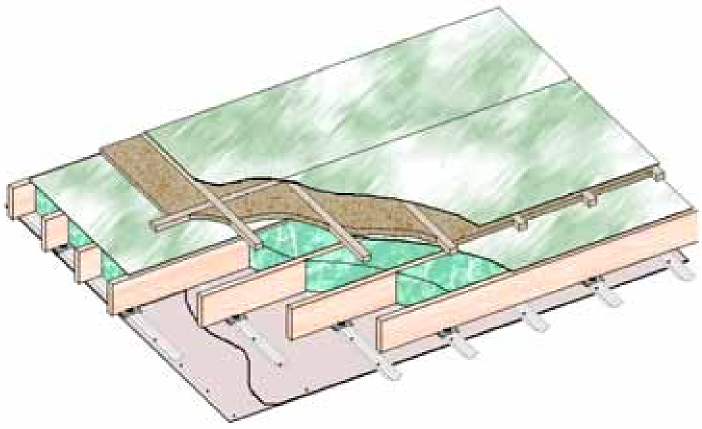
Date of test: 11-Mar-05

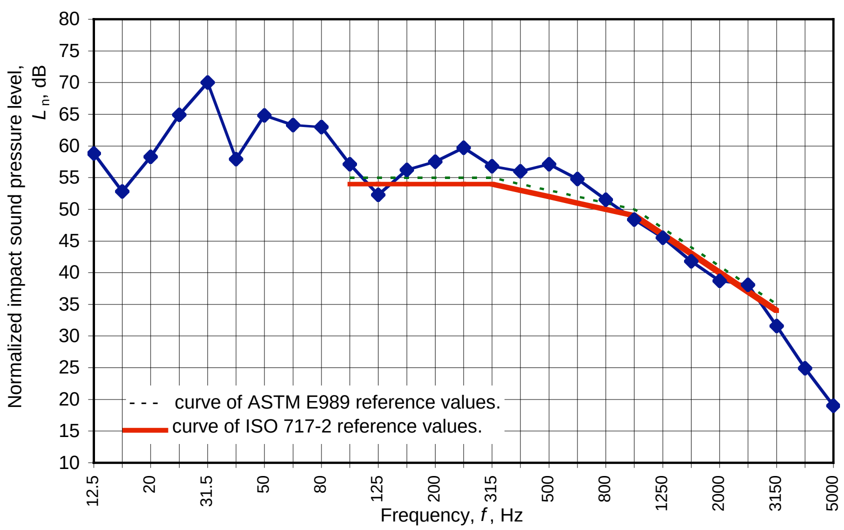
Description and identification of the test specimen and test arrangement: Client: FWPRDC

A light weight timber floor/ceiling system comprising: 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 70mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres, the cavity between the 2 layers of Plywood is filled to 40mm deep paving sand. The 7m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of *13mm GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres and the steel perimeter *J channel* fixed to the timber plates, the *furring channels* are fixed to the *LVL** joists with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	58.8
16	52.8
20	58.3
25	64.9
31.5	70.0
40	57.9
50	64.8
63	63.3
80	63.0
100	**57.1**
125	**52.3**
160	**56.2**
200	**57.5**
250	**59.7**
315	**56.8**
400	**56.0**
500	**57.1**
630	**54.8**
800	**51.5**
1000	**48.4**
1250	**45.5**
1600	**41.8**
2000	**38.7**
2500	**38.1**
3150	**31.6**
4000	24.9
5000	19.0





Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 52 (0) dB $C_{I,50\text{-}2500}$ = 4 dB

Rating according to ASTM E989:

Impact Insulation Class = 57 dB

No. of test report: **Bare floor 5** Name of test institute: University of Auckland Acoustics Testing Service.

Floor 6

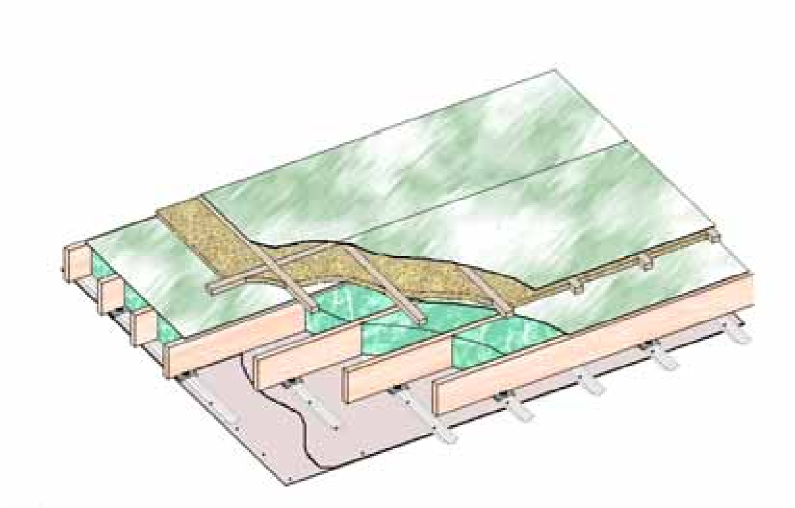
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 17-Mar-05
Client: FWPRDC

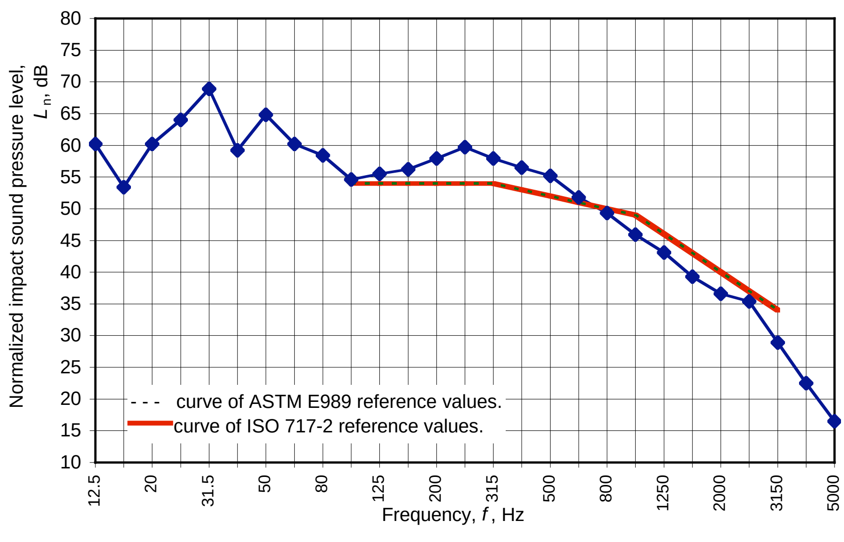
Description and identification of the test specimen and test arrangement:

A light weight timber floor/ceiling system comprising: 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 70mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres, the cavity between the 2 layers of Plywood is filled to 40mm deep with 60% paving sand and 40% sawdust. The 7m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of *13mm GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres and the steel perimeter J channel fixed to the timber plates, the *furring channels* are fixed to the LVL* joists with RSIC** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	60.2
16	53.4
20	60.2
25	64.0
31.5	68.9
40	59.2
50	64.8
63	60.2
80	58.4
100	**54.6**
125	**55.5**
160	**56.2**
200	**57.9**
250	**59.7**
315	**57.9**
400	**56.5**
500	**55.2**
630	**51.8**
800	**49.3**
1000	**45.9**
1250	**43.1**
1600	**39.3**
2000	**36.6**
2500	**35.4**
3150	**28.9**
4000	22.5
5000	16.5



Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 52 (-1) dB $C_{I,50\text{-}2500}$ = 3 dB

Rating according to ASTM E989:

Impact Insulation Class = 58 dB

No. of test report: **Bare floor 6**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 7

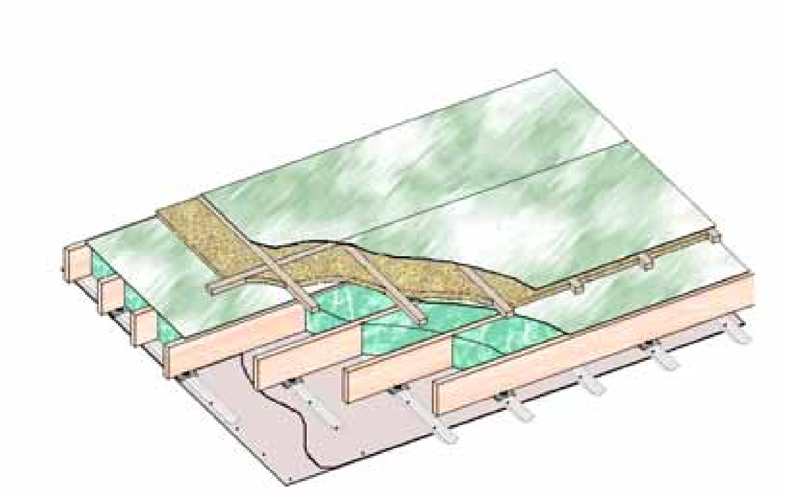
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 17-Mar-05
Client: FWPRDC

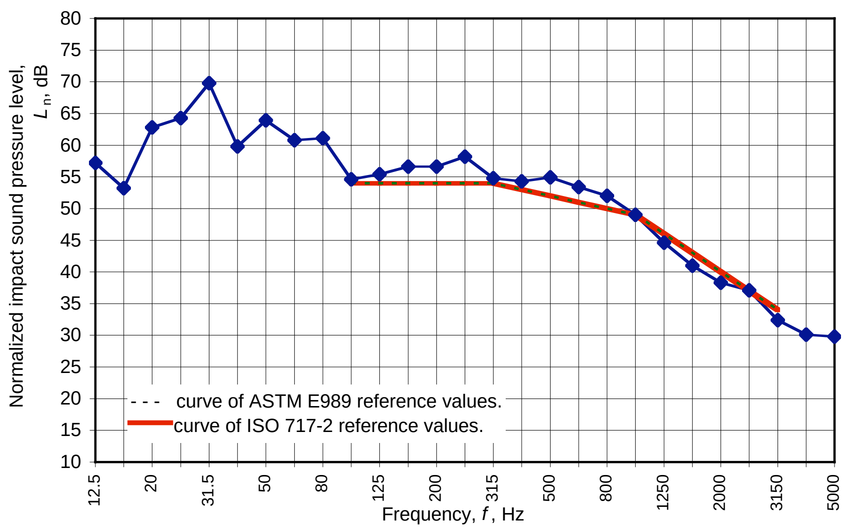
Description and identification of the test specimen and test arrangement:

A light weight timber floor/ceiling system comprising: 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 70mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres, the cavity between the 2 layers of Plywood is filled to 40mm deep with 60% paving sand and 40% sawdust. The 7m long *LVL** joists are clamped at the ends to simulate ridged connections, timber blocking is placed between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres and the steel perimeter J channel fixed to the timber plates, the *furring channels* are fixed to the *LVL** joists with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	57.2
16	53.2
20	62.8
25	64.3
31.5	69.8
40	59.8
50	63.9
63	60.8
80	61.1
100	**54.6**
125	**55.4**
160	**56.6**
200	**56.6**
250	**58.2**
315	**54.8**
400	**54.3**
500	**54.9**
630	**53.4**
800	**52.0**
1000	**49.0**
1250	**44.6**
1600	**41.0**
2000	**38.3**
2500	**37.1**
3150	**32.4**
4000	30.1
5000	29.8



Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 52 (-1) dB $C_{I,50-2500}$ = 2 dB

Rating according to ASTM E989:

Impact Insulation Class = 58 dB

No. of test report: **Bare floor 7**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 8

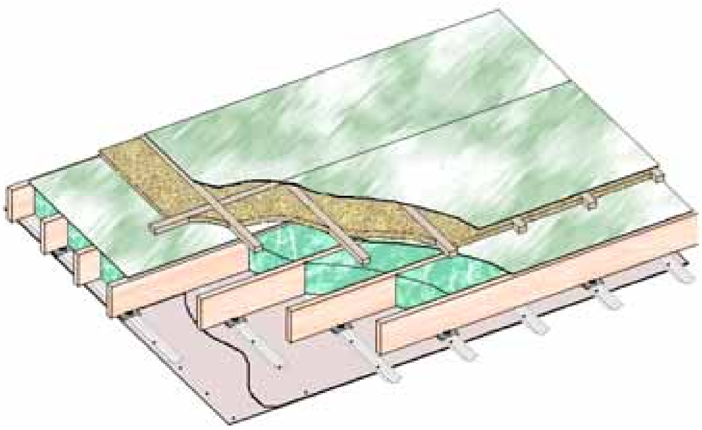
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 25-Apr-05
Client: FWPRDC

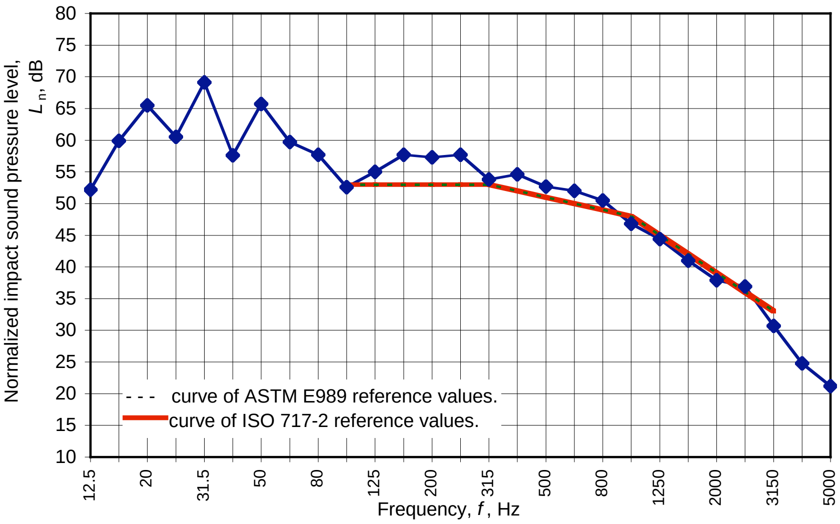
Description and identification of the test specimen and test arrangement:

A light weight timber floor/ceiling system comprising: 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 70mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres, the cavity between the 2 layers of Plywood is filled to 40mm deep with a mixture of 60% paving sand and 40% sawdust. The 5.5m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork at one end and in joist hangers fixed to a 180mm x 400mm *LVL** beam at the other end. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres and the steel perimeter *J channel* fixed to the timber plates, the *furring channels* are fixed to the LVL* joists with RSIC** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	52.2
16	59.9
20	65.5
25	60.5
31.5	69.1
40	57.6
50	65.7
63	59.7
80	57.7
100	**52.6**
125	**55.0**
160	**57.7**
200	**57.3**
250	**57.7**
315	**53.8**
400	**54.6**
500	**52.7**
630	**52.0**
800	**50.5**
1000	**46.8**
1250	**44.4**
1600	**41.0**
2000	**37.9**
2500	**36.9**
3150	**30.7**
4000	24.8
5000	21.2



Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 51 (-1) dB $C_{I,50\text{-}2500}$ = 3 dB

Rating according to ASTM E989:

Impact Insulation Class = 59 dB

No. of test report: **Bare floor 8** Name of test institute: University of Auckland Acoustics Testing Service.

Floor 9

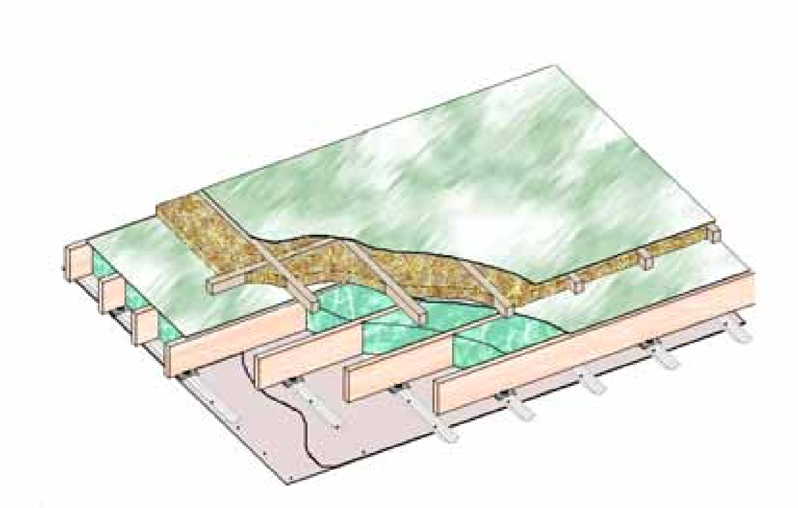
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 25-Apr-05
Client: FWPRDC

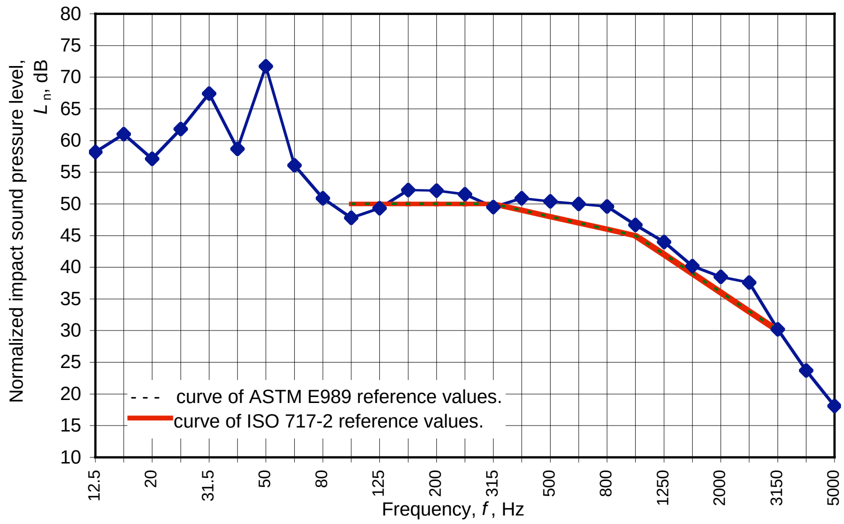
Description and identification of the test specimen and test arrangement:

A light weight timber floor/ceiling system comprising: Carpet tile on 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 90mm x 45mm battens 45mm side down at 450mm centres angle screwed to 15mm but jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres, the cavity between the 2 layers of Plywood is filled to 40mm deep with a mixture of 60% paving sand and 40% sawdust. The 5.5m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork at one end and in joist hangers fixed to a 180mm x 500mm *LVL** beam at the other end. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres and the steel perimeter J channel fixed to the timber plates, the *furring channels* are fixed to the LVL* joists with RSIC** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	58.2
16	61.0
20	57.1
25	61.8
31.5	67.4
40	58.7
50	71.7
63	56.1
80	50.9
100	**47.8**
125	**49.3**
160	**52.2**
200	**52.1**
250	**51.5**
315	**49.5**
400	**50.9**
500	**50.4**
630	**50.0**
800	**49.6**
1000	**46.7**
1250	**44.0**
1600	**40.2**
2000	**38.5**
2500	**37.6**
3150	**30.2**
4000	23.7
5000	18.1



Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:
$L_{n,w}$ (C_I) = 48 (-2) dB $C_{I,50\text{-}2500}$ = 9 dB

Rating according to ASTM E989:
Impact Insulation Class = 62 dB

No. of test report: **Bare floor 9**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 14

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 16-May-05

Description and identification of the test specimen and test arrangement: Client: FWPRDC

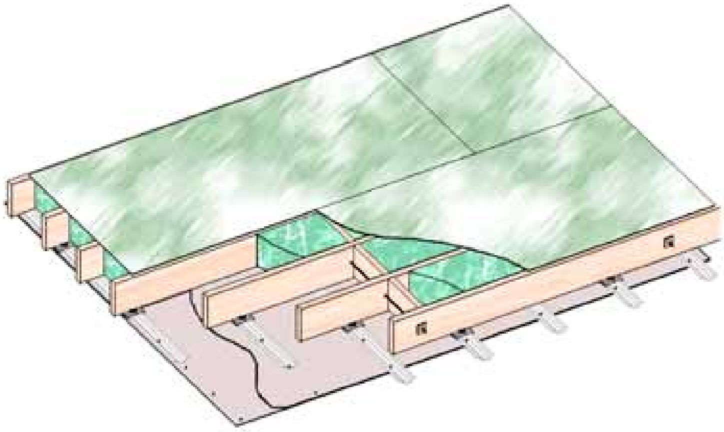
A light weight timber floor/ceiling system comprising: Butt jointed 15mm plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm x 45mm *LVL** joists at 400mm centres. The 5.5m long *LVL** joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at one side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork and in joist hangers on the other. The joists have 2 transverse stiffeners spaced 1.5m apart, these stiffeners are made up of 355mm x 300mm x 45mm pieces of *LVL** joist with a steel tensioning rod fixed through the centres of the main joists along side the 355mm blocking. The 2 transverse stiffeners do not span the full width and finish at the second to last joists 400mm from the wall. The floor cavity between the *LVL** joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo®* steel furring channels at 600mm centres and the steel perimeter *J channel* fixed to the timber plates, the furring channels are fixed to the *LVL** joists with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

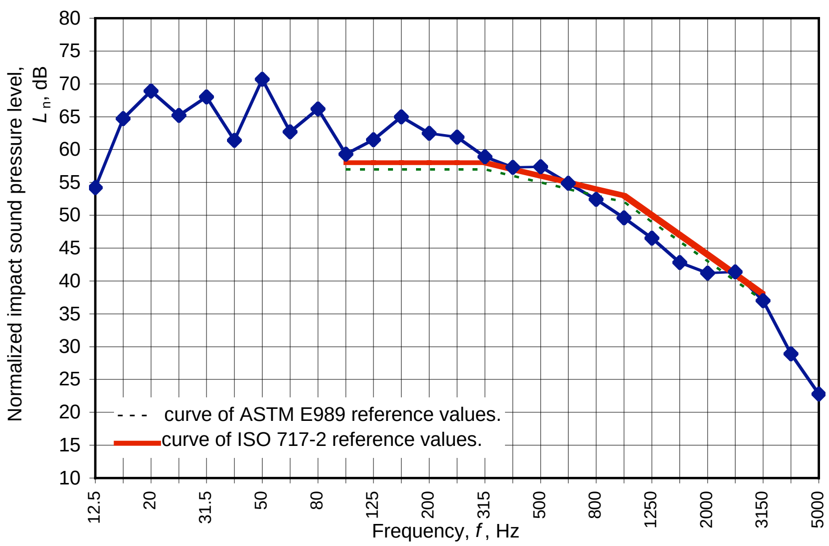
Italics are clients wording

* *LVL* Laminated Veneer Lumber

** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	54.2
16	64.7
20	68.9
25	65.2
31.5	68.0
40	61.4
50	70.7
63	62.7
80	66.2
100	**59.3**
125	**61.5**
160	**65.0**
200	**62.5**
250	**61.9**
315	**58.9**
400	**57.3**
500	**57.4**
630	**54.9**
800	**52.4**
1000	**49.6**
1250	**46.5**
1600	**42.8**
2000	**41.2**
2500	**41.4**
3150	**37.0**
4000	28.9
5000	22.8





Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 56 (0) dB $C_{I,50\text{-}2500}$ = 4 dB

Rating according to ASTM E989:

Impact Insulation Class = 55 dB

No. of test report: **Bare floor 14**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 18

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 27-May-05

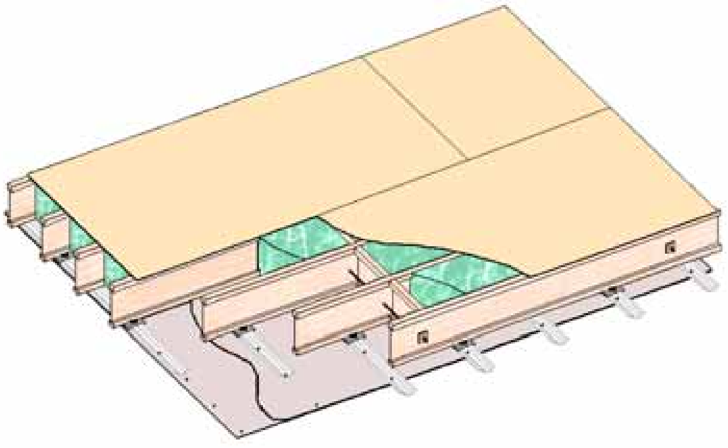
Description and identification of the test specimen and test arrangement: Client: FWPRDC

A light weight timber floor/ceiling system comprising: Butt jointed 20mm particleboard sheets fixed with 50mm square head screws at 150mm centres to 400mm deep *I joists* (90x45mm Flanges) at 600mm centres. The 5.5m long I joists are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The joists have 2 transverse stiffeners spaced 1.5m apart, these stiffeners are made up of 555mm pieces of 400mm deep *I joist* with a steel tensioning rod fixed through the centres of the main joists along side the 555mm blocking. The 2 transverse stiffeners do not span the full width and finish at the second to last joists 600mm from the wall. The floor cavity between the I joists is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo®* steel furring channels at 600mm centres and the steel perimeter *J channel* fixed to the timber plates, the furring channels are fixed to the I joists with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

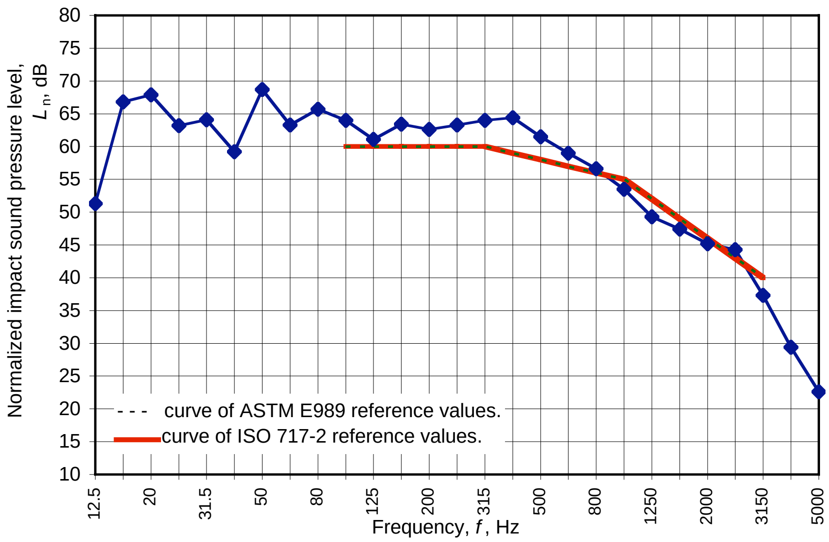
Italics are clients wording

* *LVL* Laminated Veneer Lumber

** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	51.3
16	66.8
20	67.9
25	63.2
31.5	64.1
40	59.2
50	68.7
63	63.3
80	65.7
100	**64.0**
125	**61.1**
160	**63.4**
200	**62.6**
250	**63.3**
315	**64.0**
400	**64.4**
500	**61.5**
630	**59.0**
800	**56.6**
1000	**53.5**
1250	**49.3**
1600	**47.4**
2000	**45.2**
2500	**44.3**
3150	**37.3**
4000	29.4
5000	22.6



Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 58 (0) dB $\qquad$ $C_{I,50\text{-}2500}$ = 2 dB

Rating according to ASTM E989:

Impact Insulation Class = 52 dB

No. of test report: **Bare floor 18** $\qquad$ Name of test institute: University of Auckland Acoustics Testing Service.

Floor 19

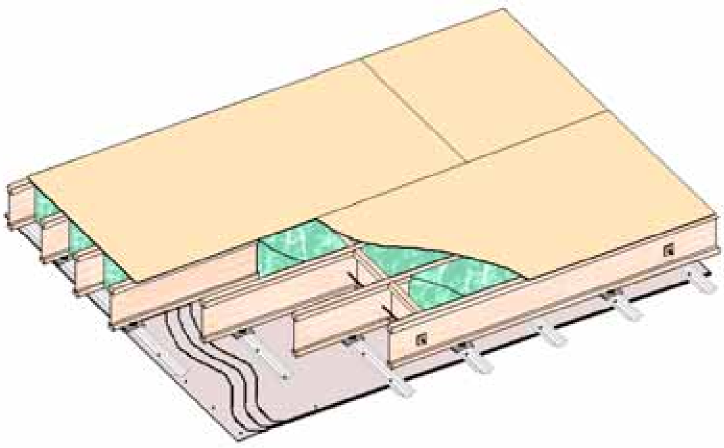
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 02-Jun-05
Client: FWPRDC

Description and identification of the test specimen and test arrangement:

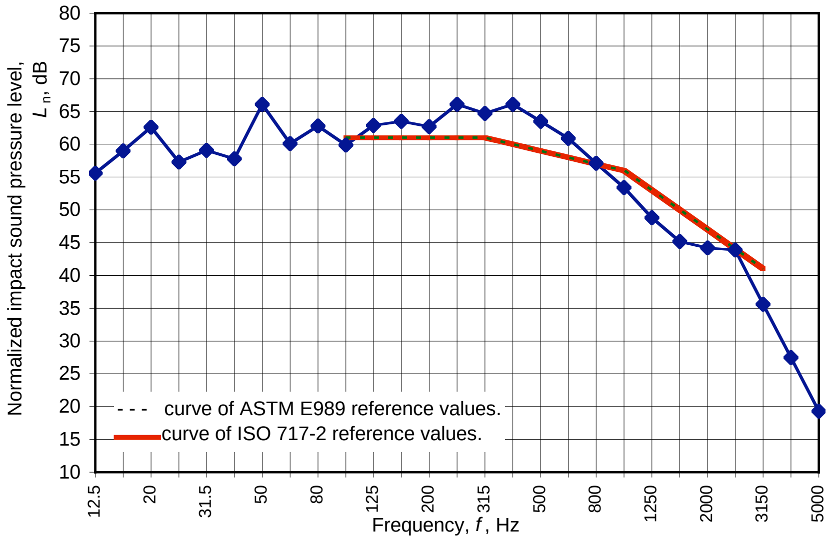
A light weight timber floor/ceiling system comprising: Butt jointed 20mm particleboard sheets fixed with 50mm square head screws at 150mm centres to 400mm deep *I joists* (90x45mm Flanges) at 600mm centres. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The joists have 2 transverse stiffeners spaced 1.5m apart, these stiffeners are made up of 555mm pieces of 400mm deep *I joist* with a steel tensioning rod fixed through the centres of the main joists along side the 555mm blocking. The 2 transverse stiffeners do not span the full width and finish at the second to last joists 600mm from the wall. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation. The ceiling comprises: 4 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres and the steel perimeter *J channel* fixed to the timber plates, the *furring channels* are fixed to the *I joists* with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	55.6
16	59.0
20	62.6
25	57.3
31.5	59.1
40	57.8
50	66.1
63	60.1
80	62.8
100	**59.9**
125	**62.9**
160	**63.5**
200	**62.7**
250	**66.1**
315	**64.7**
400	**66.1**
500	**63.5**
630	**60.9**
800	**57.1**
1000	**53.4**
1250	**48.8**
1600	**45.2**
2000	**44.2**
2500	**43.9**
3150	**35.6**
4000	27.5
5000	< 19.3

Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.



Rating according to ISO 717-2:
$L_{n,w}$ (C_I) = 59 (0) dB $C_{I,50\text{-}2500}$ = 1 dB

Rating according to ASTM E989:
Impact Insulation Class = 51 dB

No. of test report: **Bare floor 19**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 20

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 12-Jul-05

Description and identification of the test specimen and test arrangement: Client: FWPRDC

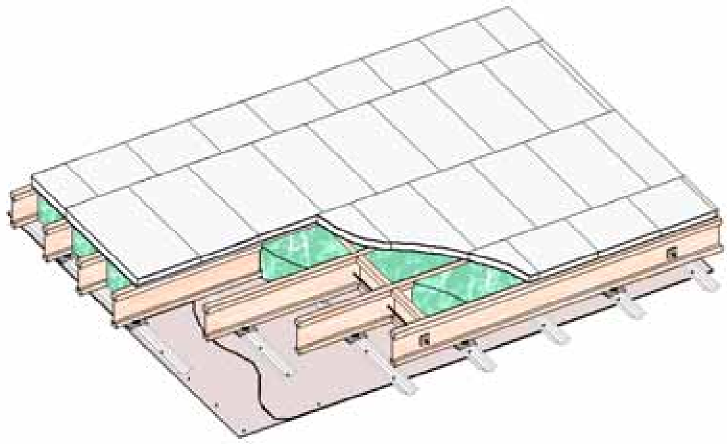
A light weight timber floor/ceiling system comprising: 75mm *Hebel* aerated concrete floor panels glued and screwed to 300mm deep *I joists* (90x45mm Flanges) at 450mm centres. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The joists have 2 transverse stiffeners spaced 1.5m apart, these stiffeners are made up of 405mm pieces of 300mm deep *I joist* with a steel tensioning rod fixed through the centres of the main joists along side the 405mm blocking. The 2 transverse stiffeners do not span the full width and finish at the second to last joists 450mm from the wall. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres, and the steel perimeter *J channel* fixed to the timber plates, the *furring channels* are fixed to the *I joists* with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

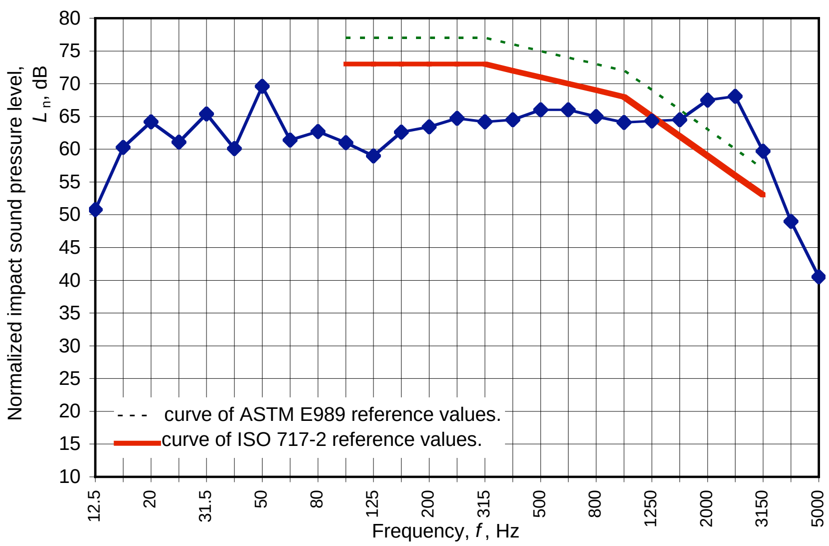
Italics are clients wording

* *LVL* Laminated Veneer Lumber

** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	50.8
16	60.3
20	64.2
25	61.1
31.5	65.4
40	60.1
50	69.6
63	61.4
80	62.7
100	**61.0**
125	**59.0**
160	**62.6**
200	**63.4**
250	**64.7**
315	**64.2**
400	**64.5**
500	**66.0**
630	**66.0**
800	**65.0**
1000	**64.1**
1250	**64.3**
1600	**64.5**
2000	**67.5**
2500	**68.1**
3150	**59.7**
4000	49.0
5000	40.5





Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 71 (-9) dB $C_{I,50\text{-}2500}$ = -8 dB

Rating according to ASTM E989:

Impact Insulation Class = 35 dB

No. of test report: **Bare floor 20** Name of test institute: University of Auckland Acoustics Testing Service.

Floor 21

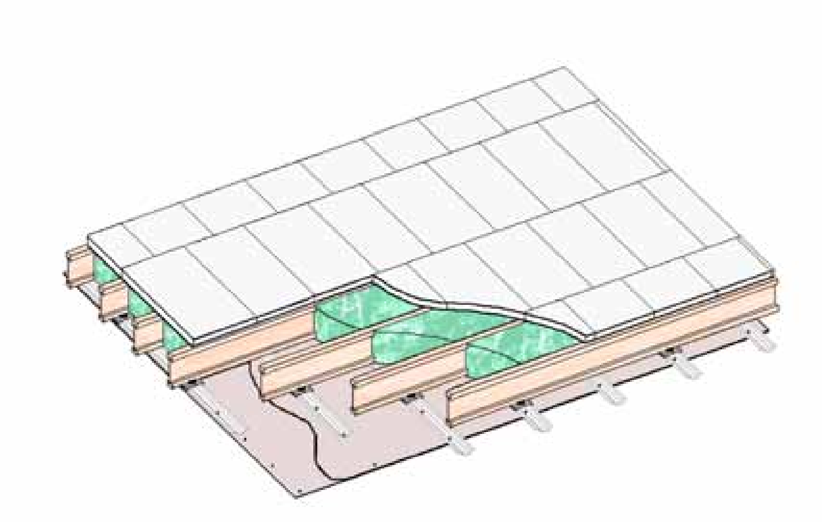
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 09-Aug-05
Client: FWPRDC

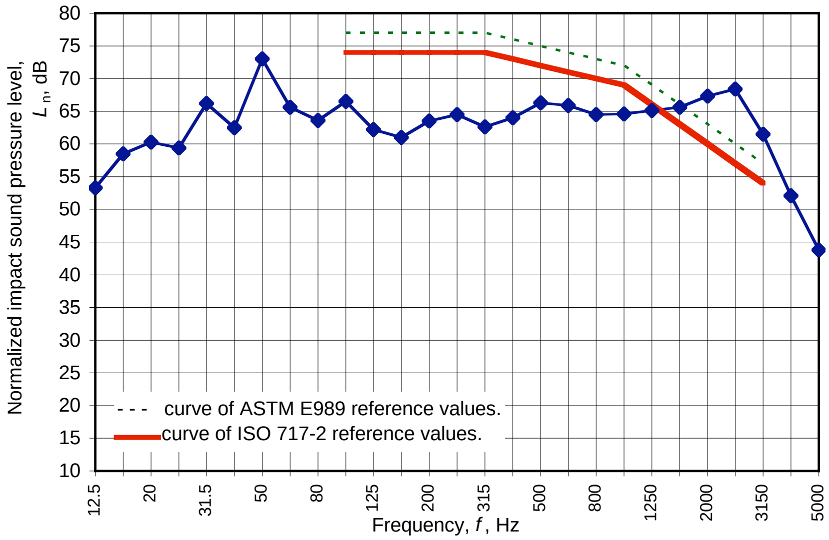
Description and identification of the test specimen and test arrangement:

A light weight timber floor/ceiling system comprising: 75mm *Hebel* aerated concrete floor panels glued and screwed to 300mm deep *I joists* (90x45mm Flanges) at 450mm centres. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres, and the steel perimeter *J channel* fixed to the timber plates, the *furring channels* are fixed to the *I joists* with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	53.3
16	58.5
20	60.3
25	59.4
31.5	66.2
40	62.5
50	73.0
63	65.6
80	63.6
100	**66.5**
125	**62.2**
160	**61.0**
200	**63.5**
250	**64.5**
315	**62.6**
400	**64.0**
500	**66.3**
630	**65.9**
800	**64.5**
1000	**64.6**
1250	**65.1**
1600	**65.6**
2000	**67.3**
2500	**68.4**
3150	**61.5**
4000	52.1
5000	43.8



Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 72 (-10) dB $C_{I,50\text{-}2500}$ = -8 dB

Rating according to ASTM E989:

Impact Insulation Class = 35 dB

No. of test report: **Bare floor 21**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 22

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 17-Nov-05

Description and identification of the test specimen and test arrangement: Client: FWPRDC

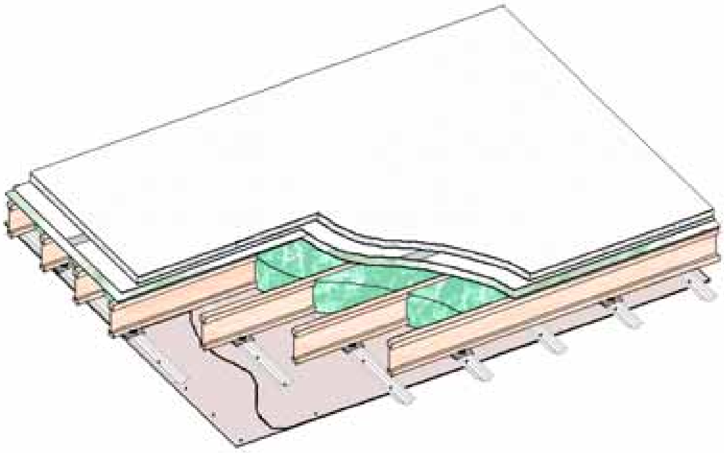
A light weight timber floor/ceiling system comprising: Alpha Gypsum concrete laid on 12mm polyethylene foam underlay loose laid with taped joints on 15mm flooring grade butt jointed plywood screw-fixed to 300mm deep *I joists* (90x45mm Flanges) at 450mm centres. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres, and the steel perimeter *J channel* fixed to the timber plates, the *furring channels* are fixed to the *I joists* with *RSIC*** clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

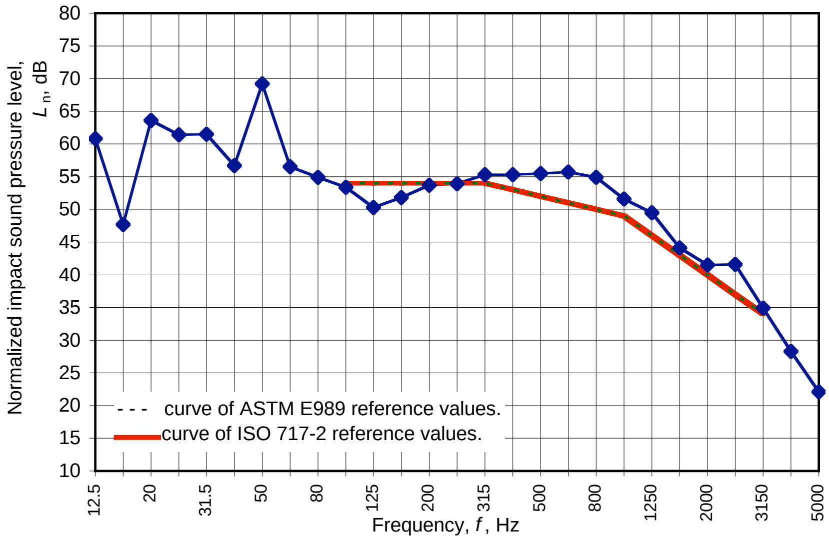
Italics are clients wording

* *LVL* Laminated Veneer Lumber

** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	60.8
16	47.7
20	63.6
25	61.4
31.5	61.5
40	56.7
50	69.2
63	56.5
80	54.9
100	**53.4**
125	**50.3**
160	**51.8**
200	**53.7**
250	**53.9**
315	**55.3**
400	**55.3**
500	**55.5**
630	**55.7**
800	**54.9**
1000	**51.6**
1250	**49.5**
1600	**44.1**
2000	**41.5**
2500	**41.6**
3150	**34.9**
4000	28.3
5000	22.1





Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 52 (-2) dB $C_{I,50-2500}$ = 4 dB

Rating according to ASTM E989:

Impact Insulation Class = 58 dB

No. of test report: **Bare floor 22**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 23

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 24-Nov-05

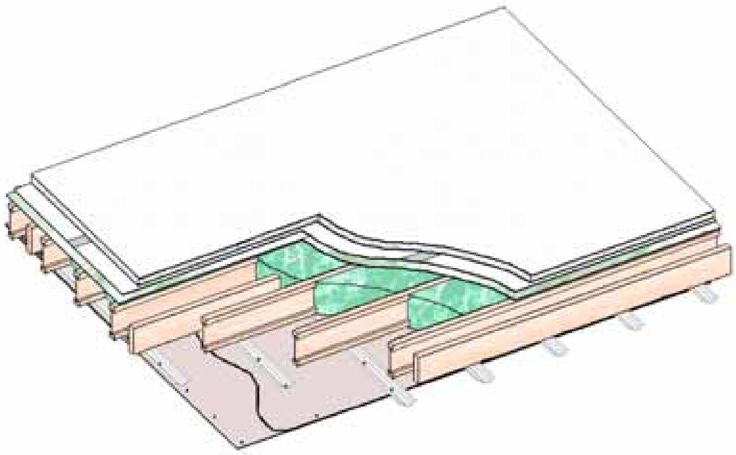
Description and identification of the test specimen and test arrangement: Client: FWPRDC

A light weight timber floor/ceiling system comprising: Alpha Gypsum concrete laid on 12mm polyethylene foam underlay with taped joints loose laid on 15mm flooring grade butt jointed plywood screw-fixed to 300mm deep *I joists* (90x45mm Flanges) at 450mm centres. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres, and the steel perimeter *J channel* fixed to the timber plates, the *furring channels* are fixed to *independent 300mm LVL joists* at 800mm? centres with clips at 800mm centres. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording

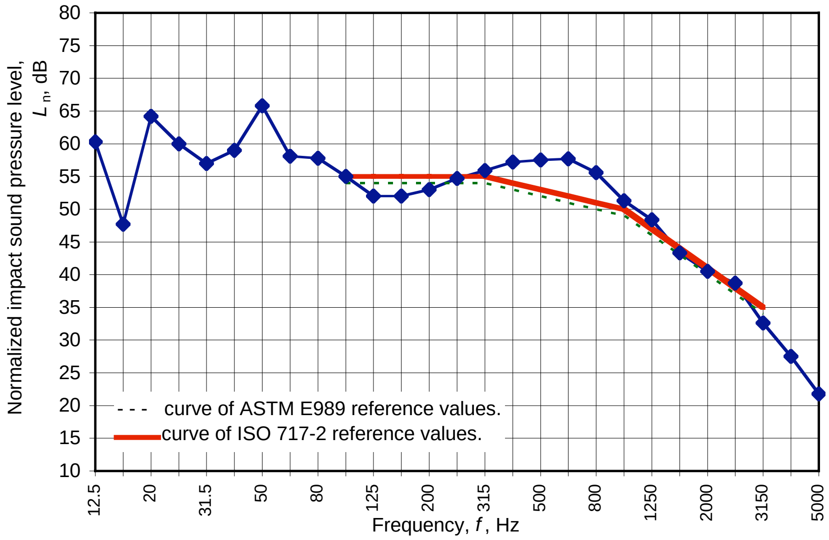
* *LVL* Laminated Veneer Lumber

** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	60.3
16	47.7
20	64.2
25	60.0
31.5	57.0
40	59.0
50	65.8
63	58.1
80	57.8
100	**55.0**
125	**52.0**
160	**52.0**
200	**53.0**
250	**54.7**
315	**55.9**
400	**57.2**
500	**57.5**
630	**57.7**
800	**55.6**
1000	**51.3**
1250	**48.4**
1600	**43.3**
2000	**40.5**
2500	**38.7**
3150	**32.6**
4000	27.5
5000	21.8

Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.



Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 53 (-2) dB $C_{I,50\text{-}2500}$ = 2 dB

Rating according to ASTM E989:

Impact Insulation Class = 58 dB

No. of test report: **Bare floor 23** Name of test institute: University of Auckland Acoustics Testing Service.

Floor 25

Normalized Impact sound pressure levels according to ISO 140-6

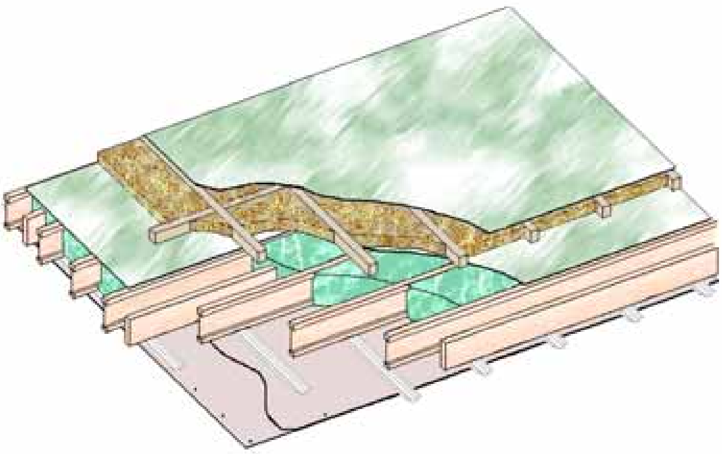
Date of test: 20-Dec-05
Client: FWPRDC

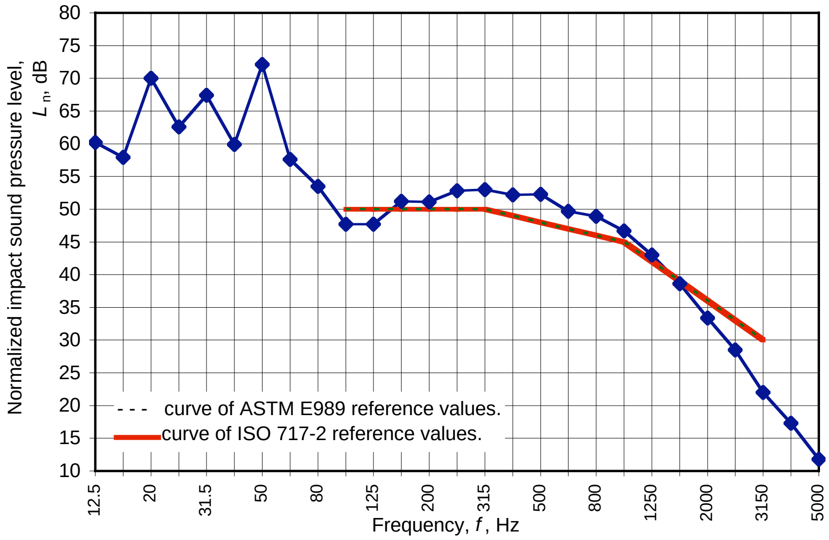
Description and identification of the test specimen and test arrangement:

A light weight timber floor/ceiling system comprising: 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 45mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm deep *I joists* at 450mm centres, the cavity between the 2 layers of Plywood is filled to 65mm deep with a mixture of 80% paving sand and 20% sawdust. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres, the *furring channels* are fixed to *independent 300mm LVL joists* mounted on 10mm waffle profile rubber pads at 1200mm centres with clips at 1200mm centres and are not fixed to the perimeter. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	60.2
16	57.9
20	70.0
25	62.6
31.5	67.4
40	59.9
50	72.1
63	57.6
80	53.5
100	**47.7**
125	**47.7**
160	**51.2**
200	**51.1**
250	**52.8**
315	**53.0**
400	**52.2**
500	**52.3**
630	**49.7**
800	**48.9**
1000	**46.7**
1250	**43.0**
1600	**38.6**
2000	**33.4**
2500	**28.5**
3150	**22.0**
4000	17.3
5000	< 11.8





Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2:

$\boldsymbol{L_{n,w}}$ **(C$_I$)** = 48 (-2) dB $\qquad$ $C_{I,50\text{-}2500}$ = 10 dB

Rating according to ASTM E989:

Impact Insulation Class = 62 dB

No. of test report: **Bare floor 25** $\qquad$ Name of test institute: University of Auckland Acoustics Testing Service.

Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 20-Dec-05

Description and identification of the test specimen and test arrangement: Client: FWPRDC

A light weight timber floor/ceiling system comprising: 300mm x 300mm ceramic tiles bonded to 10mm Fiberock flooring underlay screw-fixed at 300mm centres to 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 45mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm deep *I joists* at 450mm centres, the cavity between the 2 layers of Plywood is filled to 65mm deep with a mixture of 80% paving sand and 20% sawdust. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres, the *furring channels* are fixed to *inderpendent 300mm LVL joists* mounted on 10mm waffel profile rubber pads at 1200mm centres with clips at 1200mm centres and are not fixed to the perimeter. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* and the joints are paper taped and stopped with *GIB TradeSet® 90* stopping compound.

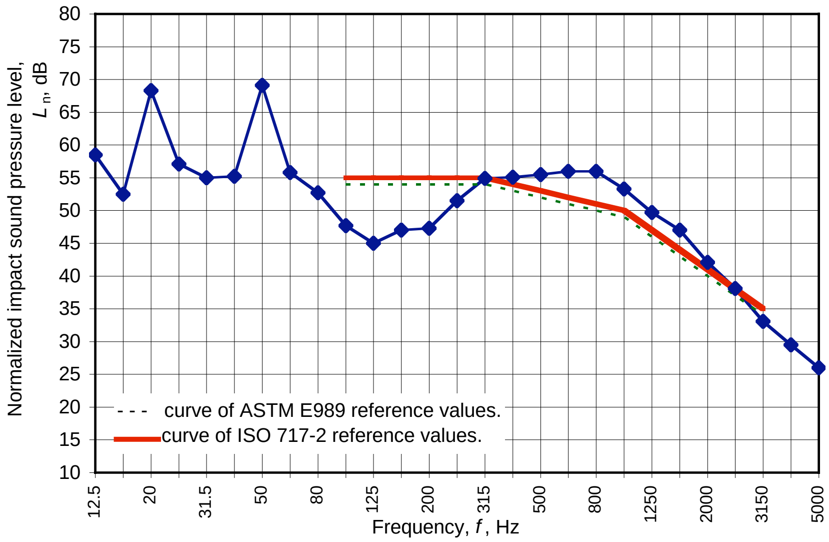
Italics are clients wording

* *LVL* Laminated Veneer Lumber

** *RSIC* Resilient Sound Isolation Clip

Frequency f Hz	L_n 1/3 Octave dB
12.5	58.5
16	52.5
20	68.3
25	57.1
31.5	55.0
40	55.2
50	69.1
63	55.8
80	52.7
100	**47.7**
125	**45.0**
160	**47.0**
200	**47.3**
250	**51.5**
315	**54.9**
400	**55.1**
500	**55.5**
630	**56.0**
800	**56.0**
1000	**53.3**
1250	**49.7**
1600	**47.0**
2000	**42.1**
2500	**38.1**
3150	**33.1**
4000	29.5
5000	26.0

Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.



Rating according to ISO 717-2:

$L_{n,w}$ (C_I) = 53 (-4) dB $C_{I,50-2500}$ = 3 dB

Rating according to ASTM E989:

Impact Insulation Class = 58 dB

No. of test report: **Ceramic tiles on floor 25**   Name of test institute: University of Auckland Acoustics Testing Service.

Floor 26

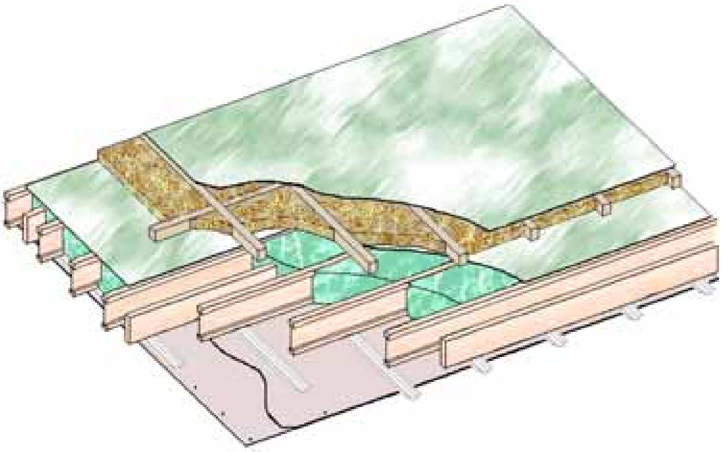
Normalized Impact sound pressure levels according to ISO 140-6

Date of test: 15-Jan-06

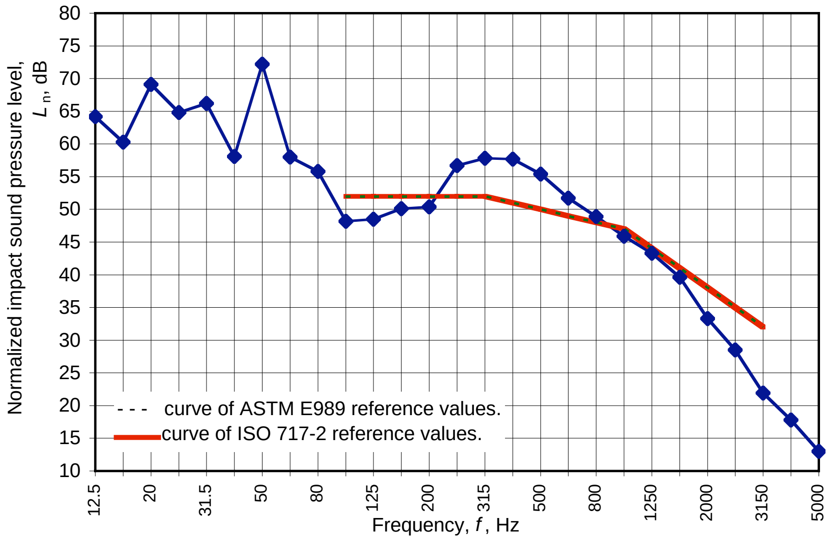
Description and identification of the test specimen and test arrangement: Client: FWPRDC

A light weight timber floor/ceiling system comprising: 1 x 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 40mm square head screws at 150mm centres onto 70mm x 45mm battens 45mm side down at 450mm centres angle screwed to 15mm butt jointed plywood sheets 2700mm x 1200mm fixed with 50mm square head screws at 150mm centres to 300mm deep *I joists* at 450mm centres, the cavity between the 2 layers of Plywood is filled to 65mm deep with a mixture of 80% paving sand and 20% sawdust. The 5.5m long *I joists* are "simply supported" at the ends with timber blocking between the ends of the joists, the joists at each side are seated on 100mm x 50mm timber plates bolted at 1m centres to the concrete blockwork. The floor cavity between the *I joists* is lined with 2 layers of 150mm thick *Pink Batts Silencer Mid Floor* bulk fibreglass insulation The ceiling comprises: 2 layers of 13mm *GIB Noiseline®* plasterboard fixed with 41mm screws at 300mm centres to 35mm *GIB® Rondo® furring channels* at 600mm centres, the *furring channels* are fixed to *independent 300mm LVL joists* mounted on 10mm waffle profile rubber pads at 1200mm centres with clips at 1200mm centres and are not fixed to the perimeter. The perimeter of the *GIB Noiseline®* plasterboard is sealed with *GIB Soundseal®* with a 90mm plaster cove to cornice. The joints are paper taped and stopped with *GIB TradeSet® 90*

Italics are clients wording
* *LVL* Laminated Veneer Lumber
** *RSIC* Resilient Sound Isolation Clip



Frequency f Hz	L_n 1/3 Octave dB
12.5	64.2
16	60.3
20	69.1
25	64.8
31.5	66.2
40	58.1
50	72.2
63	58.0
80	55.8
100	**48.2**
125	**48.5**
160	**50.1**
200	**50.4**
250	**56.7**
315	**57.8**
400	**57.7**
500	**55.4**
630	**51.7**
800	**48.9**
1000	**45.9**
1250	**43.3**
1600	**39.6**
2000	**33.3**
2500	**28.5**
3150	**21.9**
4000	17.8
5000	13.0



Notes:1.#N/A = Value not available.
2. **Bold** values are used to calculate IIC and Ln,w.
3.< indicates that the true value is lower.

Rating according to ISO 717-2: **$L_{n,w}$ (C_I) =** 50 (-1) dB	$C_{I,50\text{-}2500}$ = 8 dB
Rating according to ASTM E989: **Impact Insulation Class = 60 dB**	

No. of test report: **Bare floor 26** Name of test institute: University of Auckland Acoustics Testing Service.

9. FLOOR COST COMPARISON

The following square metre elemental costs are based generally on the Australian Construction Handbook 2005 issued by Rawlinsons and are for Sydney and Melbourne. The cost estimates were done by Ken McGunnigle (MRICS Chartered Surveyor (QS), MCIOB Chartered Builder, MNZIQS Member NZ Institute of Quantity Surveyors, BRANZ Accredited Adviser, MNZIBS, Registered Building Surveyor, MNZIOB Member of NZ Institute of Building).

The limitations of the estimated elemental rates are as follows;

- The rates are for the work in place, ie supply and fix
- Excludes GST
- Excludes contractors margin for risk and profit
- Excludes preliminaries, effect on building foundation costs and time savings for erection.
- Floor coverings are excluded
- Painting excluded
- Floor area taken as 7m x 3.2m in all cases.
- Acoustical sealant not included
- Plaster 90mm cove not included
- Supports onto walls not included.
- The purpose of the estimated elemental rates is far comparing relative costs of the systems using a standard data base. The table below does not purport to represent tender unit rates by building contractors in the market place.

Table 9-1 shows the costings. Note that the cost of the in-situ cast 150mm concrete slab is shown for reference. Also note that the concrete slab costs are very different in Melbourne as compared to Sydney. This is primarily due to the cost of formwork: in Melbourne formwork labour is very unionised compared to Sydney and hence is much more expensive. On the other hand, the cost of timber construction is almost identical in Melbourne and Sydney.

Since the elemental cost of the concrete floor is relatively high in Melbourne this would be the place to gain market traction with timber-framed systems.

Floor	Description	Estimated elemental cost in Sydney per square metre in A$ or comment
Concrete Floor	150mm Concrete Floor with hardwall plaster to suffit	204 (321 in Melbourne)
2	Base floor, 300x45 LVL at 400 centres	250
3	3xGib Sound Barrier	346
4	1xPly + batts	304
5	1xPly + 40mm sand	303
6	1xPly + 40mm sand/sawdust	304
9	1xPly + 85mm sand/sawdust	314
14	As floor 2 but with 2 transverse beams and only 5.5m long	264
18	400 I joists with 2 transverse beams	257
19	4 layers of Gib Noiseline to ceiling	322
20	Hebel floor on 300 I joists at 450 centres with 2 transverse beams	303
21	Hebel floor on 300 I joists at at 450 centres	290
22	Av 29mm thick alpha gypsum on 12mm polyethylene	293
23	Av 29mm thick alpha gypsum on 12mm polyethylene with separate ceiling joists	312
25	Battens/65mm sand sawdust with separate ceiling joists with edges free	311
26	As floor 25 but with plaster cove	317

Table 9-1. Table of comparative elemental cost. (Note; this table should be read with reference to the floor diagrams chapter, which has section drawings of each floor system.)

10. PROPERTIES OF MATERIALS USED

The following is a list of the materials used to build the floors and their associated acoustically important properties.

10.1 PANEL PRODUCTS:

15mm 5 ply Ecoply F11 plywood
Nominal Density = 560 kg/m^3
Manufacturer's nominal static bending stiffness 2360 Nm^2 along face grain, 684 Nm^2 perpendicular to face grain assuming 10.5 GPa along-grain wood stiffness.
Dynamic measurements from one sample showed that along-grain wood stiffness was 13 GPa.
Apparent measured dynamic bending stiffness along face grain (from floor measurements) is equivalent to homogenous material with E from 12 to 14 GPa.
Vibration loss factor of material assumed to be 0.03.

20mm Flooring Particleboard
Nominal Density = 710 kg/m^3
Dynamic Young's modulus (from Insul 4 Material Properties list) = 3.5 GPa.
Vibration loss factor of material = 0.03.

12.7mm GIB Sound Barrier Gypsum Fibreboard
Manufacturer's Nominal Density = 1040 kg/m^3.
Sample measured density = 1070 kg/m^3.
Manufacturer's nominal static stiffness parallel to writing on sheet = 4.5 GPa
Measured sample dynamic stiffness (at 1.6kHz) parallel to writing on sheet = 6.0 GPa.
Measured sample dynamic stiffness (at 1.6kHz) perpendicular to writing on sheet = 5.5 GPa.
Measured sample Vibration loss factor = 0.015

13mm GIB Noiseline plasterboard
Manufacturer's nominal density = 962 kg/m^3.
Dynamic bending stiffness (from Insul 4 Material Properties list) = 3.7 GPa.
Measured vibration loss factor = 0.013.

75mm Hebel Floor panels
Density with nominal moisture content = 690 Kg/m^3.
Manufacturer's Static Young's modulus = 1.715 GPa.
Vibration loss factor of material (from Insul 4 Material Properties list) = 0.02.

10.2 POURED-ON TOPPINGS/SCREEDS

USG Levelrock 3500 PS, presanded gypsum concrete
Manufacturers nominal density = 1920 kg/m^3.

10.3 JOISTS

CHH Hyspan LVL
Manufacturer's nominal density = 620 kg/m^3.
Manufacturer's nominal static Young's modulus = 13.2 GPa.
Apparent dynamic Young's modulus from measurements = 14.5 GPa to 15.5 GPa.
Assumed vibration loss factor = 0.03.
300mm CHH Hybeam I-beam (HJ300-63)

Manufacturer’s nominal linear density = 4.4 kg/m.
Manufacturer’s nominal static bending stiffness = 1111000 N m^2.
Assumed vibration loss factor = 0.03.

400mm CHH Hybeam I-beam (HJ300-90)
Manufacturer’s nominal linear density = 7.4 kg/m.
Manufacturer’s nominal static bending stiffness = 3494000 N m^2.
Assumed vibration loss factor = 0.03.

10.4 INFILL MATERIALS

150mm Tasman Insulation Midfloor Silencer
Measured sample flow resistivity = 7227 Rayls/m.
Density = 12 kg/m^3.

10.5 CEILING FIXTURES

RSIC clip
Dynamic Stiffness at 20 Hz under 130 N load (approx equiv to 25kg/m^2 ceiling surface density) = 220000 N/m.
Loss factor = 0.1.

Gib Rondo Batten
Estimated (from measurements) bending stiffness when attached to plasterboard = 11000 N m^2.

11. FLOOR DIAGRAMS AND PHOTOGRAPHS

11.1 THE TEST CHAMBER

This is an illustration of the test chamber in which the floors were built. The chamber is 7m long. Shown in the diagram are the LVL beams which divide the opening so that a shorter span can be used. Note how two separate beams were used so that the joists and the ceiling are separated.

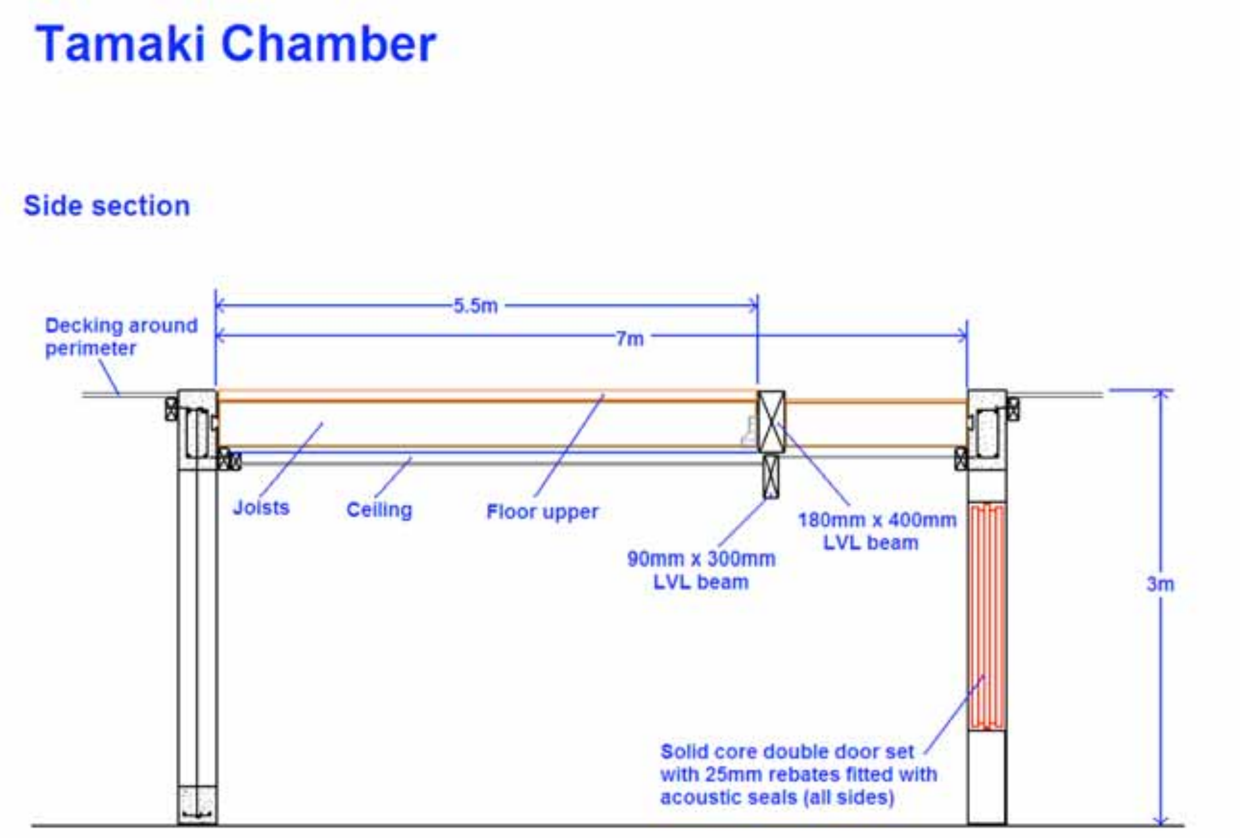
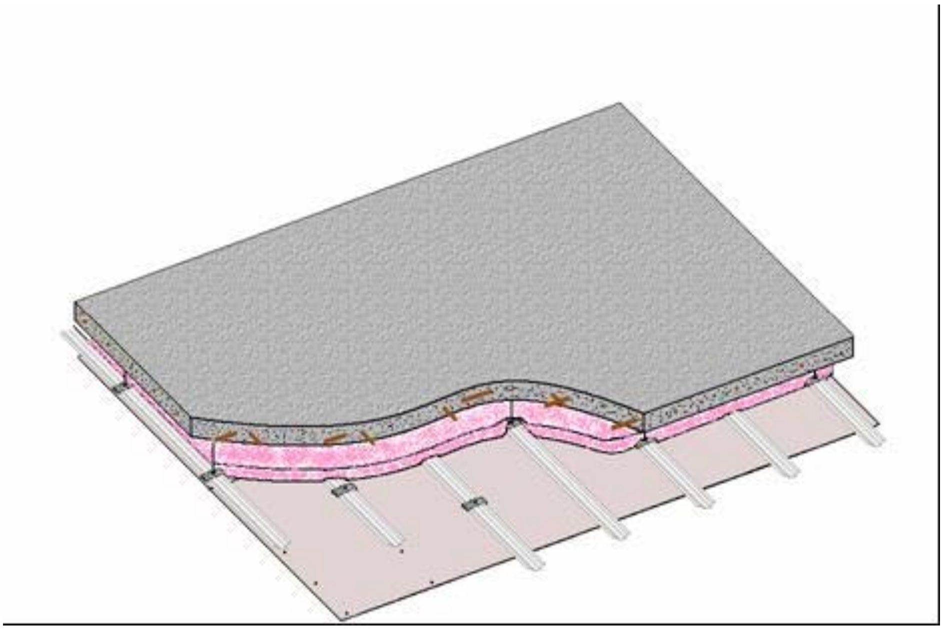


Figure 11-1. The test chamber without floor view from above.

Figure 11-2. Side view of test chamber, showing entrance doors at right.

11.2 REFERENCE CONCRETE FLOOR (FLOOR 0)

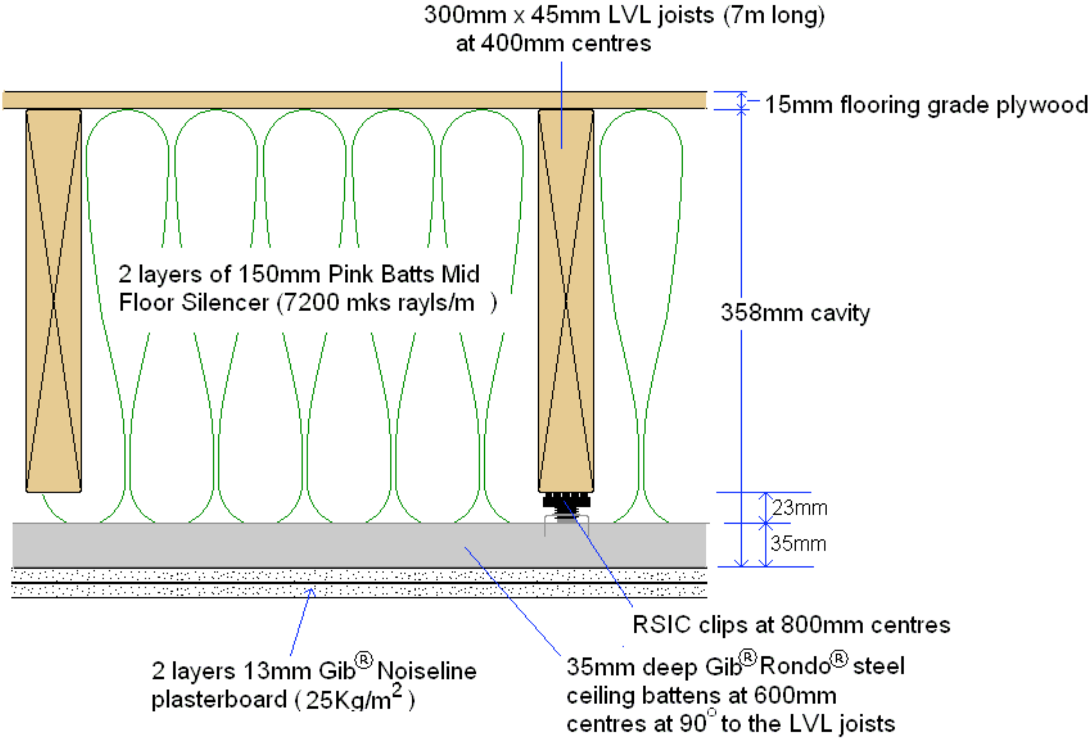
A concrete based floor/ceiling system comprising: 150mm reinforced concrete floor with a suspended ceiling comprising: 200mm long 6mm Ø threaded rods fixed to steel plates glued to the underside of the concrete slab at 600mm x 600mm centres, Rondo® ceiling clips are screwed to the threaded rods and 35mm GIB® Rondo® furring channels are held in the clips. The furring channels are screw-fixed at either end to J channels screw-fixed to the 25mm x 245mm timber perimeter plate. 1 lining of 13mm GIB® Standard plasterboard is screw-fixed at 300mm centres to the furring channels, the 230mm ceiling cavity is lined with 1 layer of 75mm Pink Batts™ R1.8 fibreglass insulation. The joints and perimeter are sealed with GIB Soundseal®.



11.3 Floor 2

Floor 2 Upper: 1 x Plywood

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 7 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) End of joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists.

3) At perimeter of ceiling; ends of steel ceiling battens and edge of ceiling lining fixed to steel 'J' channel on 100x50 timber ground. Junctions of plasterboard to timber and to blockwork filled airtight with acoustical sealant.

Floor 2. Overview of Plywood deck showing layout of plywood

Floor 2. Plywood deck to reinforced concrete edge beam junction

Floor 2. Edge junction between floor and test rig concrete beam

Floor 2. General view from below of 7m long 300x45 LVL joists

Floor 2. General view of ceiling system support

Floor 2. Ends of joists simply supported on timber ground with solid blocking. Also shown are steel batten, perimeter J channel, RSIC clips and fiberglass sound absorber in ceiling cavity

Floor 2. Shows steel batten spanning 800mm between RSIC clip and steel J channel

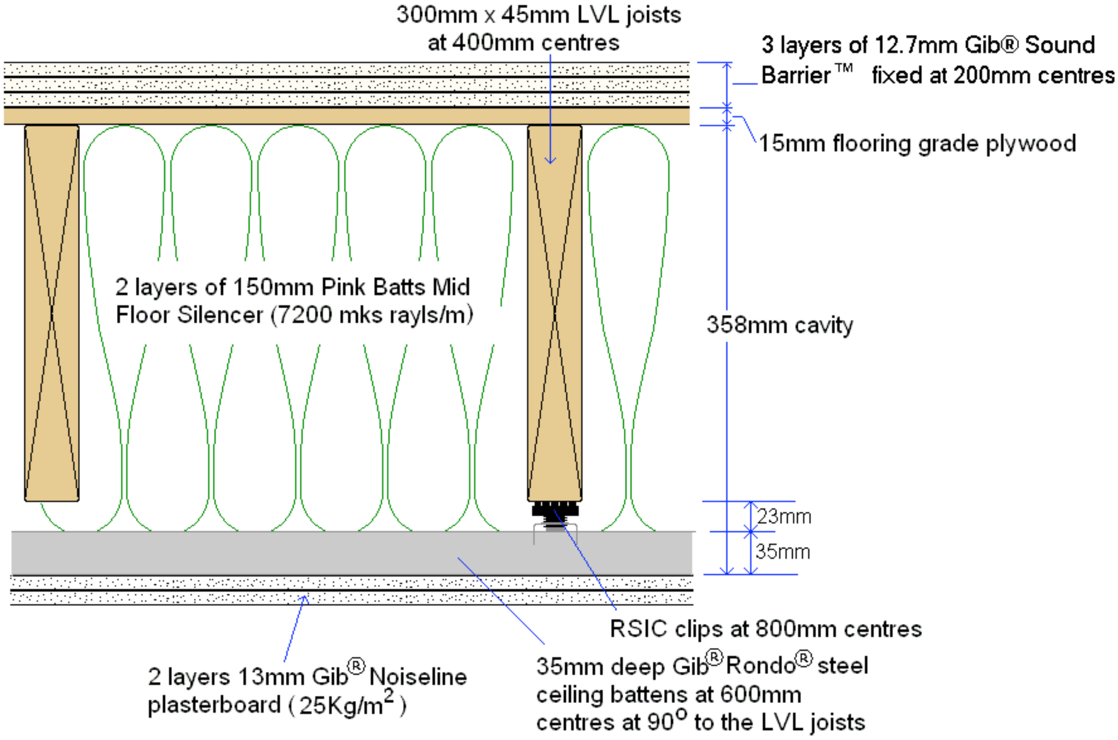
Floor 2. Junction of ceiling batten to steel J channel on to timber ground over blockwork

Floor 2. Close up of floor joist with RSIC clip to ceiling batten connection

11.4 FLOOR 3

Floor 3. Upper: 1 x Plywood, 3 x Gib®SoundBarrier™

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 7 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) End of joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists.

3) At perimeter of ceiling; ends of steel ceiling battens and edge of ceiling lining fixed to steel 'J' channel on 100x50 timber ground. Junctions of plasterboard to timber and to blockwork filled airtight with acoustical sealant.

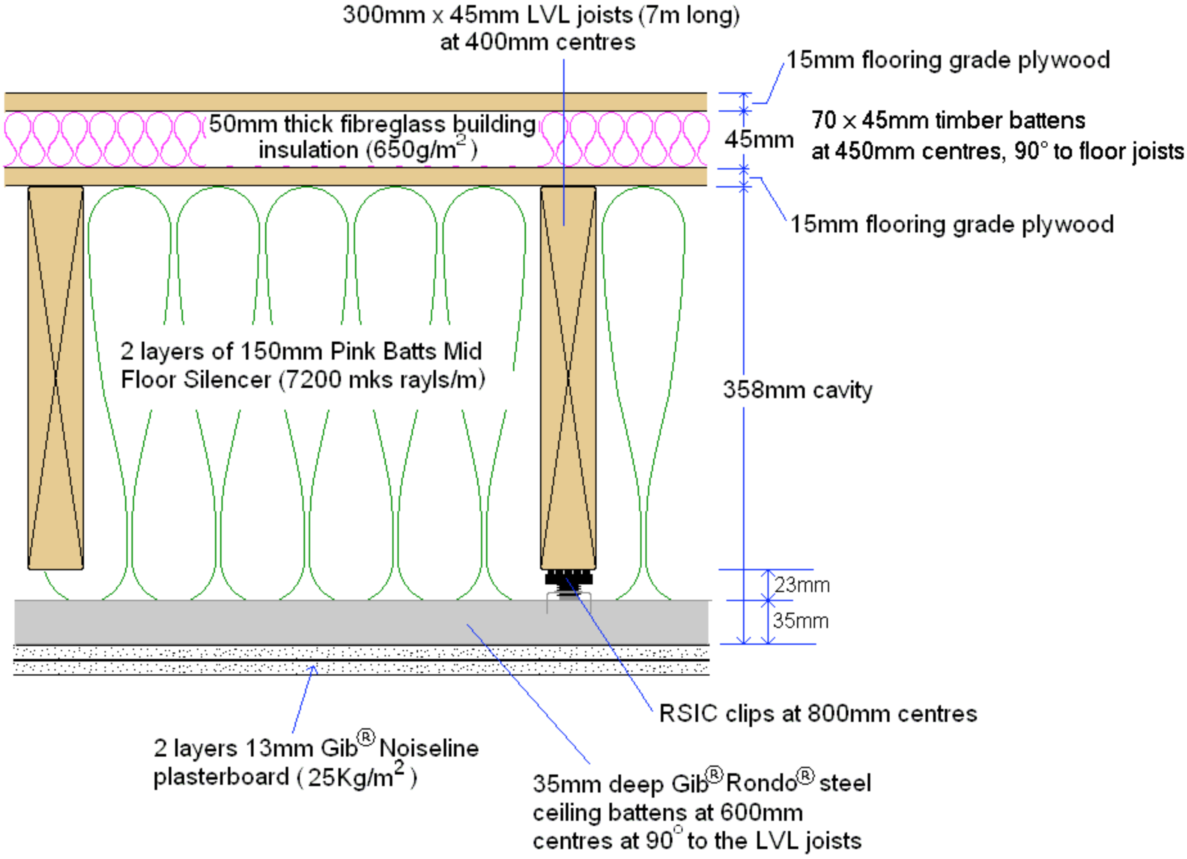
Floor 3. Overview of gypsum fibreboard deck showing layout.

Refer to photographs for Floor 2 for ceiling system details.

11.5 FLOOR 4

Floor 4. Upper: 1 x Plywood, battens/Fibreglass, 1 x Plywood

SECTION FIGURE 1. **Typical section across joists**



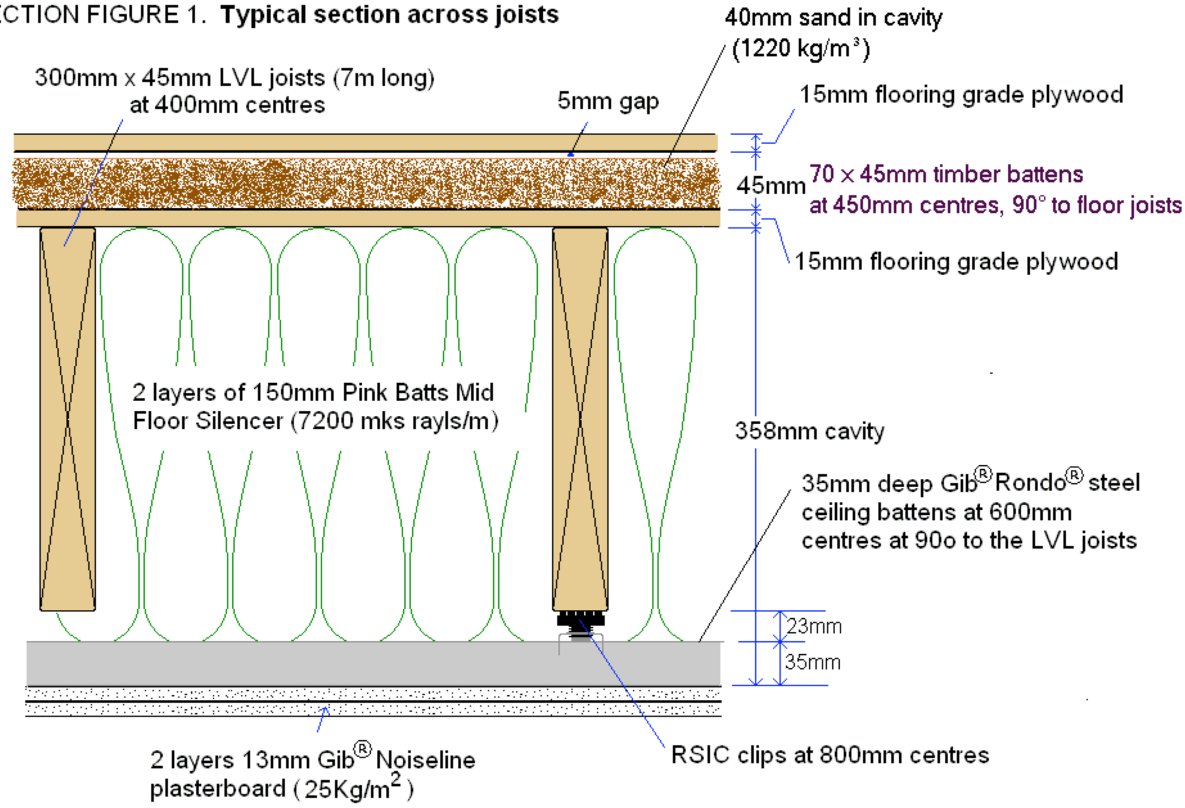
Notes: 1) Floor size 7 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.
2) End of joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists.
3) For construction detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Refer to photographs for Floor 2 for ceiling system details.

11.6 FLOOR 5

Floor 5. Upper: 1 x Plywood, battens/sand, 1 x Plywood

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 7 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) End of joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists.

3) For construction detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Floor 5. View of plywood flooring over 70x45 battens on flat with sand infill

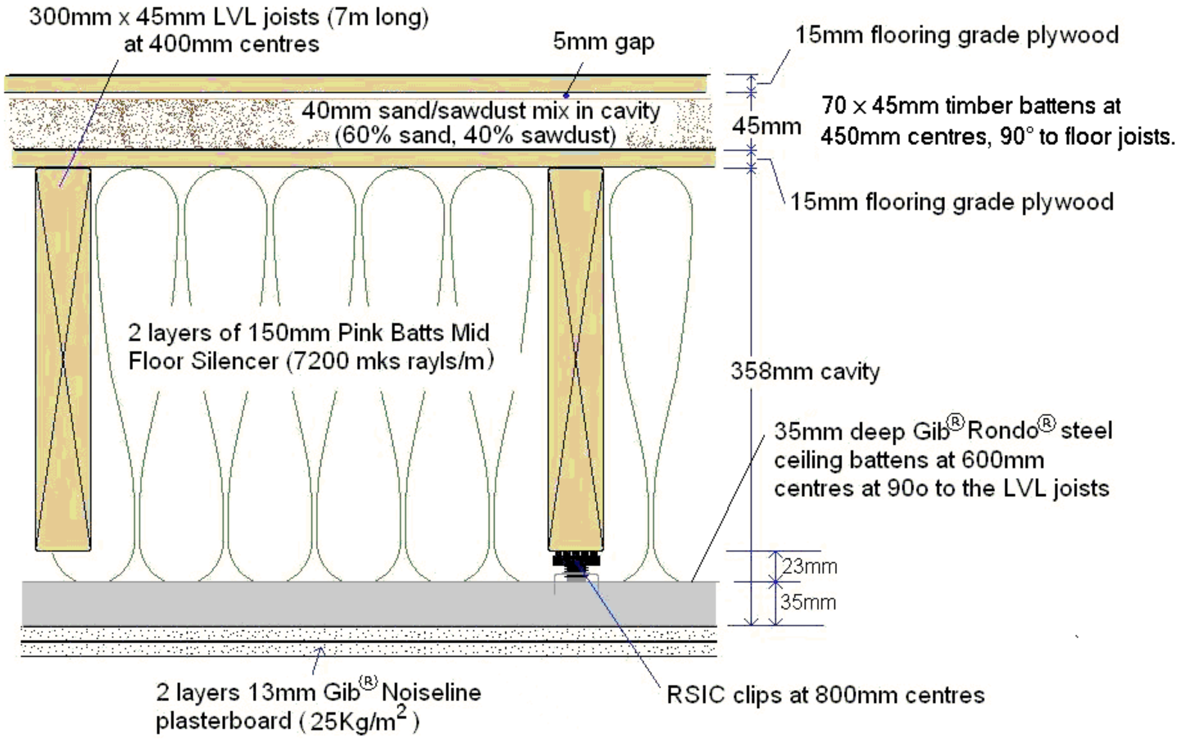
Floor 5. Sand infill between 45mm deep battens

Refer to photographs for Floor 2 for ceiling system details.

11.7 FLOOR 6

Floor 6. Upper: 1 x Plywood, battens/sand-sawdust, 1 x Plywood

SECTION FIGURE 1. **Typical section across joists**



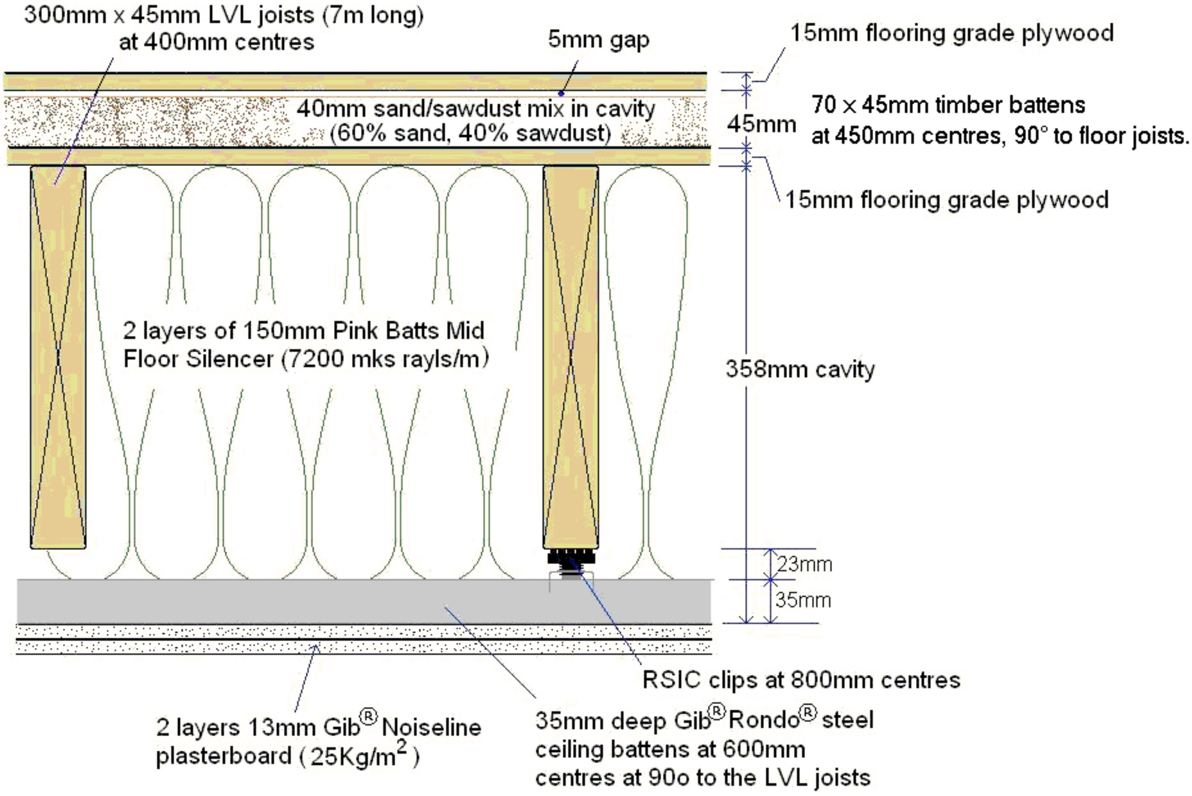
Notes: 1) Floor size 7 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.
2) End of joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists.
3) For construction detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Refer to photographs for Floor 2 for ceiling system details.

11.8 FLOOR 7

Floor 7. Upper: 1 x Plywood, battens/sand-sawdust, 1 x Plywood

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 7 x 3.2m . Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) End of joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists.

3) Each end of the floor clamped to simulate the dead load of a second storey.

4) For construction detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Floor 7. Clamping to ends of floor

Floor 7. Close up of holding down bolts to end of clamping beam

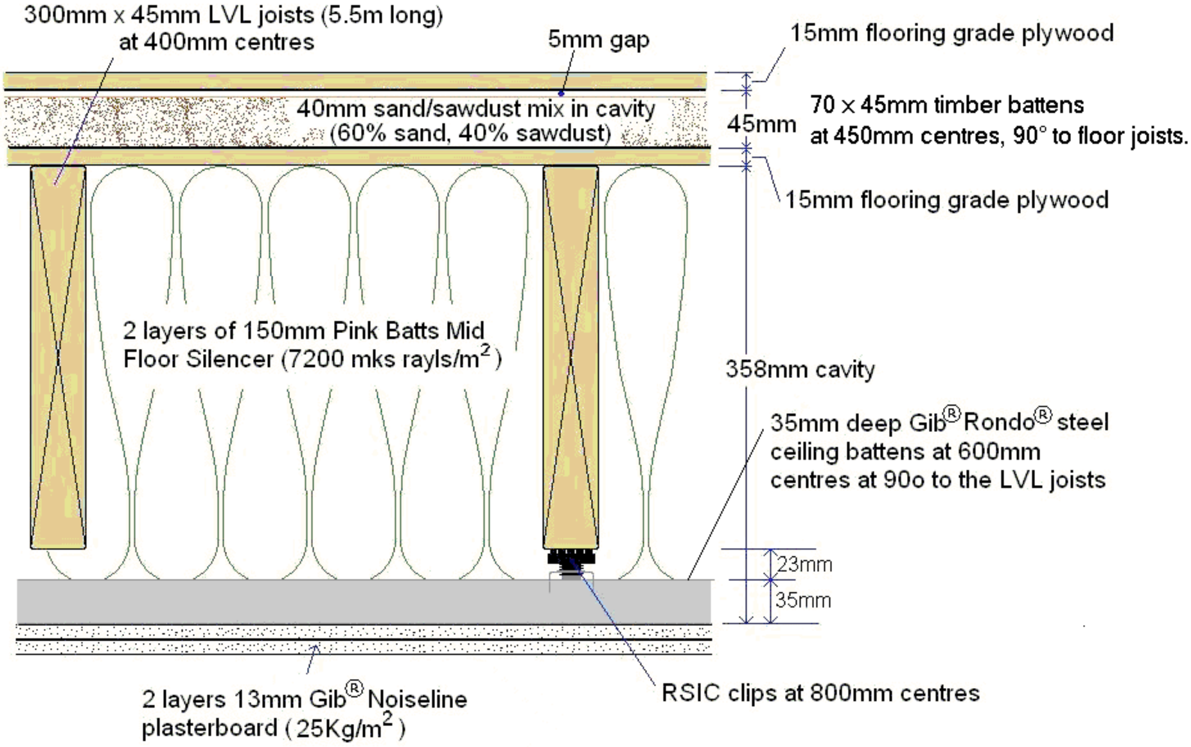
Floor 7. View of clamping down to end of floor

Refer to photographs for Floor 2 for ceiling system details.

11.9 FLOOR 8

Floor 8. Upper: 1 x Plywood, battens/sand-sawdust, 1 x Plywood

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) For construction detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Floor 8. Cross beam above to support ends of floor joists with separate joist to support edge of ceiling

Floor 8. General arrangement of 300 LVL joists and support off cross beams with separate joist to support edge of ceiling

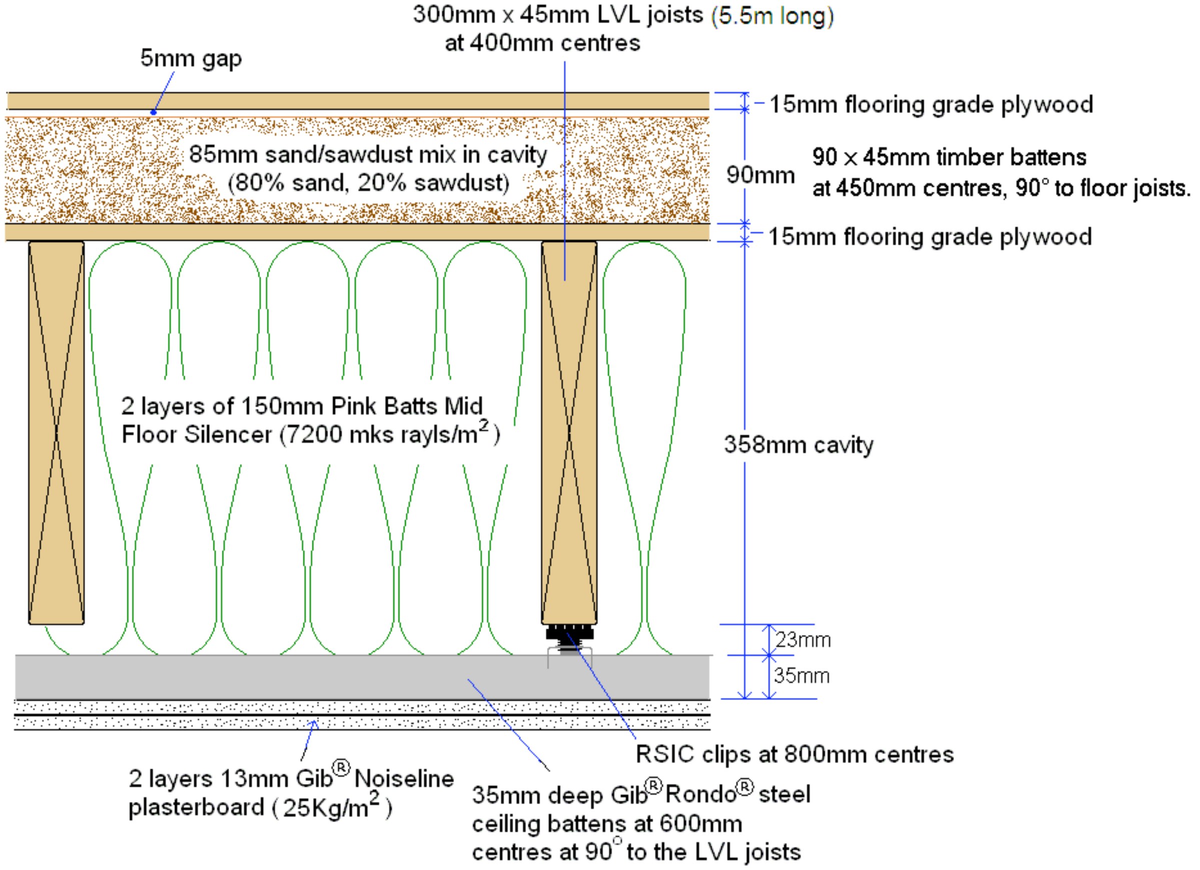
Floor 8. View of cross beam showing joist hangers

Refer to photographs for Floor 2 for ceiling system details.

11.10 FLOOR 9

Floor 9. Upper: 1 x Plywood, battens/sand-sawdust, 1 x Plywood

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

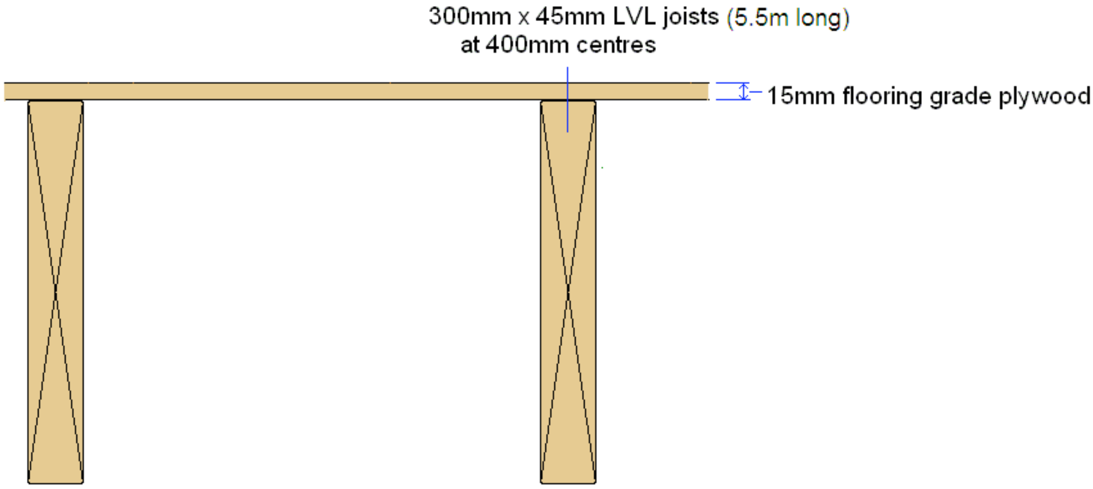
3) For construction detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1

Refer to photographs for Floor 2 for ceiling system details.

11.11 FLOOR 10

Floor 10. Upper: 1 x Plywood Lower: No ceiling

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

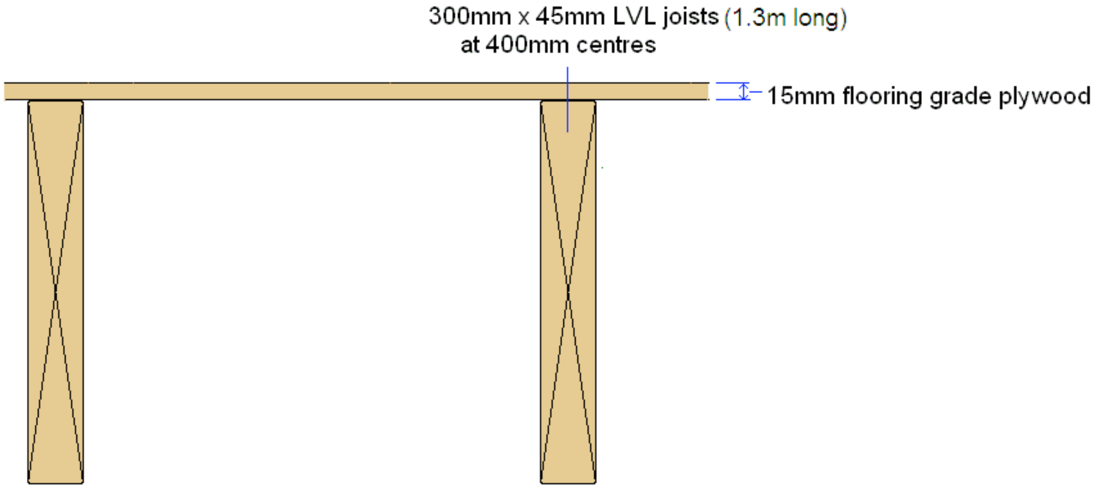
3) Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

Floor 10. Underside of floor showing supporting beam at end.

11.12 FLOOR 11

Floor 11. Upper: 1 x Plywood. Lower: No ceiling

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 1.3m x 3.2m

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

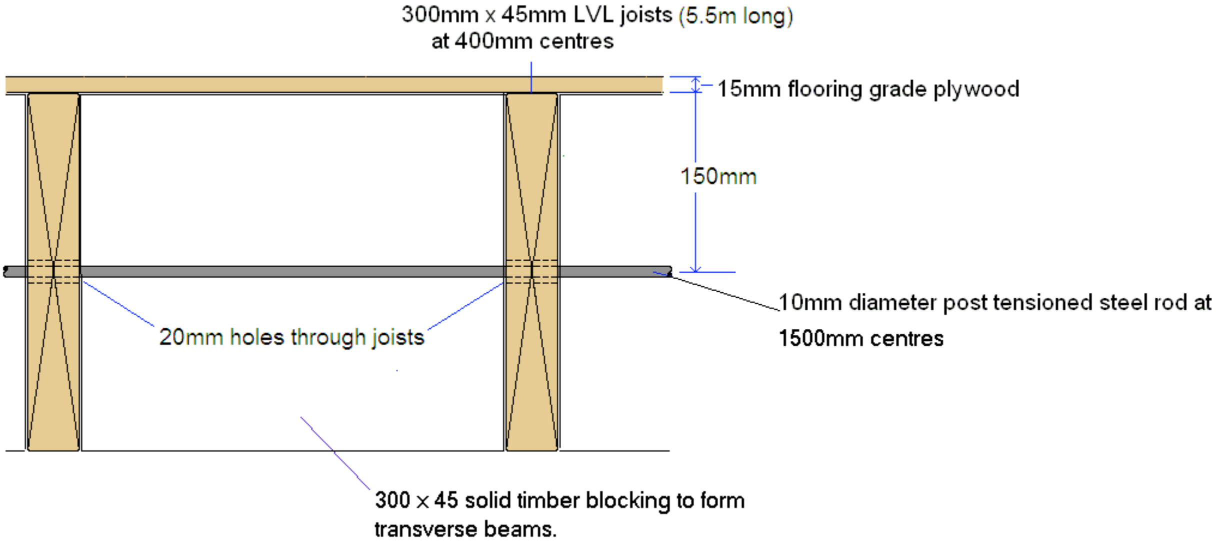
3) Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

Floor 11. Underside of floor

11.13 FLOOR 12

Floor 12. Upper: 1 x Plywood. Mid: Post tensioned x 4. Lower: No ceiling.

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 5.5m x 3.2m . Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring-washers and nuts tightened with a spanner

4) Four transverse stiffening beams were installed at 1500mm centres.

Floor 12. View of underside of floor showing four transverse stiffening beams

Floor 12. View of cross beam and plywood flooring from above

Floor 12. General view of underside of floor showing four transverse beams and cross beam supporting joists on both sides

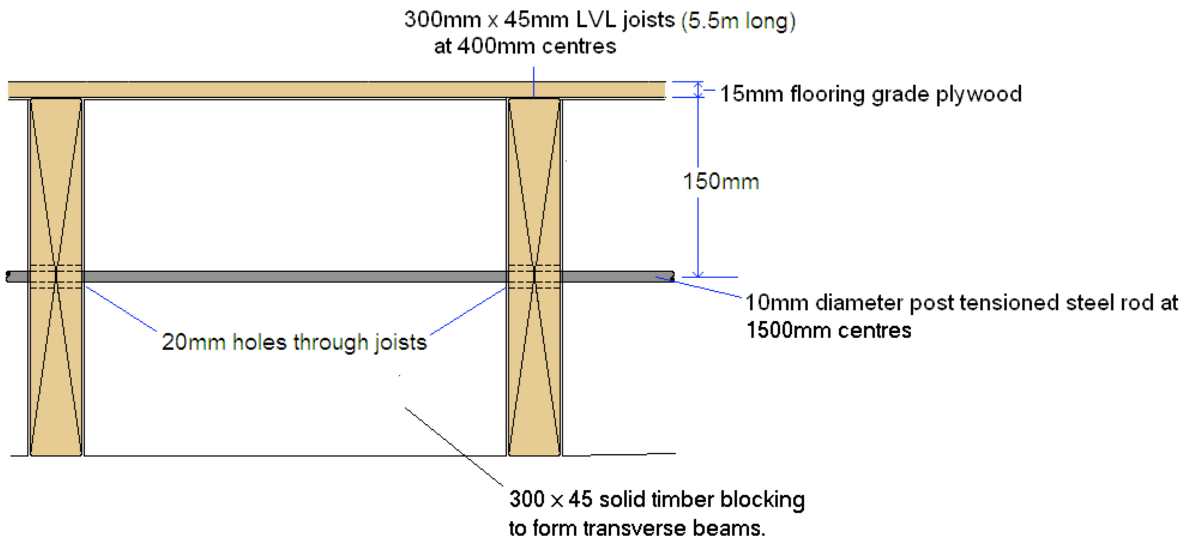
Floor 12. Close up of end of steel rod showing 150x150x10mm steel plate with 35x35 square washer, spring washer, washer and nut

Floor 12. Shows solid blocking using 300x45 LVL and end of post tension rod on penultimate joist

11.14 FLOOR 13

Floor 13. Upper: 1 x Plywood. Mid: Post tensioned x 2. Lower: No ceiling.

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 5.5m x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring-washers and nuts tightened with a spanner

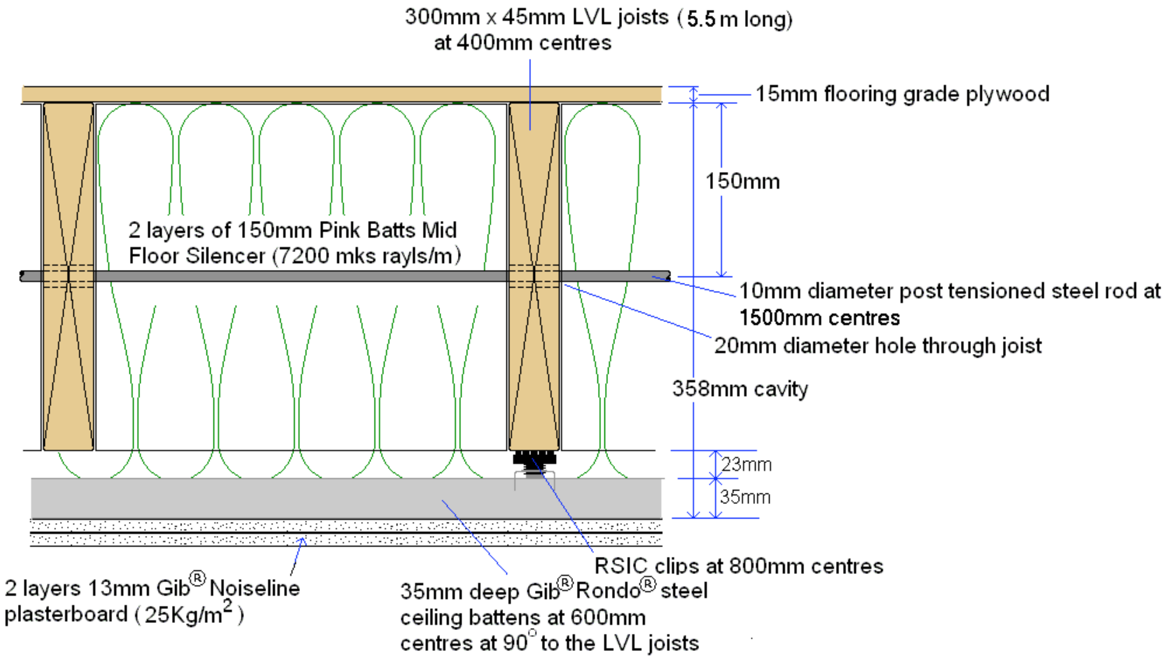
4) Two transverse stiffening beams were installed in mid span at 1500mm centres.

Floor 13. Illustrates two transverse beams under floor

11.15 FLOOR 14

Floor 14. Upper: 1 x Plywood. Mid: Post tensioned x 2.

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 5.5m x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring- washers and nuts tightened with a spanner

4) Two transverse stiffening beams were installed in mid span at 1500mm centres.

5) For construction detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

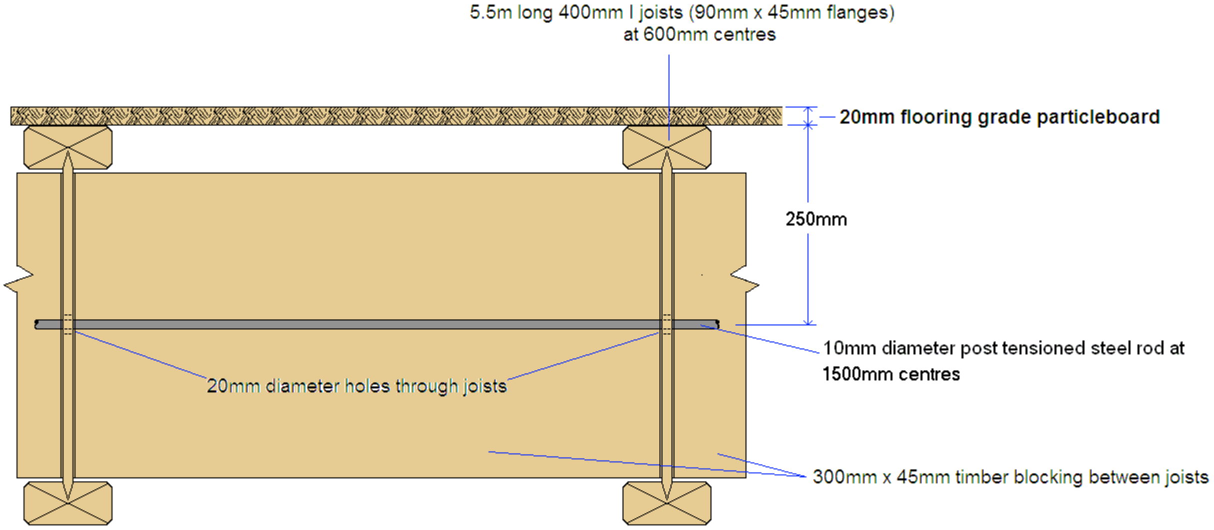
Refer to photographs for Floor 2 for ceiling system details.

Refer to photographs for Floor 13 for joist system details.

11.16 FLOOR 15

Floor 15. Upper: 1 x Particleboard. Mid: 400 I beams, post tensioned x 2. Lower: No ceiling.

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 5.5m x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring-washers and nuts tightened with a spanner

4) Two transverse stiffening beams were installed in mid span at 1500mm centres.

Floor 15. Ends of post tensioned beams

Floor 15. Floor joist to transverse beam junction shows steel rod below central axis of beam

Floor 15. Simply supported ends of joists with boundary joist continuously supported

Floor 15. Shows 400 deep I joists at 600 centres with two central transverse beams up to penultimate joist

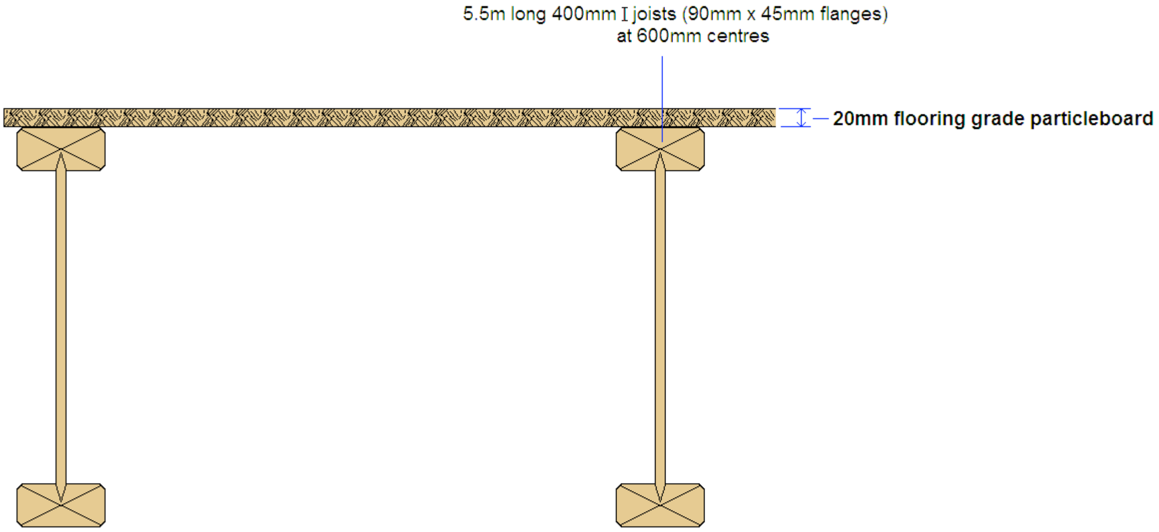
Floor 15. General view of the ends of the transverse beams

Floor 15. View of ends of 400 I joists supported on joist hangers off cross beam

11.17 FLOOR 16

Floor 16. Upper: 1 x Particleboard. Mid: 400 I beams. Lower: No ceiling.

SECTION FIGURE 1. **Typical section across joists**



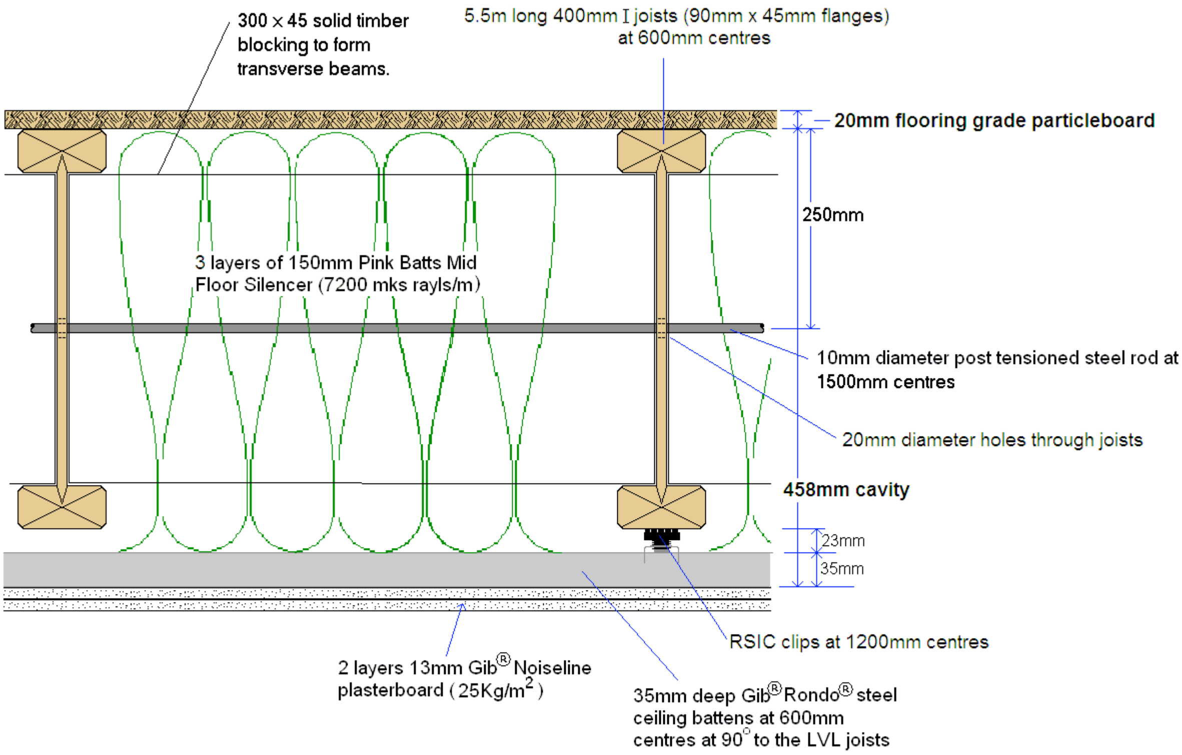
Note: 1) Floor size 5.5m x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

11.18 FLOOR 17

Floor 17. Upper:1 x Particleboard. Mid: 400 I beams, Post tensioned x 2.

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 5.5m x 3.2m . Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring-washers and nuts tightened with a spanner

4) Two transverse stiffening beams were installed in mid span at 1500mm centres.

5) Cavity only partially filled (About two thirds of cavity depth)

6) For detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Floor 17. View of partially full cavity

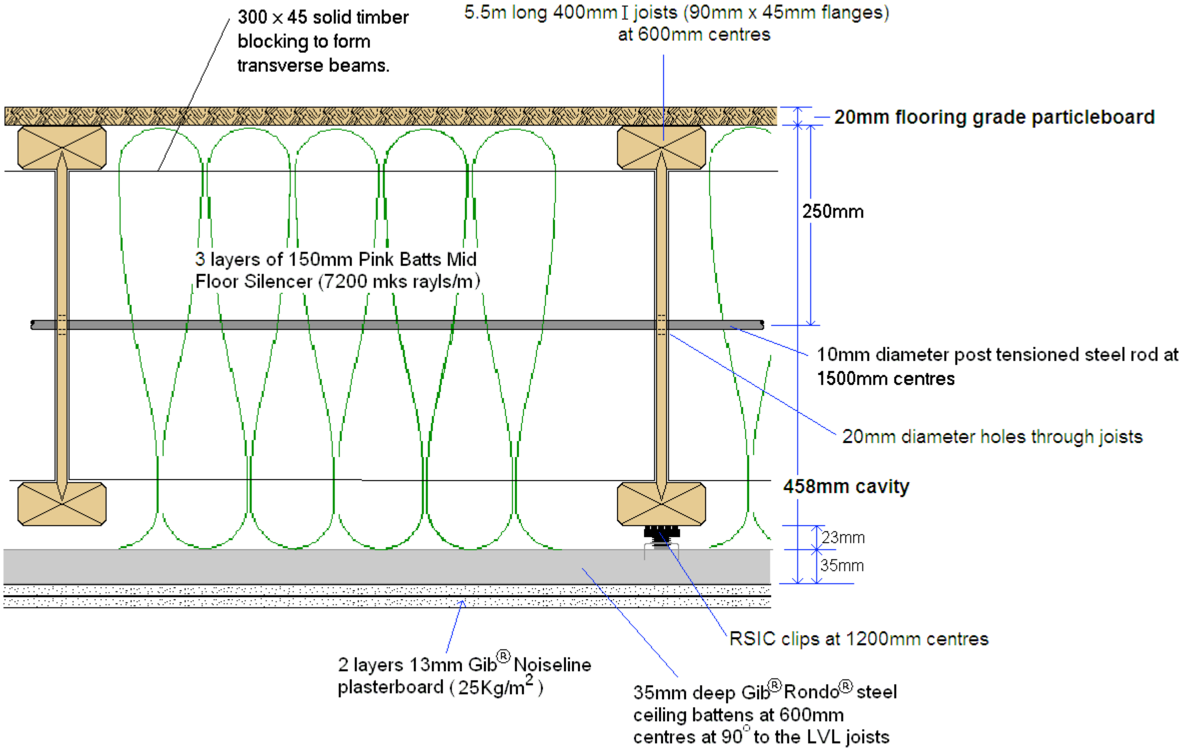
Floor 17. Side view of partially full cavities

Refer to photographs for Floor 2 for ceiling system details.

11.19 FLOOR 18

Floor 18. Upper: 1 x Particleboard. Mid: 400 I beams, Post tensioned x 2.

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 5.5m x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring-washers and nuts tightened with a spanner

4) Two transverse stiffening beams were installed in mid span at 1500mm centres.

5) For detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

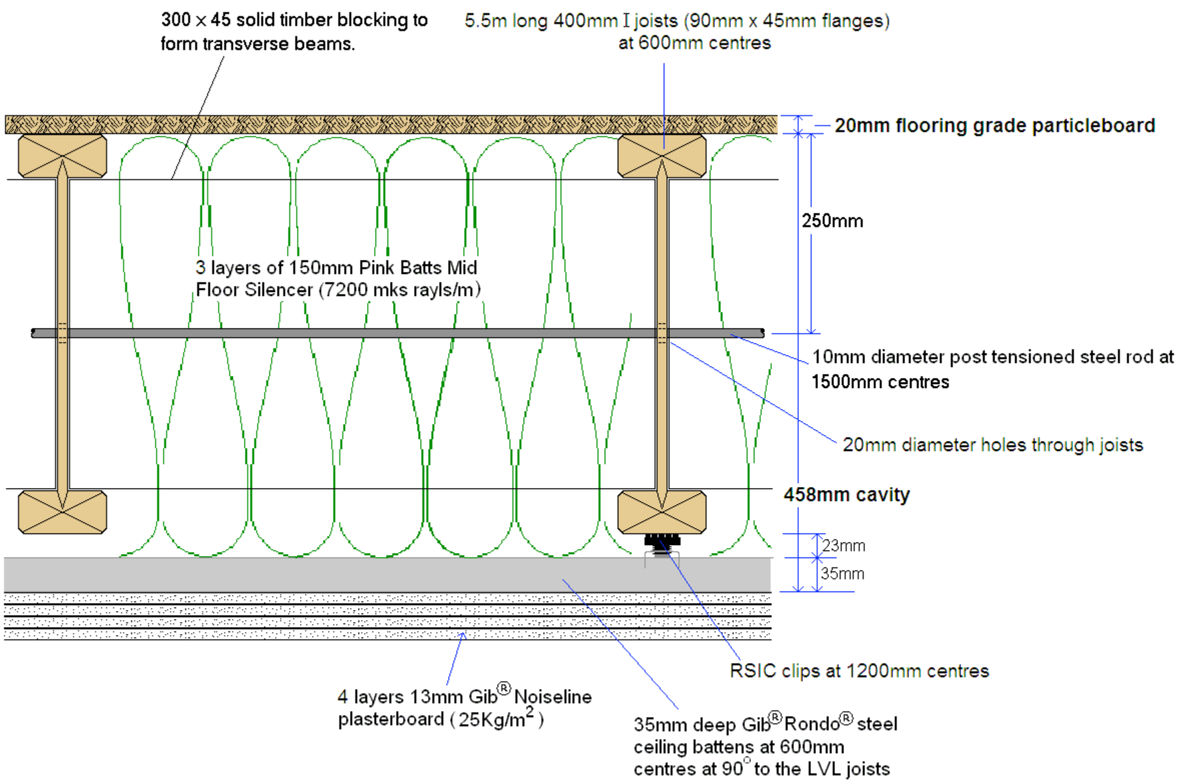
Floor 18: View of full cavities.

Refer to photographs for Floor 2 for ceiling system details.

11.20 FLOOR 19

Floor 19. Upper:1 x Particleboard. Mid: Post tensioned x 2. Lower: 4 x ceiling lining.

SECTION FIGURE 1. **Typical section across joists**



Note: 1) Floor size 5.5m x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring-washers and nuts tightened with a spanner

4) Two transverse stiffening beams were installed in mid span at 1500mm centres.

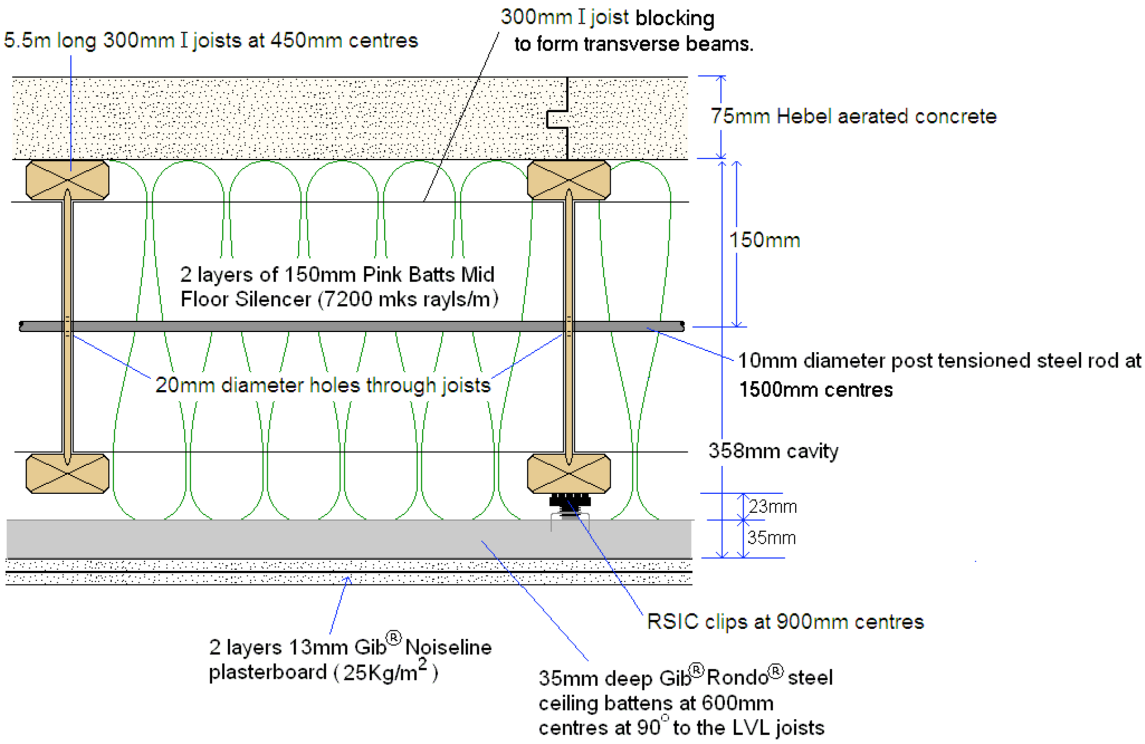
5) For detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Refer to photographs for Floor 2 for ceiling system details.

11.21 FLOOR 20

Floor 20. Upper: 1 x Hebel aerated concrete

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m . Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Transverse stiffening beams consist of solid 300mm x 45mm timber blocking and steel rods at 90° to the floor joists, each end has a 10mm thick steel plate with spring-washers and nuts tightened with a spanner

4) Two transverse stiffening beams were installed in mid span at 1500mm centres.

5) For detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Floor 20. Ends of joist supported on joist hangers off the cross beam

Floor 20. General view from above of 300 I joists with two transverse beams

Floor 20. Close up view of the two transverse beams

Floor 20. General view of the Hebel floor

Floor 20. Junction of the Hebel floor to test rig reinforced concrete beam

Floor 20. General view of the underside of the Hebel floor

Floor 20. End of transverse beams

Floor 20. Hebel floor panel section

Floor 20. Hebel floor panel section - 2

Floor 20. One end of joists supported on joist hangers off cross beam

Floor 20. One end of joists simply supported on 100x50 timber ground off blockwork

Floor 20. View of floor structure before Hebel flooring placed in position

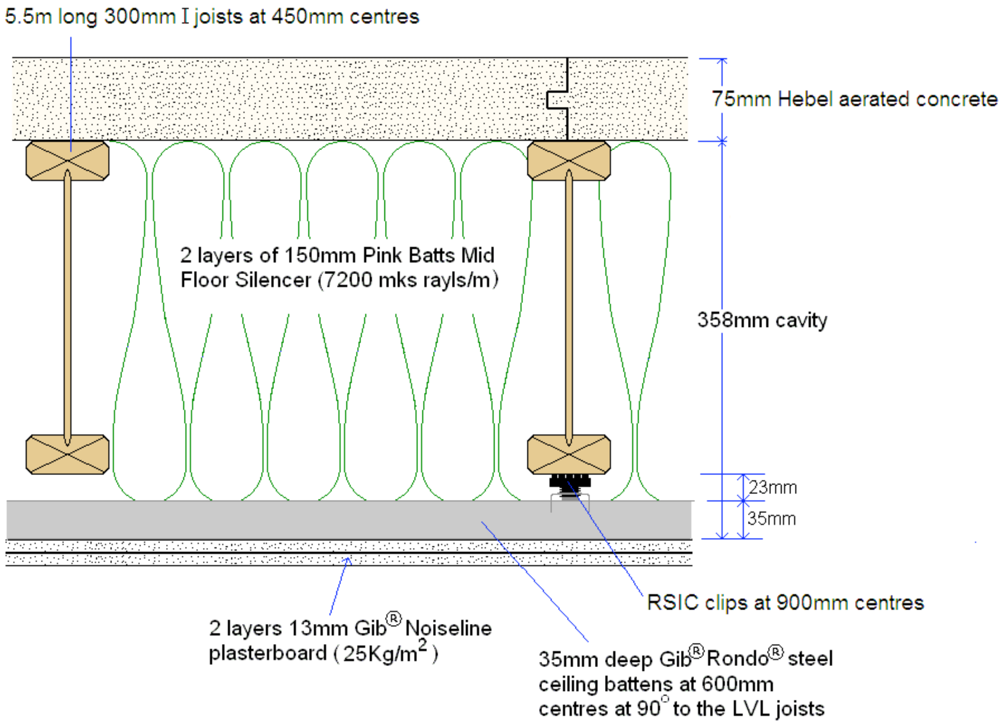
Floor 20. End of transverse beam before Hebel flooring in place, shows steel rod on central axis of beam

Refer to photographs for Floor 2 for ceiling system details.

11.22 FLOOR 21

Floor 21. Upper: 1 x Hebel aerated concrete

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

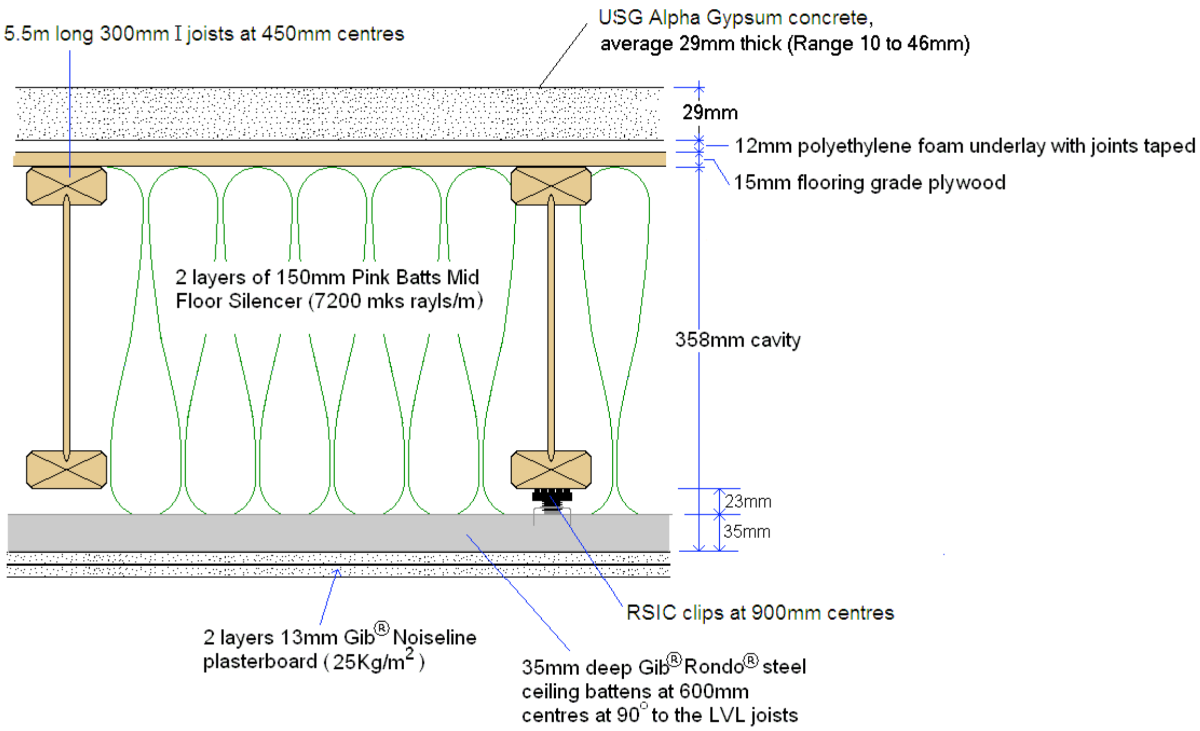
3) For detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

Refer to photographs for Floor 2 for ceiling system details.

11.23 FLOOR 22

Floor 22. Upper: 1 x plywood, Alpha Gypsum concrete on underlay

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) For detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.

4) Gypsum concrete was USG Levelrock Floor Underlayment 3500 pre-sanded.

Floor 22. First pour of gypsum concrete on polyethylene foam underlay with taped joints

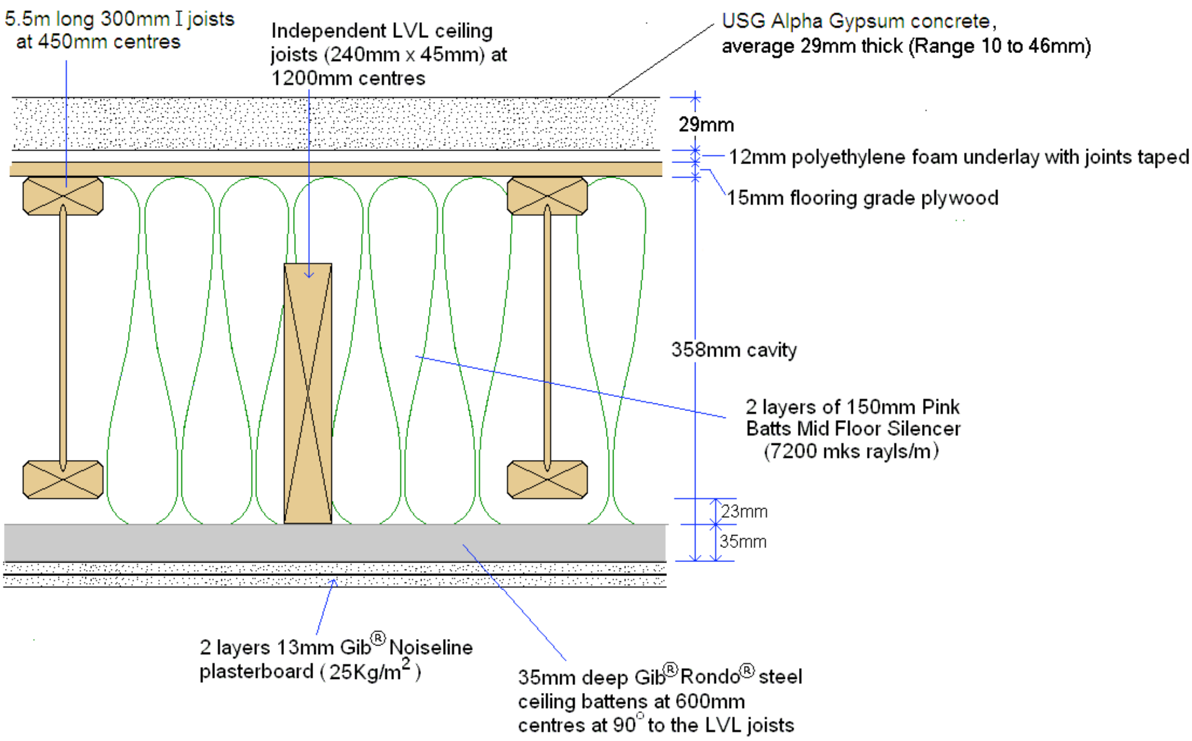
Floor 22. Completed gypsum concrete flooring, depth ranged from 10 to 46mm with average of 29mm thick

Refer to photographs for Floor 2 for ceiling system details.

11.24 FLOOR 23

Floor 23. Upper: 1 x plywood, Alpha Gypsum concrete on underlay

SECTION FIGURE 1. **Typical section across joists**

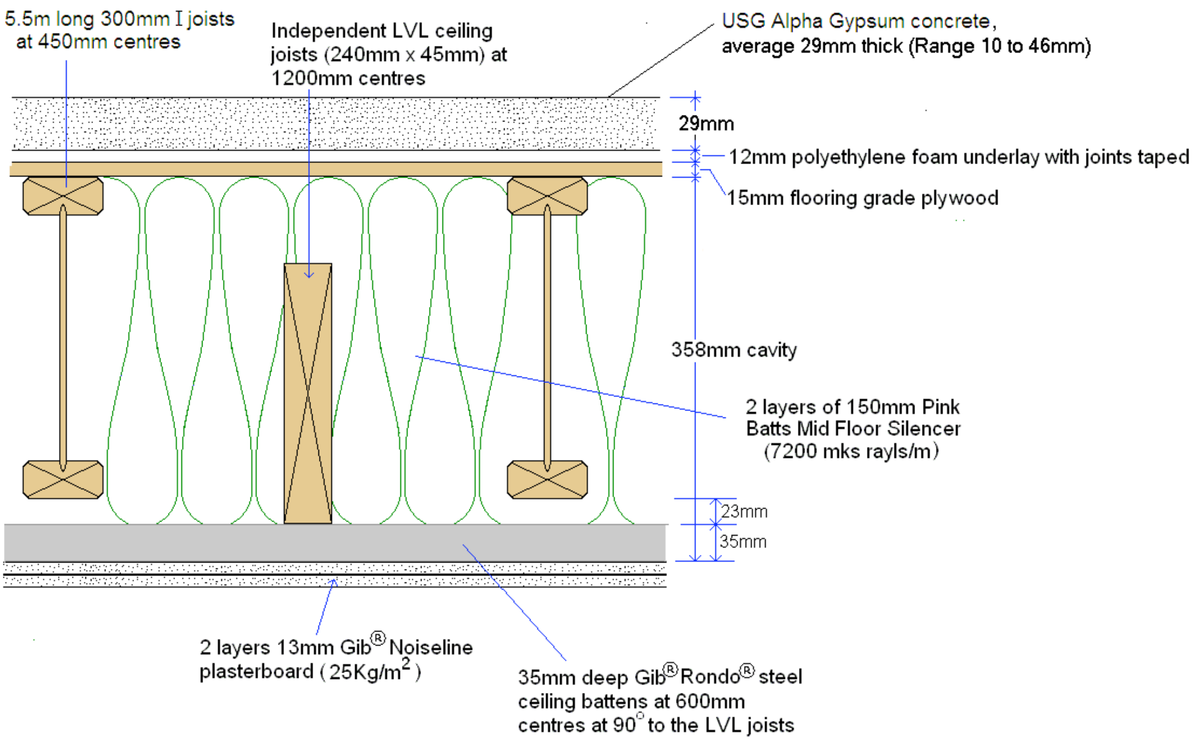


Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.
2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam
3) Ends of ceiling joists supported on metal joist hangers.
4) For detail at perimeter of ceiling refer to note 3 on Floor 2, Section Figure 1.
5) Gypsum concrete was USG Levelrock Floor Underlayment 3500 pre-sanded.

11.25 FLOOR 24

Floor 24. Upper: 1 x plywood, Alpha Gypsum concrete on underlay. Lower: ceiling isolated

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.

2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam

3) Ends of ceiling joists supported on 100 x 50 x 10.5mm thick Shearflex rubber pads.

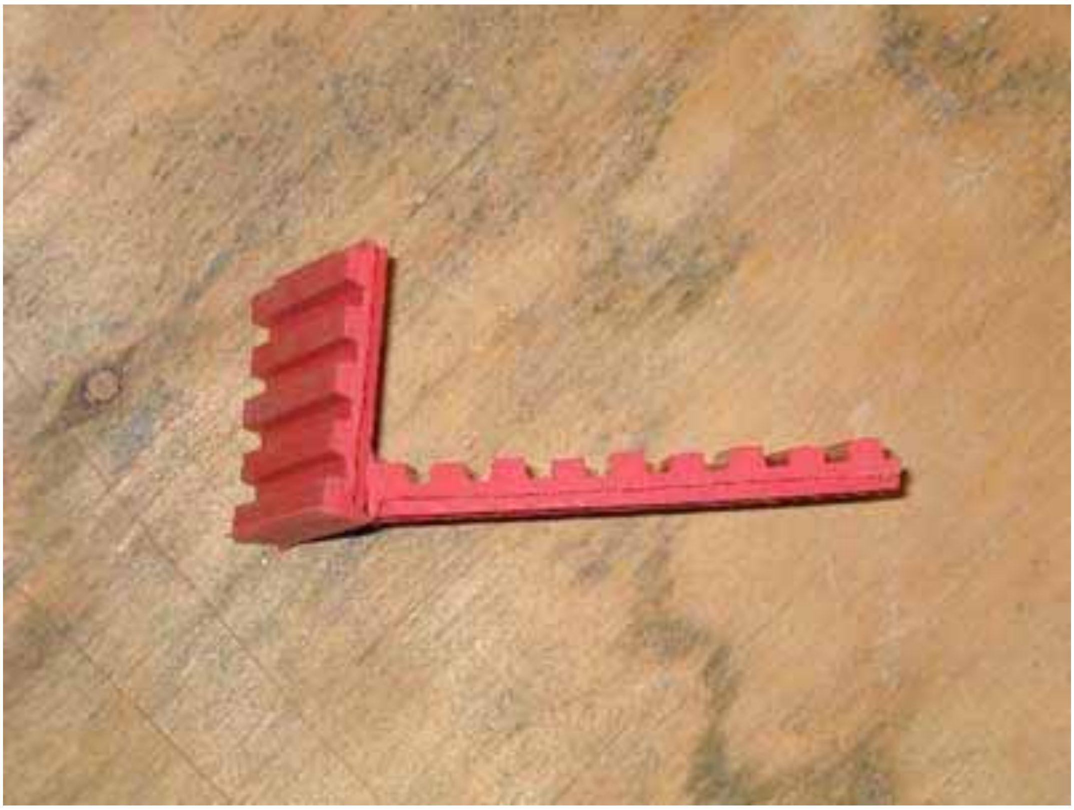
4) At perimeter of ceiling, steel ceiling battens and ceiling linings were cut to provide a 5 to 10mm gap adjacent the timber ground on the blockwork.

5) Gypsum concrete was USG Levelrock Floor Underlayment 3500 pre-sanded.

Floor 24. Ceiling separation at sides

Floor 24. Ceiling separation at ends

Floor 24. Close up of ceiling separation at corner

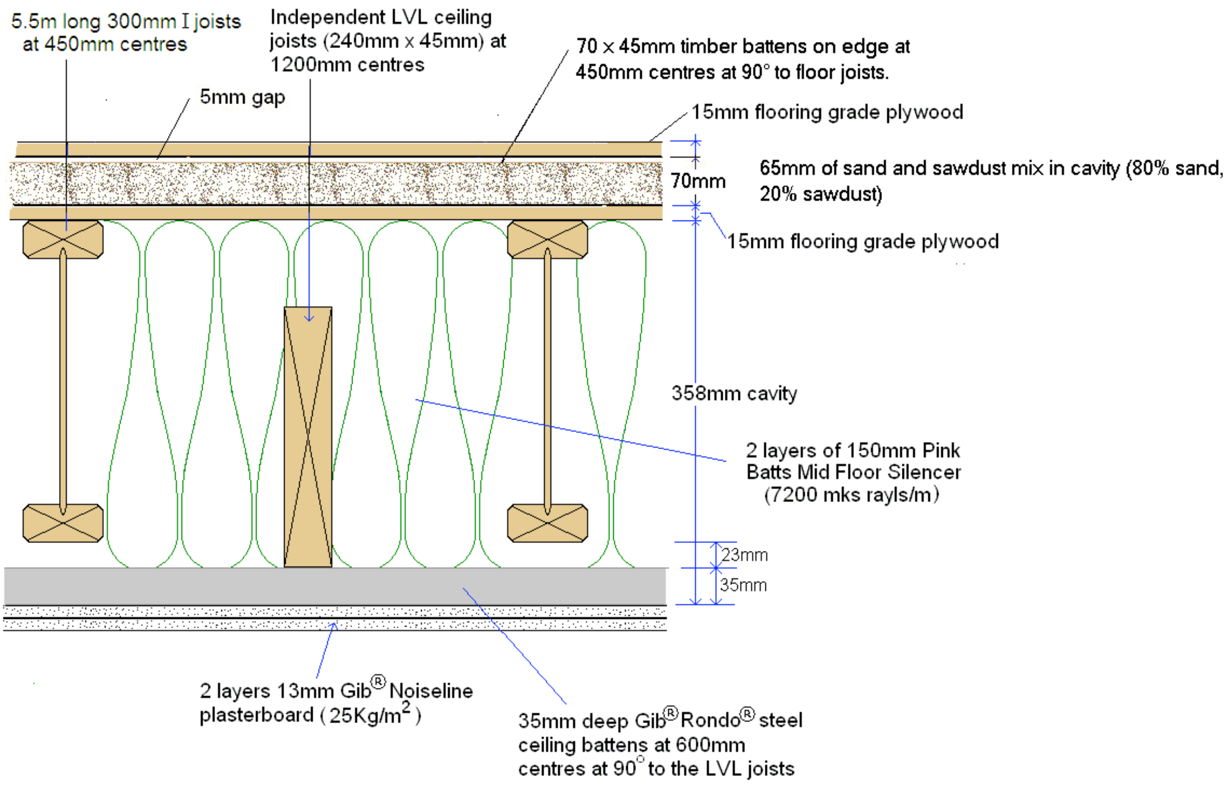


Floor 24. Close up of Shearflex rubber pads

11.26 FLOOR 25

Floor 25. Upper: 1 x Plywood, battens / sand & sawdust, 1 x Plywood. Mid: ceiling joists: Lower: ceiling isolated.

SECTION FIGURE 1. **Typical section across joists**

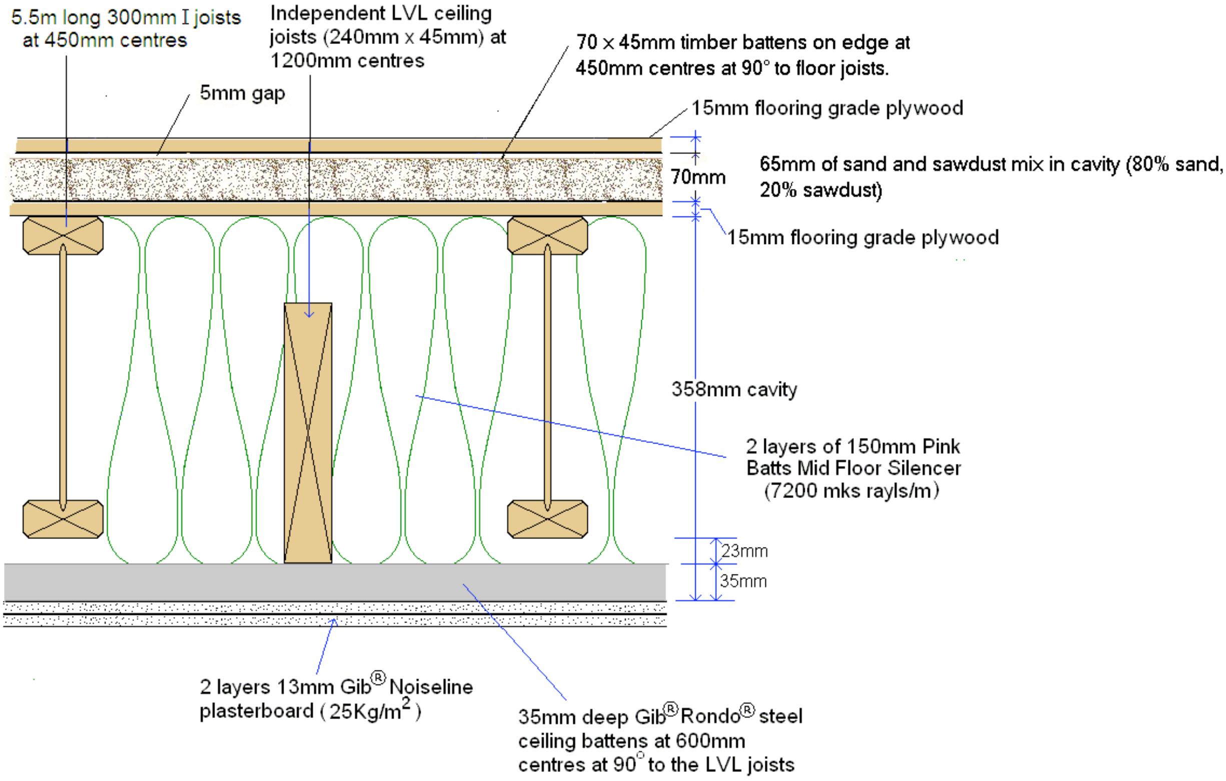


Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.
2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam
3) Ends of ceiling joists supported on 100 x 50 x 10.5mm thick Shearflex rubber pads.
4) At perimeter of ceiling, steel ceiling battens and ceiling linings were cut to provide a 5 to 10mm gap adjacent the timber ground on the blockwork with acoustical sealant in gap.

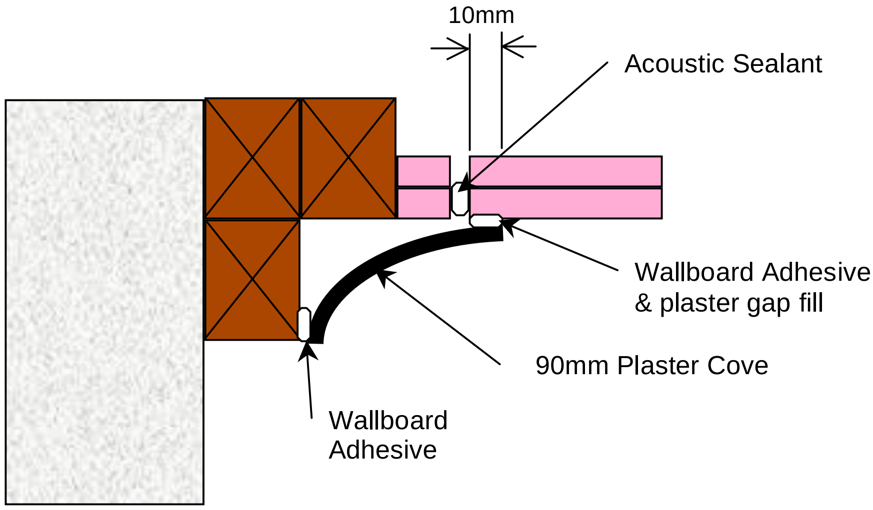
11.27 FLOOR 26

Floor 26. Upper: 1 x Plywood, battens / sand & sawdust, 1 x Plywood. Mid: ceiling joists: Lower: ceiling isolated with cornice.

SECTION FIGURE 1. **Typical section across joists**



Notes: 1) Floor size 5.5 x 3.2m. Perimeter of flooring to test rig junction filled airtight with acoustical sealant.
2) One end of floor joists simply supported on 100x50mm timber grounds with solid blocking between ends of joists, other end on joist hangers off cross beam
3) Ends of ceiling joists supported on 100 x 50 x 10.5mm thick Shearflex rubber pads.
4) At perimeter of ceiling, steel ceiling battens and ceiling linings were cut to provide a 5 to 10mm gap adjacent the timber ground on the blockwork with acoustical sealant in gap and 90mm plaster cove to cornice.



Floor 26: Edge detail of coving fixing to ceiling edge.

Floor 26. Coving in corner

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