New Zealand Acoustics

Volume 25, 2012 / #1

Frequency Behaviour of Basic Floor Structures

Balancing the Demands for a Comfortable Thermal & Acoustic Built Environment

Saving the Cost of Building Anechoic Chambers

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New Zealand Acoustics

Volume 25, 2012 1st Quarter

Features

Regulars

Cover Photo: Toru, Kopernika 21 Str., wooden beam ceiling on the 1st floor, 16th cent.

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From the President and Editor

From the President

Dear Members,

My word, the journal seems to come around so quickly! I'm sure it was only a few weeks ago that John was begging me for my input into the Christmas 2011 edition – and yet, here we are in March, and he's once again reminded me to put together some words.

Christmas and New Year are distant memories, but I hope the break was good for you, and that you have all come into 2012 refreshed and enthusiastic and keen to do some great acoustics work this year.

For your general information, an update on our not-really-so-new-now Membership regime. At the time of writing, we officially have 21 Members, 10 Affiliate Members, and three memberships pending Committee approval. I must confess that one of these 'pending' memberships is mine, as I completely forgot to incorporate my employer reference....you'd think I really should know better, wouldn't you?!

These figures indicate that approximately one third of the Society's current members have responded to the call for formal membership. Once again, I encourage those of you who have not submitted their application documentation to do so.

We also have five Fellows of the Society to whom certificates of membership will be issued. The acoustic fraternity (should that also be sorority? It's hard to know what's politically correct these days...) is indebted to the significant contribution to the field of acoustics and to the Society made by these Fellows – Stuart Bradley, George Dodd, Mark Johnson, Sir Harold Marshall and John

Quedley – and we wish to acknowledge this.

It is the Committee's intention, as previously proposed to the

Publication Dates and Deadlines

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The Deadline for material for inclusion in the journal is 1st of each publication month, although long articles should ideally be received at least 2 weeks prior to this.

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membership, to develop a formal system of documenting and recognising Continuing Professional Development (CPD) amongst its members. This serves to both encourage, and demand of its members, that a certain level of direct involvement in the acoustic community and ongoing learning is maintained, to ensure members represent the highest possible standard of practice in the discipline of acoustics. The aim is to have the CPD structure in place by the end of July.

This brings me to my neatly-planned segue to the topic of the biennial ASNZ Conference; this will mean that attendance at the ASNZ's 2012 New Zealand Conference can be recognised for those members who can make it as contributing to their ongoing CPD!

The Conference is planned to be held in Wellington in September. Stay tuned for more details, and of course check the website for updates. I'm sure our esteemed editor will also have more to say regarding recent updates to the Society's website.

Take it away, John...

Best regards to all until the next edition!

Rachel Foster

Editor's Ramble

Hi Everyone, and Happy New Year!

Welcome to a new volume of NZ Acoustics for 2012. You might start to notice a few changes to the layout in this issue. Against advice, I have decided to present our featured articles in two-column format; this more closely matches similar publications and often, our source material, which makes less work for me! This also has the effect of freeing up a bit more space for a few new items and the return of some old favourites.

I am pleased to announce that we will be making our research articles available online from now on. This is a decision that has been agreed with the Society council, with the intention of making papers available from the society website: http://www.acoustics.ac.nz/.

Our hope is to have articles indexed and searchable by the major web search engines, so that papers can be given an impact factor; this should make the journal a more desirable place to publish new results. Personally, I would like to see more material that is relevant to a wider section of the Society membership.

In this issue there are three research articles, starting with an interesting paper that examines the noise generated by building ventilation systems. The authors discuss balancing thermal comfort with 'audible comfort', due to the noise made by circulating air through the distribution system. Energy usage modelling is used along with climate projections for the UK.

In the second work, the team at The University of Auckland discuss making high quality acoustic measurements without an acoustic chamber (no doubt trying to do themselves out of a job!). The final article concerns the frequency behaviour of various basic floor structures with the aim of validating the technique for rating sound transmission specified in EN ISO 12354-2. The Society has received an open letter from the ICA, and once again I have elected to publish this in full on page 26.

Also in this issue we have the minutes of the recent Acoustics Standards workshop in Wellington. Each of the NZS acoustics standards was discussed and the notes from the meeting have been summarised in tabular form on pages 28-29. At this meeting it was noted that Draft NZTA State Highway Construction Noise Guide is being circulated for consultation. More information on the draft can be found on page 33.

There are a few more sound snippets in this issue, and of course, another edition of the crossword! *All the best,*

John Cater

CONFERENCE ANNOUNCEMENT

The Acoustical Society of New Zealand will hold its biennial conference in Wellington this September. Sharpen your wits and pencils and get those papers rolling-final papers are due on 31 July. Paper templates and more details will be circulated as the time draws nearer. ¶

Balancing Comfortable Thermal & Acoustic Built Environments in a Sustainable Future

Michael Barclay[1], Jian Kang[1], Steve Sharples[1], Bo Wang[1], Hu Du[2]

(1) School of Architecture, The University of Sheffield, United Kingdom

(2) Northumbria University, Newcastle upon Tyne, United Kingdom

A paper previously presented at ISSA 2010, 29-31 August 2010, Auckland entitled "The Challenge of Balancing the Demands for a Comfortable Thermal and Acoustic Built Environment in a Sustainable Future"

Abstract

The future demands for building ventilation are likely to have an impact on the susceptibility of buildings to the ingress of external noise. Maximizing building natural ventilation can be an attractive goal but care should be taken to consider such factors as exposure to road noise. Climate projections give information about changes that could occur over the next 90 years, this is a time scale relevant to buildings. It would seem appropriate to quantify the benefits and challenges of noise control strategies in terms of ventilation rates and energy over the life time of a building. In this research whole building ventilation and energy use during the summer months was investigated with building energy modelling. Opening characteristics were adjusted according to noise levels at the façade given by noise mapping. The effect of noise control strategies on ventilation and energy modelled with weather data representing the current day was compared with that representing the future according to the latest climate projections for UK.

INTRODUCTION

Sustainability is a wide ranging concept but at its core is a concern for the long term well being of the environment and the responsible use of natural resources. In this paper what this means for the built environment and its interrelationships with acoustics is investigated, some background to this will be introduced first.

In (Yu & Kang, 2005) a number of ways in which acoustics may affect the sustainability of the built environment are discussed. This included the consequences of higher density urban communities, natural means of noise control, building envelope design, acoustic materials and the impact of local power generation. The example presented of natural means of noise reduction is the introduction of vegetation into the urban area. Replacing geometrically reflecting boundaries with diffusely reflecting boundaries can significantly increase attenuation along a street length (Kang, 2002). In this way the strategic introduction of vegetation, particularly vegetation with dense foliage down to ground level (Attenborough, 2004) can provide noise reduction with the added benefit to aesthetic and environmental aspects.

Remedial treatments are often expensive and inefficient so simulation can be a useful tool to identify problems and optimize solutions. Noise mapping software was used to model power generation as a noise source in the case study presented in the work of (Yu & Kang, 2005). The propagation of wind turbine noise through hypothetical residential areas was modelled for a variety of land forms. It was found that various land forms can bring considerable SPL differences in terms of noise barrier effects of buildings and ground profile. The effect of turbine height was also investigated, when the height was increased from 10m to 46m, the SPL increase could be 10-20dB in far field.

Buildings and the urban area complex with many varied processes involved. Simulation can be a useful tool to deal with some of the complexity involved in for example natural ventilation. Natural ventilation strategies are difficult to implement for buildings in urban areas due to a number of reasons, such as lower wind speeds, higher temperatures due to the urban heat island effect, pollution and noise (Ghiaus et al., 2006). In their work street canyon situations were addressed with measurements of noise levels being taken outside the façade at different heights above street level. Relationships were then defined between street aspect ratio, height above street level and noise levels at which occupants might be motivated to close the windows. This demonstrated how the influence of noise on ventilation changes with position on the building façade.

The pressure differences that drive natural ventilation, wind and or buoyancy effects, are very weak, typically less than 10Pa. The easiest way to achieve the least restriction of a ventilation path is to open large areas of the façade. This can conflict with attempts to reduction noise ingress. External noise levels are often given as the reason for airconditioning buildings (Wilson & Nicol, 1994). Summertime over-heating risk could be an increasing problem for the future. Future performance analysis of case study buildings (Jentsch & Bahaj, 2008; Holmes & Hacker, 2007) suggested that with expected future temperature rises providing a comfortable summer time indoor environment without a heavy reliance on mechanical cooling will be one of the major challenges. Natural ventilation is a key part of summer time cooling strategy particular for buildings with low energy aspirations.

Various systems exist that reduce noise ingress whilst minimising the restriction of the ventilation path. Some examples of these include passive system that stagger glazing, employ absorbing liners or louvers and active systems (Kang & Zhemin, 2007; Oldham et al., 2005; Kang & Brocklesby, 2005).

The interrelationship between building envelope performance in terms of acoustics insulation and natural ventilation is focused on in (Barclay et al., 2010) noise mapping and building energy simulation was linked to quantify acoustic considerations in terms of natural ventilation and cooling energy use. As an extension to this the degree to which projected climatic changes effects these interrelationships is the subject of this investigation.

Some brief background to climate change will be covered in the next sections, including its relevance to the built environment and the modelling that the projections are based on.

Climate change

Climate change is an important issue for the built environment with the built environment responsible for approximately 40% of the UK energy consumption (Commission, 2005) and possibly over 50% of the UK's carbon emissions (Department for Environment, 2008). This area is therefore of vital importance in reducing the UK's climate emissions as the built environment is seem as a sector were potential for reductions is large. An overview of the various strategies for reducing energy consumption and emissions from buildings is given by among others (Clarke & Johnstone, 2008). This included strategies for improving the efficiency of old and new buildings, Future technology and design tools such as simulation. A more specific look at thermal comfort and energy can be found in (Holmes & Hacker, 2007) which concluded that sustainable design should take into account future performance.

One of the central purposes of a building is to provide a comfortable environment regardless of external conditions. Climate change will affect how easily this is achieved. This is the case both in terms of adaptation and mitigation. There are important connections for the built environment between adaptation and mitigation. For example one of the main problems for buildings under projected climate is an increase in overheating risk (Jentsch & Bahaj, 2008; Holmes & Hacker, 2007; Hacker & Holmes, 2005). Increasing the comfort cooling could be seen as a move to adapt to the future scenario but this could be damaging to mitigation efforts if this was done by increasing energy use and carbon emissions. In addition future climatic change is particularly relevant to the built environment due to the relatively long life time of buildings and the slow turnover of the buildings stock. Climate change projections are available for the coming decades and this is a timescale relevant to the built environment.

Climate change projections

The most comprehensive information about how climate change might affect the UK is given by UKCIP02 (Hulme & Jenkins, 2002) and most recently by UKCP09 (Murphy et al., 2009). These projections are based on mathematical models of the climate system known as global climate models. These attempts to represent the many processes and interactions that affect the climate. They have been developed over time and in UKCP09 the following is represented: Firstly the movement of the atmosphere plus the physical processes that occur in it, such as the formation of clouds and precipitation, and the passage of terrestrial and solar radiation through it. Secondly the movement and exchange of heat, momentum, salt and water vapour from the oceans. Thirdly the land which affects air flow over it, and the hydrological cycle at the surface and in the soil beneath it. Lastly the cryosphere; ice on land and on sea (Murphy et al., 2009).

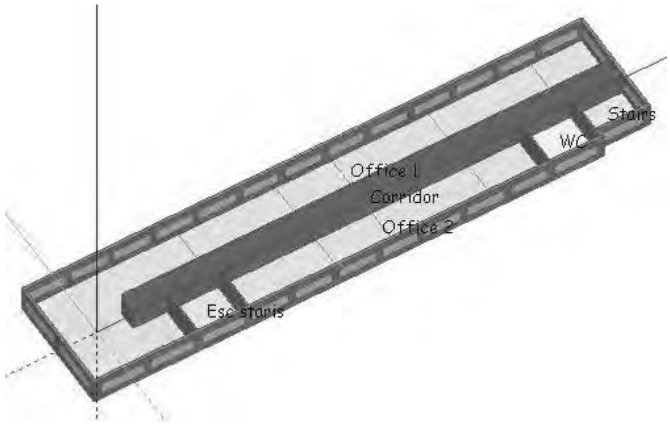

Figure 1. Floor plan of office building 1.

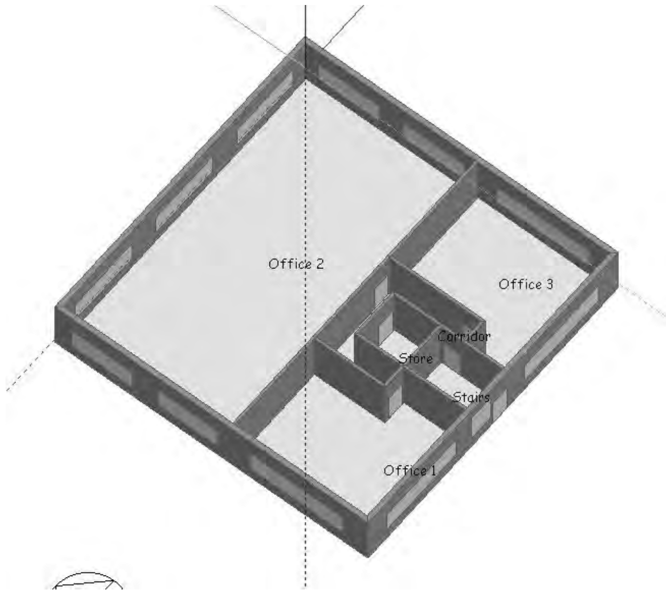

Figure 2. Floor plan of office building 2.

As well as increases in the number of processes represented in the models the increase in computational resources available to run these simulations has enabled finer spatial and temporal resolution of the models. This is illustrated by the improvement in horizontal resolution from 500km grid (IPCC, 1990) to 110km grid (IPCC, 2007) resolution of northern Europe.

Emission scenarios

The starting point for modelling the future behaviour of the climate is the generation of "emission scenarios" which are story lines describing possible future paths for the anthropogenic factors that affect the climate. In (Swart & Nakicenov, 2007) the IPCC Special report on emissions scenarios, six widely used key scenarios are presented. These scenarios use different assumptions about the demographic, economic and technological trends of the future to give a set of emission rates. Emission scenarios provided the radioactive forcing for the climate change predicted for the UK in UKCIP02 (Hulme & Jenkins, 2002) and in UKCP09 (Murphy et al., 2009).

Although the IPCC special report on emission scenarios does not assign probabilities to the different emission scenarios it should be noted that (Raupach et al., 2007) suggested that emission rates since 2000 have exceeded even the highest emissions scenario.

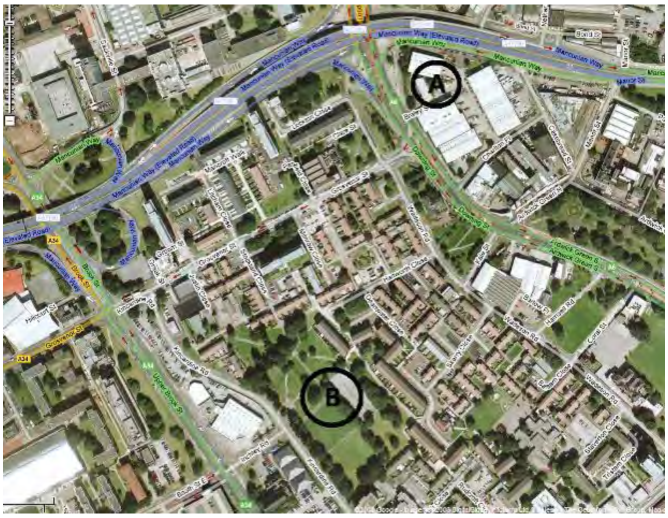

Figure 3. Area of Manchester used for noise mapping.Source: (Google maps, 2006).

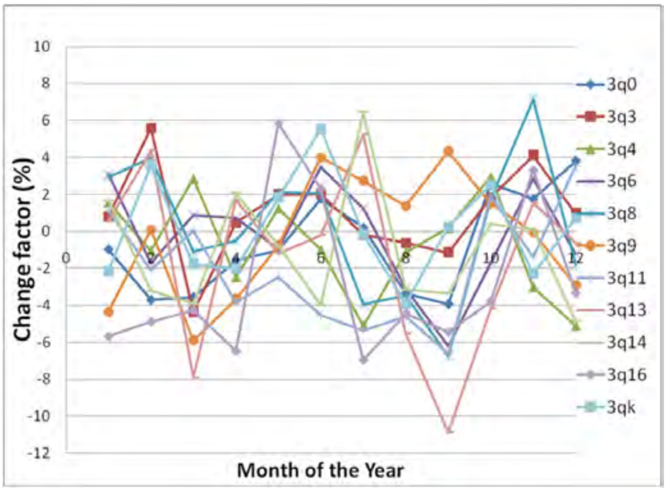

Figure 4. 2020 to 2080 change factors for Manchester wind speeds at each month of the year.

Downscaling

To get more detailed information about the climate for a particular part of the world such as the UK regional climate models (RCMs) can be used. These use the global model for the boundary conditions so that as fine a mesh as possible can be used for the region of interest. This enables better representation of the topography and importantly coastline morphology. This general approach of increasing the spatial and temporal resolution of global climate models is called downscaling.

To enable the evaluation of building performance in weather conditions expected in the future, predictions about the future need to be incorporated into weather data. Weather data used for building simulation is usually required at hourly temporal resolution. A review of methods to achieve this is given by (Guan, 2009).

Morphing or time series adjustment is the term given to a popular method of imposing the climate change predictions onto a chosen weather time series representing the current weather (Hacker et al., 2009). The change to the weather variable is imposed by either a shift or a stretch or both depending on which variable. This methodology was evaluated by comparing

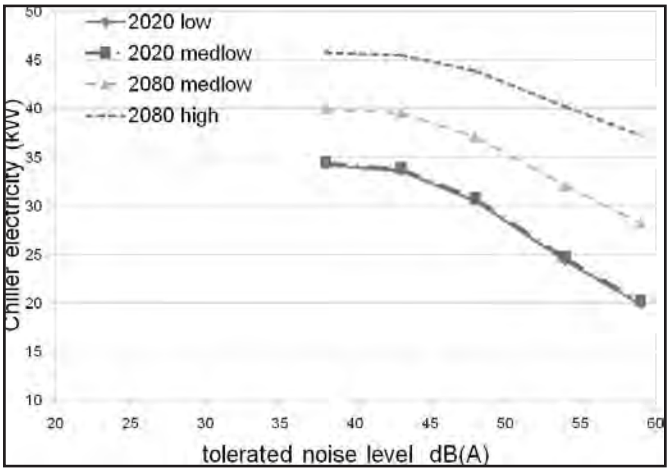

Figure 5. Building 2 in position A.

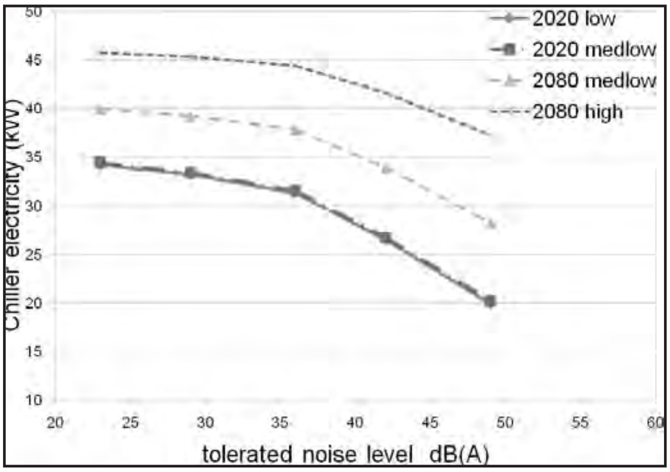

Figure 6. Building 2 in position B.

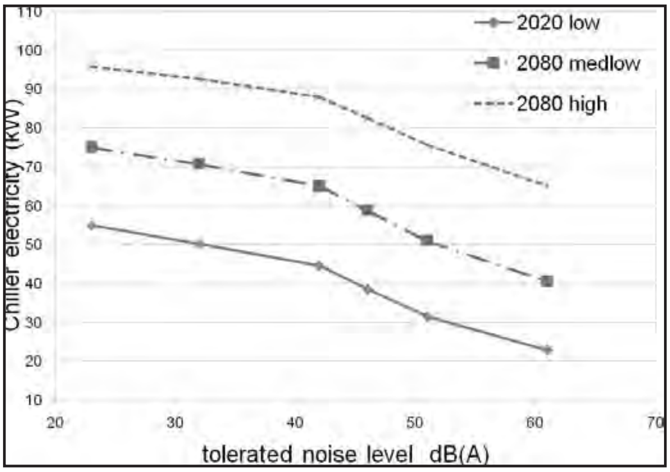

Figure 7. Building 1 in position B.

the heating degree day of morphed weather data to that given directly in UKCIP02 (Hulme & Jenkins, 2002). It was found that the heating degree days calculated corresponded well and this was thought to providing some confidence that this method was appropriate for producing future weather data (Belcher & Hacker, 2005). The method was used by the Chartered Institute of Building Services.

Engineers (CIBSE) who are the standard source of weather data for building evaluation in the UK. Climate change weather files for 14 locations in the UK are available (CIBSE, 2009) and this source of hourly weather data was used in this investigation.

METHODOLOGY

The method used here to quantify acoustic considerations in terms of ventilation rates and cooling energy use is similar to that employed previously (Barclay et al., 2010). Calculated noise levels at the façade of a building are used to determine how much the windows on that façade are opened.

The noise level that each window is exposed to is available from building evaluation calculations done with noise mapping software. The opening area created by the opening of a window is treated as a simple aperture in the façade of the building. Effective sound insulation of the façade is then treated as a function of the percentage of window that is opened. The approach was similar to that used in (Oldham et al., 2005; De Salis et al., 2002). This will also apply when various acoustic window arrangements are used (Kang & Zhemin, 2007; Oldham et al., 2005; Kang & Brocklesby, 2005). The accuracy of this method may be limited when openings are small and due to the assumption of frequency independence. The purpose here is to give relative relationships so these assumptions were considered initialy appropriate.

Between the maximum and minimum levels of noise ingress experienced when all windows are either opened to their maximum or fully closed, a number of tolerated noise levels are set. The window opening at all points on the façade are adjusted so that noise ingress is as close to these tolerated noise levels as possible. The intermediate tolerated noise levels correspond to levels where a mixture of different opening areas occurs over the façade of the building depending on its noise exposure. A separate building energy calculation is carried out for each tolerated noise level. These are run over a summer time period to quantify the effectiveness of natural ventilation cooling.

For this work the whole building level air flow patterns and cooling energy use was modelled for an extended summer time period. DesignBuilder/EnergyPlus software (DesignBuilder Software Ltd, 2009) was used for this. The DesignBuilder user interface uses EnergyPlus as its simulation engine. EnergyPlus is a building energy calculation tool that has been widely used and tested (Henninger & Witte, 2009). It provides a heat balance based solution to the heating and cooling loads required to maintain a building's thermal conditions. Various modules link into this core calculation to enable the representation of the building and its processes. This includes the airflow network module that is of particular importance in this work.

The approach used in this study was to use the cooling energy output from mixed mode buildings during a June to August time period. The June to August time period is represented by typical hourly weather data covering these months of the year. In mixed mode buildings internal comfort conditions are primarily maintained by natural ventilation. When this is inadequate active cooling is introduced (DesignBuilder Software Ltd, 2009). The cooling energy used by the air handling unit will therefore be used to indicate the extent to which the acoustic environment has affected the natural ventilation potential. A floor plan for the two buildings used in this work, buildings 1 and 2, are shown in Figures 1 and 2. Both buildings are representative offices buildings rather than examples of sustainable best practice.

The mapping of road traffic noise for this study was completed using the software CadnaA (DataKustik GmbH, 2004). The area mapped in Manchester is shown in Figure 3, the two positions of the example buildings are marked A and B. The building position A was next to the motorway and was in contrast to a less noisy position B. The positions were chosen due to their relatively different noise exposure and to minimise the inaccuracies due to significant reflections.

Climate change weather data

The first set of results are produced with weather data incorporating climate change projections from UKCIP02 these are weather files provided by CIBSE (CIBSE, 2009). The weather files used described typical weather conditions for Manchester with the addition of monthly climate change. Information about their use and Background are given in Hacker et al., 2009. The so called morphing method is used to produce this data and a description of the algorithm is given below. Morphing incorporates the climate change projections into a current weather data time series by one of the following three processes depending on the variable (Jentsch & Bahaj, 2008).

- 1. A 'shift' which adds the UKCIP02 predicted absolute monthly mean change (Belcher & Hacker, 2005)

  $$x = x_0 + \Delta x_m \qquad (1)$$

  where x is the future climate variable, x_0 the original present day variable and Δx_m the absolute monthly change according to UKCIP02. This method is for atmospheric pressure.

- 2. A 'linear stretch' of hourly weather data parameter by scaling it with the UKCIP02 predicted relative monthly mean change (Belcher & Hacker, 2005)

  $$x = a_m x_0 \qquad (2)$$

  where a_m is the fractional monthly change according to UKCIP02. This method is used for wind speed.

- 3. A combination of a 'shift' and a 'stretch'. An hourly weather data parameter is 'shifted' by adding the UKCIP02 predicted absolute monthly mean change and 'stretched' by the monthly diurnal variation of this parameter (Belcher & Hacker, 2005):

  $$x = x_0 + \Delta x_m + a_m(x_0 - x_{0m}) \qquad (3)$$

  where x_0 is the monthly mean related to the m variable x_0, and a_m is the ratio of the monthly variances of Δx_m and x_0. This method is used for dry bulb temperature. It uses the UKCIP02 predictions for the monthly change of the diurnal mean, minimum and maximum dry bulb temperatures in order to include predicted variations of the diurnal cycle.

Weather files were available for the 2020's, 2050's and 2080's. The 2020's were assumed to represent essentially the present day as this time slice covers the 30 year time period of 2010 – 2030. Some climate change has been incorporated into this first time slice as the base weather files are drawn from the 1982 – 2004 period but these initial climate change factors are small compared to later changes. This can be seen from the results, were the low and medium low scenarios are essentially the same for the 2020's.

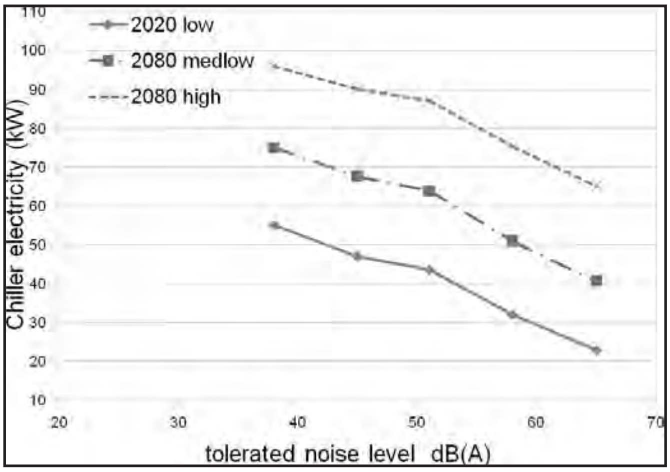

Figure 8. Building 1 in position A.

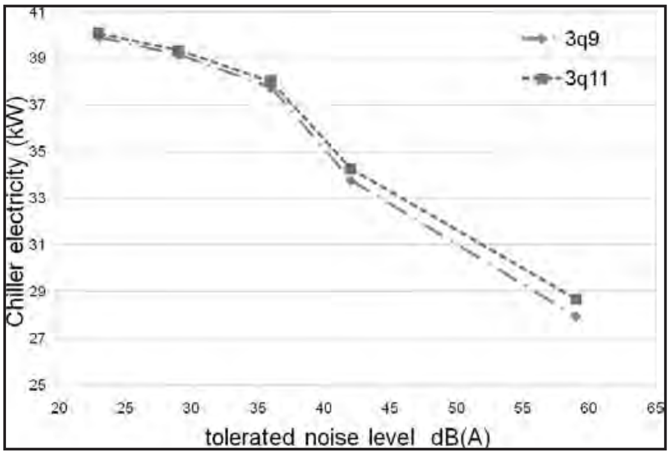

Figure 9. Building 2 in position B with 2080 medium low weather file. Two variants of the 11 member RCM used for wind speed are indicated in the legend.

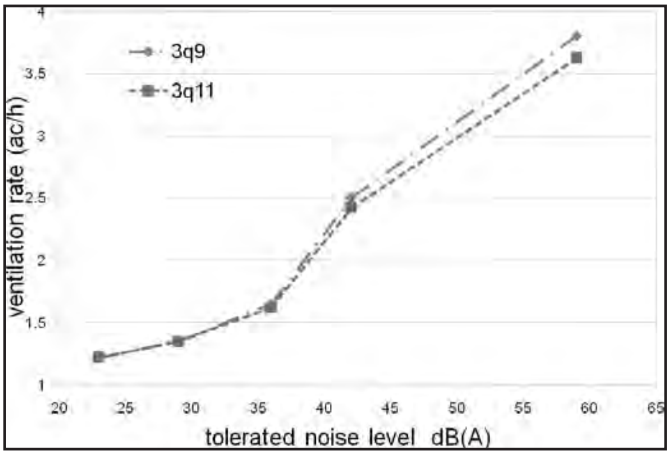

Figure 10. Building 2 in position B with 2080 medium low weather file. Two variants of the 11 member RCM used for wind speed are indicated in the legend.

UKCP09

Producing projections for something as complex as the earth's climate system is an exceptionally challenging undertaking. There are many sources of uncertainty that will affect the projections. These include structural error relating to the scheme used to represent climate processes and also the choice of value for parameters within this scheme.

In UKCP09 which is the latest climate change projections for the UK a probabilistic approach was adopted (Murphy et al., 2009). Many variant of climate models where used to sample areas of uncertainty in the representation of key physical and biogeochemical processes of the climate system. The probabilistic projections then presented the information so that the degree to which the available evidence supports a certain climate outcome can be seen.

The evidence assembled included an ensemble of climate models from the met office and also from other modelling centres from around the world. This is a similar approach to that adopted by for example the ensembles project (Hewitt & Griggs, 2004) but with a more systematic sampling of modelling uncertainties.

In UKCP09 probabilistic projections could not be provided for some variables, these were soil moisture, latent heat flux, snowfall rate and wind speed. Wind speed is particularly relevant to this study as it is a key driver of natural ventilation. The lack of wind in the probabilistic projections was partly due to this variable being unavailable from some climate models. Where it is available changes in wind speed show a large degree of variation and little sign of a systematic change for the future.

The extent to which the uncertainties in future wind behaviour will affect natural ventilation rates and therefore the degree to which this might translates to changes in acoustic insulation of buildings façades is looked at in this work.

11 member RCM

One source of information about the future behaviour of wind is the 11 member RCM. This made up part of the ensemble used to produce UKCP09. The aim here is to undertake an initial investigation of the sensitivity of the acoustic natural ventilation relationships to the internal modelled variability of the wind. As there are no probabilistic projections for wind speed in UKCP09 it is not possible to check where in the probability distribution each RCM projection for this variable lies. It is therefore not possible to say whether projections from one of the 11 RCM variants, is more likely than the other. In this study the sensitivity of the natural ventilation and acoustic relationship is tested to changes that represent the upper and lower bounds available from the 11 member RCM data set.

The RCM output was accessed via the LINK project (UK Meteorological Office, 2009). Figure 4 shows the variability of projections for change in wind speed. These change factors were calculated from the 11 Member RCM output which was made up of continuous daily time series from 1950 to 2099. The legend indicates the 11 variants of the HADRM3 climate model.

As can be seen there is significant variation in projection of change in wind speed. For an initial investigation of the sensitivity of natural ventilation to these variations in change in wind speed two sets of change factors were chosen that represented the upper and lower bounds of wind change factors for the months considered in the building energy simulation. These were variants 3q9 and 3q11.

As is standard practice (Hulme & Jenkins, 2002), the continuous absolute daily wind speed values were converted to relative change factors between the 30 year time periods. In this case it involved comparing the averaged wind speed for each month over the 2020's time period with that over the 2080's time period. These monthly change factors were then applied to the hourly wind time series according to the method described earlier using equation (2). This was done for the two HADRM3 variants 3q9 and 3q11 using the same initial hourly weather file

Continued on page 12...

Sound Snippets: Listening to the Brain

Eavesdroping by Brainwave

Neuroscientists may one day be able to hear the imagined speech of a patient unable to speak due to stroke or paralysis, according to researchers at the University of California, Berkeley.

The scientists have reconstructed frequency spectrograms of spoken words by two separate models based solely on recorded temporal lobe activity in a volunteer subject. The words are more or less recognizable, even though the model had never encountered these specific words before.

These scientists have succeeded in decoding electrical activity in the brain's temporal lobe – the seat of the auditory system – as a person listens to normal conversation. Based on this correlation between sound and brain activity, they then were able to predict the words the person had heard solely from the temporal lobe activity.

"This research is based on sounds a person actually hears, but to use it for reconstructing imagined conversations, these principles would have to apply to someone's internal verbalizations," cautioned first author Brian N. Pasley, a post-doctoral researcher in the center. "There is some evidence that hearing the sound and imagining the sound activate similar areas of the brain. If you can understand the relationship well enough between the brain recordings and sound, you could either synthesize the actual sound a person is thinking, or just write out the words with a type of interface device."

Pasley and his colleagues enlisted the help of people undergoing brain surgery to determine the location of intractable seizures so that the area can be removed in a second surgery. Neurosurgeons typically cut a hole in the skull and safely place electrodes on the brain surface or cortex – in this case, up to 256 electrodes covering the temporal lobe – to record activity over a period of a week to pinpoint the seizures. For this study, 15 neurosurgical patients volunteered to participate.

Pasley visited each person in the hospital to record the brain activity detected by the electrodes as they heard 5-10 minutes of conversation. Pasley used this data to reconstruct and play back the sounds the patients heard. He was able to do this because there is evidence that the brain breaks down sound into its component acoustic frequencies – for example, between a low of about 1 Hertz (cycles per second) to a high of about 8,000 Hertz –that are important for speech sounds.

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Continued from page 10...

and resulted in two weather files for the 2080's. These two files were the same except for the description of wind speed. They represented the upper and lower bounds of change in wind speed taken from the 11 member RCM.

The emissions scenarios used are somewhat different in the two generations of climate models. Medium low B2 and medium high A2 were used in UKCIP02 for the middle emission scenarios. For the 11 member RCM, the emission scenario medium A1B is used. Pattern scaling factor are often used to convert changes between emission scenarios. For this case it does not seem appropriate due to the lack of a steady trend in wind speed.

This method is more appropriate for other variables such as temperature. Medium low B2 and medium A1B were the closest in terms of CO_2 concentration and total radiative forcing (Swart & Nakicenov, 2007). Therefore 11 member RCM change factors for the wind were applied to the wind speeds from the CIBSE medium low weather file. This was deemed to be appropriate here as the purpose is to look at the impact of variability in change in wind speed on the natural ventilation rate.

RESULTS

The first set of results, Figures 5 to 8, compare different future time slices and emission scenarios. Results for low, medium low and high emission scenarios are plotted for the 2020's and 2080's. Average chiller electricity use by the air handling unit during occupied hours is plotted against tolerated internal noise level.

The results are displayed from minimum chiller use corresponding to the situation where all windows are opened and maximum chiller use corresponding to the situation where windows are sealed. These end points represent the limits of this investigation. The points in between sample the possible tolerated internal noise levels that represent partial opening of the façade. In a sense the tolerated noise level indicates the level of opening of the façade. Larger tolerated noise levels indicate larger opening of the building façade.

Initial changes in climate appear to be slight compared with those in the 2080's. This can be seen from the results, were the low and medium low scenarios are essentially the same for the 2020's.

Generally the results show an increase in chiller energy use as warming due to climate change is introduced. This is what would be expected. It also illustrates how maintaining summer time thermal comfort will increase with the severity of climate change. This corresponds with previous work for example (Jentsch & Bahaj, 2008).

The benefit of introducing noise mitigation measures over the whole building might be estimated by considering the natural ventilation rates equivalent to a higher noise tolerance. The relationships between tolerated noise level and cooling energy requirements are consistent with the results without climate change weather data. This can be seen in the general shape of the graphs with different climate change projections, staying relatively constant. For example with building 2 initial opening of the façade is less effective for cooling relative to a larger increase in noise ingress. This is the case for building 2 in both positions but most markedly in position A.

For building 2 as the severity of climate change increases there is a flattening of the curve representing the acoustic ventilation relationship. This indicates opening the façade becomes less effective in contributing to the cooling of the building. This could be due to the higher external air temperatures under future scenarios decreasing the cooling effect of the introduction of outside air. This effect is not so apparent for building 1.

The second set of results, Figures 9 and 10, show the impact of variability in wind speed predictions on the cooling requirements and natural ventilation rates of building 2. Both chiller electricity and ventilation rate quantities are average occupied values over the summer period investigated. The weather data used for both these sets of building simulations were CIBSE 2080's medium -low files for Manchester. The only change in the weather files used for the results below is the change in wind speed between the 2020's and 2080's, these are taken from the two variants of the 11 Member RCM, 3q9 and 3q11. The ventilation rate given in Figure 10 is the average occupied fresh air introduced into the building given in air exchanges per hour.

The different predictions in change in wind speed appear to have a relatively minor effect on ventilation rate for this building and this summer time period. The influence of the change in wind speed increases as the façade is opened.

DISCUSSION

The results suggest that providing a comfortable thermal and acoustic environment could become more strained in the future according to the projected temperature changes. Initial changes representing the 2020's are slight but these increase with varying severity for the 2080's, depending on the emission scenario.

The difference between the medium low and high scenarios during the 2080's indicates the benefits of emission reduction efforts. Also indicated in these results by the still significant increase in cooling energy for the medium low 2080's scenario is that even with emission reductions a certain level of climate change seems likely to occur in the future due to historic emissions and the climate systems thermal inertia.

Differences in the sensitivity of different buildings to climate change are indicated by more flattening of the results for building 2 than for building 1 as the severity of climate change increases.

The influence of using the two different variants of the 11 members RCM for the predictions of wind speed is relatively slight. This suggests that the uncertainty about wind speed predictions might not be a major factor for building evaluation. This could aid a more complete use of the UKCP09 projections as wind speed was not included in these projections.

While the changes in noise/sound environment in the future are not within the scope of this paper, it is certainly important to integrate such changes in future studies, for example, the effects by the development of quiet vehicles.

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Can We Save the Cost of Building Anechoic Chambers?

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A paper previously presented at ISSA 2010, 29-31 August 2010, Auckland

Abstract

This work looks at using coherent averaging to measure transducer responses with high precision without using an anechoic chamber. The use of coherent averaging in building acoustics is familiar to those who use deterministic signals (e.g.. MLS) as the basis for their measurements. The primary concern is to achieve a sufficient signal to noise ratio so that results relate to the system being measured rather than unrelated noises. This technique requires conditions to be unchanging with time but coherent averaging can be used to advantage in situations where conditions are purposefully rendered time-varying. It is possible to select or reject contributions to a measurement by choosing some transmission paths to be time invariant and making others – ones we wish to remove from the measurement - varying. In previous work we have shown that by rotating a loudspeaker-microphone couple in a highly reverberant room we can measure the loudspeaker (or microphone) transfer function with the same accuracy achievable in an anechoic chamber by using this technique to suppress the reverberation in the room. In this more recent work we consider whether any particular deterministic signal – e.g. A log 'chirp' – is more advantageous for this application and whether the availability of the new soundfield-type microphones offers an improved way for making such measurements.

INTRODUCTION

Addressing the theme of the conference from the point of view of the Acoustics Testing Service (ATS) of the University of Auckland we consider that one of the largest risks to our continued existence (i.e. our sustainability) – and presumably that of similar testing services in other parts of the world - is the cost of our facilities. In the case of the ATS the maintenance and rental charges for our suite of reverberation and anechoic chambers comprise the largest items of the annual budget. The reverberation chambers are in regular demand for insulation, sound power and absorption measurements whereas in comparison the large anechoic room is little used commercially.

Building on work we have reported earlier [1] we have been exploring alternative techniques for obtaining the information traditionally measured in anechoic chambers. If these are satisfactory they will obviate the expense and resources required for building and maintaining these major items of acoustical equipment.

USES FOR ANECHOIC CHAMBERS

International and national standards show the uses which involve anechoic environments [e.g. 2, 3] for formal measurements. These are –

1. Transducer frequency responses and calibration
2. Transducer directionality
3. Sound power determinations.

In addition they are often used for:

1. Low noise emission measurements
2. Noise source identification in complex machinery or engines
3. Subjective experiments where highly controlled sound fields are required.

Finally, in our experience, the anechoic chamber can be a valuable teaching tool for students in acoustics and related courses. If we were to dispense with anechoic chambers alternatives for these uses would be desirable. Preferably these alternatives would only require other readily available spaces or environments.

MEANING OF ANECHOIC.

The word anechoic is quite clearly based on the word 'echo' to which the prefix 'an' meaning 'without' has been added. 'Echo' seems to have been adopted into the English language as early as the 15th century and originated from the Greek myth of the nymph (i.e. a minor divinity who is eventually mortal) Echo. Classical scholars are divided about whether Echo was named because she ultimately existed only through the sounds she could make (Note: echo derives from ekhe = sound or noise) or because – in an alternative version of the myth – she was fated only to be able to speak by repeating what was said to her

So 'anechoic' could be argued to mean either 'without any sound' or 'without audible repetition of sounds'.

Lay understanding of echo is an audible repeat of a sound separated in time from the original sound and therefore might support the latter meaning. However, typical anechoic chambers can be seen to address both meanings in that

1. Their reflection suppressing lining removes all audible repetitions, and
2. Their highly insulating wall construction removes all audible external sound.

ALTERNATIVES TO ANECHOIC CHAMBER MEASUREMENTS

1. Sound Power measurement in a reverberation chamber [4] or using an intensity probe [5] present more attractive alternatives to the time consuming series of measures over an enclosing surface as required for an anechoic determination of sound power.
2. Low noise measurements do not, in principle, require an anechoic chamber and any well-insulated space can substitute. Similarly, noise source identification can be carried out in non-anechoic environments by intensity measurement or using an acoustic camera [for example 6]
3. Sound fields for subjective experiments are arguably best controlled in an anechoic chamber but more and more we are realising that other factors (especially vision) strongly mediate reactions to sounds [7] so that results obtained in an anechoic chamber can be strongly biased or even artefactual. Thus more realistic environments for subjective assessments are to be preferred.

The remaining major use for anechoic chambers – that of transducer measurement and calibration – is what our present work addresses. The aim is to demonstrate that an alternative is viable which can be undertaken almost anywhere including highly reverberant rooms.

Whilst this might indicate that anechoic chambers are nor needed for objective sound measurements it must be admitted that continuing access to an anechoic chamber for students to experience this environment, the behaviour of sounds, and the attendant subjective effects provides a teaching tool of almost inestimable value!

TRANSDUCER RESPONSE MEASUREMENT

We propose that coherent averaging can be used to remove the reflected sound in an ordinary room by purposefully introducing time-variance in the room reverberant field that we want to discriminate against. The technique we propose leaves the direct sound unaffected by the variation.

Method

The traditional methods for measuring responses of microphones and loudspeakers require either an anechoic chamber for a quasi-steady state measurement - or windowing of a transient measurement (obtained by convolution of the results of a deterministic signal measurement e.g. MLS or chirp with the original source signal).

Since anechoic chambers are expensive and relatively rare, much use is made of the latter technique and measurements are therefore made in normal, reasonably reverberant rooms. Trace (II) in Figure 3(a) is a typical example of the impulse response of a loudspeaker obtained in proximity to a reflecting surface. The first and largest spike represents the direct sound from the loudspeaker. To obtain the loudspeaker response free from the distorting effects of room reflections we must window out this direct sound. The arrival time of the first reflection puts a limit to the width of the time window we can use. If this is smaller than the length of the impulse response of the loudspeaker we are not able to measure the response correctly, and the frequency resolution for our analysis of the response is limited.

These limitations may in principle be avoided by making measurements in an ordinary room but employing a coherent averaging technique where the repeated measurements have been made in such a way that the direct sound between source and transducer remains the same but the reflected sound is changed so as to be uncorrelated each time. For example in the case of the single reflecting surface we can use the method illustrated in Figure 1.

The loudspeaker and microphone are mounted on a turntable so that they are fixed relative to each other. The turntable is rotated whilst coherent averaging of MLS periods is carried out. The rotation varies the travel time of the unwanted reflection whilst keeping the direct path time-invariant.

The variation happening during a single MLS period has the

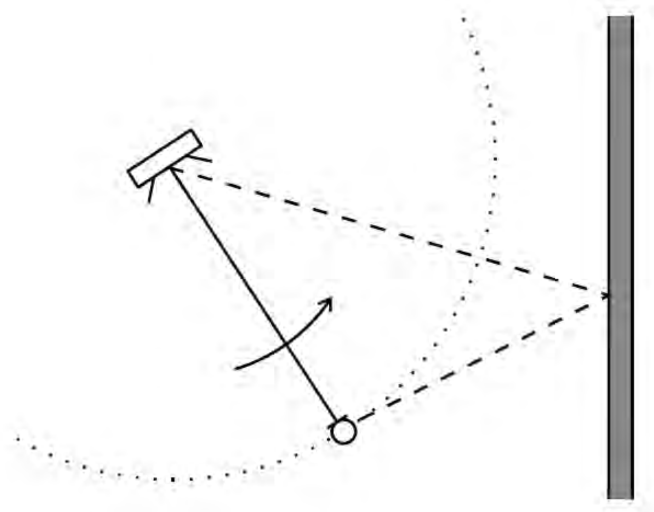

Figure 1. Measurement set-up with rotating transducers for reflection suppression by averaging

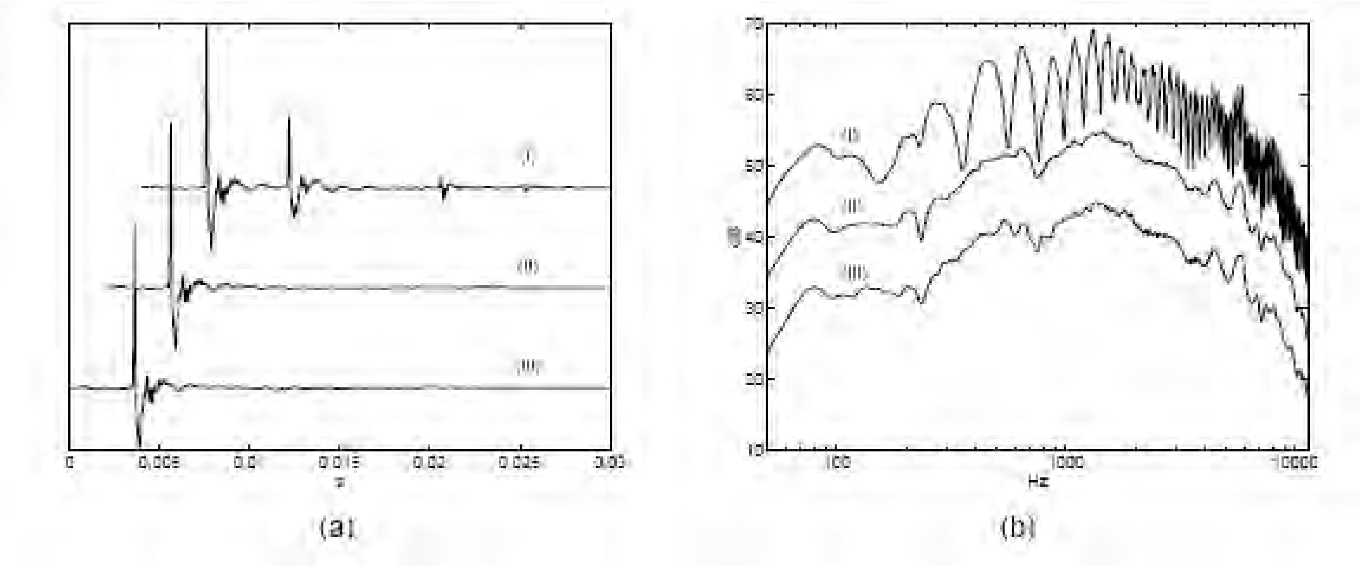

Figure 2. The responses of a loudspeaker found from MLS responses: (I) near a reflecting surface, (II) near a reflecting surface but with the loudspeaker and microphone rotating, and (III) in an anechoic chamber.

effect of transforming some of the reflected energy into a time-spread, frequency dependent noise-like component, which can be reduced by coherent averaging [8]. In addition, the responses from different periods will be different, and the reflected energy will behave more or less incoherently during averaging.

Therefore, when measuring in an ordinary room, if the plane of the rotation is skewed with respect to all significantly planar surfaces of the room, the contribution of the room reflections is made incoherent and a high direct-to-reverberant energy ratio can be built up by averaging a suitable number of periods of the signal.

Figure 2(a) and (b) shows how the true response of a loudspeaker is successfully extracted using this technique, the averaged response was found using 14 MLS periods of 5.7s each, during two full revolutions of the turntable. In principle this will also work with a single period if the length of the sequence is sufficiently long. The main requirement is that the path length variation of the major reflections are made sufficiently large, at least on the order of the wavelength for the relevant bandwidth.

Theory

For each location of the source and of the receiver, the impulse response is different. The impulse response is composed of:

- Direct sound
- Early reflections from the walls and objects in the room
- Reverberation i.e. where the reflection density is so high it is impossible to distinguish the different contributions.

Many measurements are made in various places in the room. By averaging them, we will build up the ratio DIRECT to REVERBERANT sound ratio (DRR).

In an anechoic room the impulse response, $h(k)$, is simply the direct sound component. In the "reverberant" room, the room produces an additional response $r(k)$ which is different for each measurement position (Figure 3).

If an average is made of N measurements, the pressure measured by the microphone becomes:

$$h_{av}(k) = h(k) + \frac{1}{N}\sum_{n=1}^{N} r_n(k) \approx h(k) \qquad (1)$$

Below the mixing time, t_{mix} $\sqrt{V}$ (V = the volume of the room), direct sound is summed coherently and the early reflections, will sum incoherently. Above the mixing time, each impulse response can be approximated as a noise sequence $x_n(k)$ with an exponential envelop.

$$r_n(k) \approx e^{-ak} x_n(k) \qquad (2)$$

The corresponding DRR in dB becomes:

$$DRR = 10\log\left(\frac{\left\langle \left|h(k)\right|^2 \right\rangle}{\left\langle \left|\frac{1}{N}\sum_{n=1}^{N} r_n(k)\right|^2 \right\rangle}\right) \qquad (3)$$

where <> indicates a time average.

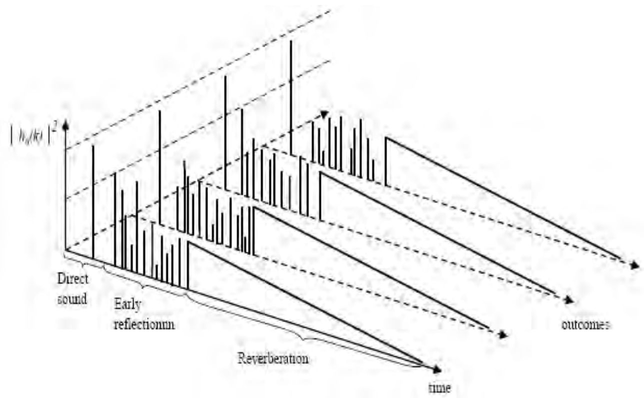

Figure 3: Examples of successive signals received by the microphone

Our task is now to predict the value of *N* that will be required to increase this to a value high enough, e.g. 10 dB, so that the measurement result can be considered to consist only of direct sound.

We can investigate this analytically for simple geometries (e.g. a rectangular room) by a standard Green's functions approach or, for more general geometries, by an image source model. But in all cases simplifications and approximations are required if we are to make predictions which can be tested against practical measurements. In the limit we might, for example, assume that the room satisfies the conditions of a Sabine space so we may regard the reverberant field (which includes the early reflections) as uniform throughout the volume. Then if the room has a total absorption, A, and an average surface absorption coefficient, α, a source with a sound power output, W, will create a reverberant sound with an equivalent intensity, I_{rev}, given by:

$$I_{rev} = 4W(1-\alpha)/A \quad (4)$$

The direct sound from the source - if it has a directivity factor, Q, in the direction of the receiver a distance, r, away - will create a direct sound intensity, I_{dir}, given by

$$I_{dir} = QW/4\pi r^2 \quad (5)$$

In this case the DRR reduces to:

$$DRR = 10\log\{QA/16\pi r^2(1-\alpha)\} \quad (6)$$

Alternatively since we usually describe a room in terms of its reverberation time, T, we can use the fact that for a room of volume, V,

$$T = 0.16V(1-\alpha)/A \quad (7)$$

to write:

$$DRR = 10\log\{QV/100\pi r^2 T\} \quad (8)$$

This indicates that in order to have the direct sound component at least 10 dB above the reverberant sound the measurement process has to improve the DRR by an amount

$$\text{Gain required} = 10\log\{1000\pi r^2 T/QV\} \quad (9)$$

If we assume that each time we repeat the signal the transducers have moved to a new position such that the reverberant sound components are uncorrelated, the number, *N*, of repeats required – since the gain is 10logN – is:

$$N = 1000\pi r^2 T/QV \quad (10)$$

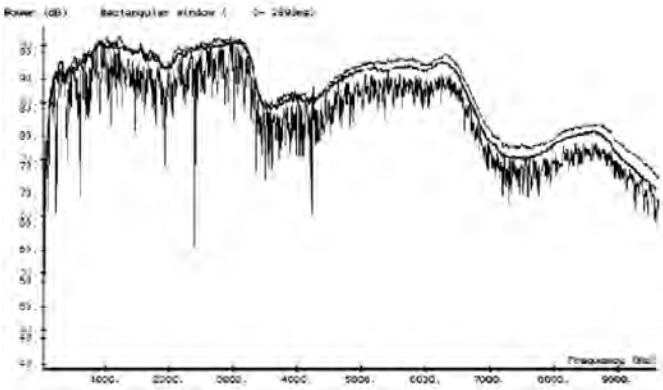

Figure 4. An example of how the proposed technique of coherent averaging an rotation of the source and microphone in a reverberant room can remove the reverberant sound component. Bottom trace is the stationary response, the middle trace is the rotated response and the top trace shows the anechoic chamber measurement of the response.

In the case of an omnidirectional source measured at a microphone distance of 1m, in a room of $50m^3$ and RT of 1s, this would imply that we need to repeat the signal a minimum of 65 times.

Using a source and microphone rotated together on a turntable the number of circles, S, ofdiameter, d, to be swept is given by:

$$S = N/P \text{ where } P = \pi(\sin^{-1}(\lambda/8d))^{-1} \quad (11)$$

Practical Considerations

In practice the main difficulties are created by 1) the need to move the transducers throughout the room without changing their separation or orientation with respect to one another, and 2) the need to have sufficiently different positions that the reverberant components are uncorrelated.

Since we have no guarantee that in a particular measurement arrangement the unwanted components will present as incoherent we need to incorporate a check that the averaging process truly does produce a slower accumulation of unwanted compo nents compared with the wanted component. A "2 bin" approach can be used in which alternate sequence responses are accumulated in different bins which can then be compared both for estimates of the suppression of the incoherent signal in different parts of the spectrum. This then allows an estimate the measurement effort required to achieve a selected DRR given any room geometry and arbitrary transducer positions in the room.

These matters were addressed further in the conference presentation, but experience with using the technique has demonstrated that 1) rotation of the transducers is a feasible basis for the required movement and 2) that due to the larger correlation lengths in rooms at low frequencies it is at these frequencies that the room effect is more difficult to remove.

So far measurements have been made using MLS as the source signal but in principle any deterministic signal having an appropriate spectrum could be used. However, we have been investigating other time spread signals [e.g. 9, 10] which are more advantageous than others for system response measurements depending on the conditions of measurement (e.g. nonlinearity in the equipment, stationarity of conditions). Therefore consideration of the relative merits of these different signals for this application is part of our present work.

Recently affordable soundfield-type microphones have become available comprising multiple capsules able to decompose multi-path room sound fields. These might offer the possibility of reducing the measurement effort by reducing the number of sweeps required to achieve a desired DRR.

CONCLUSION

It has been argued that most of the measurements for which anechoic chambers have been used can be made in other environments and therefore there is a reduced need for building and maintaining anechoic chambers.

The need for an anechoic environment for measuring and calibrating transducers has for some time been obviated to some extent by the use of measuring impulse responses and then removing the reflections with a time window but this leads to a limitation on the resolution in the measurement and an associated low frequency limit.

This work has focussed on demonstrating the feasibility of making measurements of transducer responses in ordinary reverberant rooms without the need for a time windowing approach – and hence avoiding the limitations of such an approach

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Rap Powers Medical Sensor

The driving bass rhythm of rap music can be harnessed to power a new type of miniature medical sensor designed to be implanted in the body.

The heart of the sensor is a vibrating cantilever, a thin beam attached at one end like a miniature diving board. Music within a certain range of frequencies, from 200-500 Hertz, causes the cantilever to vibrate, generating electricity and storing a charge in a capacitor, said Babak Ziaie, a Purdue University professor of electrical, computer and biomedical engineering.

When the frequency falls outside of the proper range, the cantilever stops vibrating, automatically sending the electrical charge to the sensor, which takes a pressure reading and transmits data as radio signals. Because the frequency is continually changing according to the rhythm of a musical composition, the sensor can be induced to repeatedly alternate intervals of storing charge and transmitting data.

"You would only need to do this for a couple of minutes every hour or so to monitor either blood pressure or pressure of urine in the bladder," Ziaie said. "It doesn't take long to do the measurement."

The device is an example of a microelectromechanical system, or MEMS, and was created in the Birck Nanotechnology Center at Purdue University. The cantilever beam is made from a ceramic material called lead zirconate titanate, or PZT, which is piezoelectric, meaning it generates electricity when compressed. The sensor is about 2 centimeters long. Researchers tested the device in a water-filled balloon.

A receiver that picks up the data from the sensor could be placed several inches from the patient. Researchers experimented with four types of music: rap, blues, jazz and rock. "Rap is the best because it contains a lot of low frequency sound, notably the bass," Ziaie said.

The sensor is capable of monitoring pressure in the urinary bladder and in the sack of a blood vessel damaged by an aneurism. This technology could be used in a system for treating incontinence in people with paralysis by checking bladder pressure and stimulating the spinal cord to close the sphincter that controls urine flow from the bladder. "A wireless implantable device could be inserted and left in place, allowing the patient to go home while the pressure is monitored," Ziaie said.

The complete findings are detailed in the following conference paper: A. Kim, T. Maleki, and B. Ziaie "A Novel Electromechanical Interrogation Scheme For Implantable Passive Transponders" The 25th International Conference on Micro Electro Mechanical Systems, Paris, France, 29 Jan - 2 Feb 2012

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World's Tiniest Ear

Physicists at the Nanosystems Initiative Munich (NIM) have recently managed to detect sound waves at minuscule length scales. Their nanoear is a single gold nanoparticle that is kept in a state of levitation by a laser beam. Upon weak acoustic excitation the particle oscillates parallel to the direction of sound propagation. The nanoear is capable of detecting sound levels of approximately -60 dB. Thus, it is about a million times more sensitive than the hearing threshold of the human ear, which by convention is set at 0 dB.

This new method opens a new world to scientists: for the first time, otherwise imperceptibly weak motions – minuscule sound waves – can be visualized. The scientists developed the nanoear in two stages. "First, we validated the basic principle using a relatively strong sound source" group leader Andrey Lutich explains. "In the second step we were able to detect significantly weaker acoustic excitations." The main element in both cases is a gold nanoparticle, 60 nm in diameter, which is kept suspended by a so-called optical trap using a red laser. Each of the experiments was done in a small water drop on a cover slide.

In the first case, a needle serves as a sound source. It is glued onto a loudspeaker membrane and emits acoustic waves towards the trapped gold particle. The scientists successfully detected the oscillations of the trapped particle optically using a dark-field microscope and an ordinary digital camera. The recorded videos clearly showed the particle oscillating parallel to the propagation direction of the sound waves.

In a second step, the physicists used the a nanoprinting method to fix a small number of gold particles on the cover slide. These particles are heated periodically using a green laser. As a result they emit very weak sound waves towards the single levitating gold nanoparticle. The interaction between the sound waves and the trapped particle is very weak. Therefore, the displacement of the particle cannot be detected directly with available optical methods.

The physicists showed that the frequency of the sound source is clearly enhanced in the measured Fourier spectrum. Control experiments in which the sound source was driven at varying frequencies confirmed this observation and the high sensitivity of the nanoear.

"With our nanoear, we have developed a nano-microphone that allows us to get closer than ever to microscopic objects" Alexander Ohlinger explains. "By observing the oscillations of a single gold nanoparticle, tiny movements can be detected." In this way, the nanoear could yield important information on the minute motions of cells, cell organelles or artificial microscopic objects. Additionally, no high-end devices are necessary as only well-established methods are used.

© Adapted from "Optically Trapped Gold Nanoparticle Enables Listening at the Microscale." A. Ohlinger, A. Deak, A. A. Lutich, and J. Feldmann. Phys. Rev. Lett. 108, 018101 (2012) ¶

Frequency Behaviour of Basic Floor Structures

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Abstract

In order to obtain reliable estimates of the impact sound insulation between rooms, it is necessary to know the acoustic performance of each element composing the floors. The contribution of the flanking transmissions, the attenuation of floating floors and the weighted normalized impact sound pressure level of the basic structure need to be determined in order to apply the simplified calculation method according to the EN ISO 12354-2 standard. With the aim of verifying the range of validity of the calculation method proposed by the EN ISO 12354-2 standard for typical basic beam floor structures, a research based on on-site measurements was conducted. This paper provides an analysis in terms of spectrum trend, predicted average weighted normalized impact sound pressure level and reduction of impact sound pressure level obtainable with a generic floating floor typology. The study can represent a starting point for a correct estimation of the impact sound insulation in new buildings and renovation plans.

INTRODUCTION

The aim of this work is to analyse the acoustic design of the common basic beam floor constructions in building technology: the basic wooden beam floor structures and concrete beam with perforated brick structures. The issue of the performance of the former type of structure is frequent in renovations of historical buildings. In addition, for basic wooden beam floor structures, there are no empirical calculation methods to evaluate the impact sound level, while for basic concrete beam with perforated brick structures the available method is not reliable. Therefore, it is difficult to estimate the impact sound insulation for complete horizontal partitions.

DESCRIPTIONS OF INVESTIGATED STRUCTURES

The investigated horizontal partitions are composed of two parts: the structural one (basic beam floor) and the upper one (floating floor). The former can usually be built as a heavyweight or lightweight part. The heavyweight basic floor part usually consists of concrete (solid floor or beam floor); the lightweight basic floor part usually consists of:

- beam and pot floor structures (where the pots are composed by perforated bricks);
- wooden frame floor structures.

The beam and pot floor structures (*bpf*) are typically composed of a structural part (reinforced concrete beams 12-14 cm width, together with reinforced concrete slab 4-6 cm thickness) and perforated bricks or polystyrene blocks (16-28 cm thickness) as shown in Figure 1.

The complete basic floor structure has a usual density of about 160-400 kg/m^2. The lightweight wooden frame basic floors (*lwf*) are typically made of wooden beams with different spaces between beams, wood boarding and light concrete slab with 4-6 cm thickness (Figure 2).

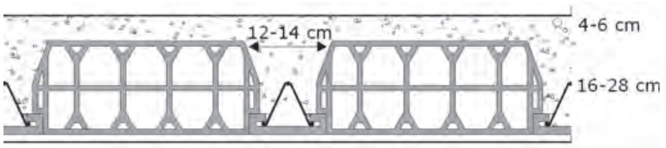

Figure 1. Typical beam and pot basic floor structure

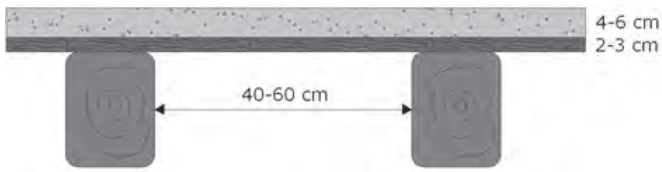

Figure 2. Lightweight wood basic floor structure

The role of the concrete slab is to supply appropriate stiffness and strength to the structure, in order to perform the function of the diaphragm drive for the distribution of horizontal forces and to protect the underlying resistance structure against the risk of fire from spaces above. The concrete slab has a usual density of about 1500 kg/m^3 or more.

This kind of lightweight structure often fails to provide adequate sound insulation (both for impact and airborne sound insulation) compared with concrete slabs or beam and pot structures. In order to find out how the frequency spectrum trend of the bpf and the *lwf* systems can influence the determination of the impact sound insulation index of the complete horizontal partitions, adequate on-site measurements were conducted.

INVESTIGATION ON IMPACT SOUND PRESSURE LEVEL SPECTRUM OF THE BASIC FLOOR CONSTRUCTIONS

For concrete slabs (homogeneous floor construction), the equivalent weighted normalized impact sound pressure level can be determined with the simplified model equation of the EN ISO 12354-2/2000 standard [2]:

$$L_{n,w,eq} = 164\text{-}35 \log(m') \quad \text{dB} \qquad (1)$$

where m' is the mass per unit area of homogeneous floor construction. On-site measurements demonstrate good correspondence between the equation and the obtained results [3-4].

The EN ISO 12354-2 standard extends the use of equation (1) to bpf structures, where the pots are composed of perforated bricks, by including this type of structure among the homogeneous constructions, as reported in Annex B (Figure 3).

However, on-site measurements carried out on a significant number of bpf structures have shown how the equation reported in EN ISO 12354-2 standard for the calculation of $L_{n,w,eq}$ index underrates the results [5]. The investigation demonstrates how the mean value of the frequency spectrum trend could be represented with the following equation:

$$L_{n,w,eq} = 16.4l\ g(f) + 26 \text{ dB} \qquad (2)$$

The calculated linear regression coefficient is equal to 0.98 and the average evaluation index of L_{nw0}, measured according to EN ISO 717-2 [6], is equal to 87 dB with a standard deviation of 2.4 dB. All the measured spectra $L'_{ni,0}$ are reported in Figure 4.

The results also demonstrate that there is no direct relation between the $L_{n,w,eq}$ quantity and the mass per unit area m' of the basic floor structure (Table 1).

For *lwf* structures the estimation of acoustic performance with the simplified model equation of the EN ISO 12354-2 standard is not applicable. The only way to know the acoustic behaviour is to carry out on-field measurements.

The first obtained results were presented in [1] and [7]. Further investigations on *lwf* structures were carried out in building yards in very different geographic locations (implying use of the same technology but different manpower). These were composed of:

- wood beams with 60 cm spaces between beams;
- wood boarding with 2.5 cm thickness;
- concrete slab with 6-8 cm thickness.

The obtained results are shown in Figure 5.

The mean value of the frequency spectrum trend could be represented with the following equations:

$$L_{n,eq,avg} = 9.7\log(f)+52 \text{ dB} \quad \text{for } f<1600 \text{ Hz} \qquad (3)$$

$$L_{n,eq,avg} = (-7.4)\log(f)+106 \text{ dB} \quad \text{for } f>1600 \text{ Hz} \qquad (4)$$

The calculated linear regression coefficient is 0.97 for both the equations and the average evaluation index L_{nw0}, measured according to UNI EN ISO 717-2, is equal to 87 dB with a standard deviation of 2.9 dB.

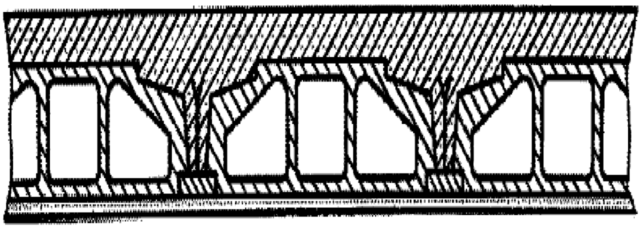

Figure 3. Type of basic floor construction as identified by standard EN ISO 12354-2-Annex B: beam and pot category

The typical spectrum of the *lwf* structures can determine different values of the weighted normalized impact sound pressure level also for structures with similar mass and geometry (Figure 6).

No relation between the calculated evaluation index L_{nw0} and the mass per unit area of each structure was found.

Table 1 Weighted normalized impact sound pressure level values as a function of mass per unit area values of the beam and pot basic floor structures

Basic floor height	m' [kg/ m^2]	measured $L'_{n,w}$ (dB)	$L'_{n,w}$ (dB) ST12354-2
16+4	230	84-87	81
18+4	255	83-88	80
20+4	275	83-89	79
24+4	305	88	77
28+4	334	88-91	76

INFLUENCE ON THE WEIGHTED NORMALIZED IMPACT SOUND PRESSURE LEVEL VALUE

Figure 7 shows a comparison between the mean value of the frequency spectrum trend for both beam and pot and lightweight wood basic floor structures.

The different structures have very different mass values (about 100 kg/m^2 for *lwf* and about 280 kg/m^2 for *bpf*).

The overall impact sound pressure level for the two spectra is quiet different (L_{eq} = 90.9 dB for *lwf* and L_{eq}=88.4 dB for *bpf*); the results of the weighted normalized impact sound pressure level are nearly the same ($L_{n0,W}$ = 86.8 dB for *lwf* and $L_{n0,W}$ = 86.5 dB for *bpf*).

Both spectrum trends shown in figure 7 increase with the frequency domain. The curve slope is greater for *bpf* structures. For *lwf* structures the slope of the curve increases until 1600 Hz and then decreases with a similar slope until 5000 Hz.

The *lwf* construction irradiates more energy at low frequency than the bpf one. This confirms, as expected, different modal behaviours of the two types of structure [8].

The reference curve (ISO 717-2) penalizes the high frequency spectrum components. This is demonstrated with the comparison between the frequency spectrum of a typical *bpf* structure (on site measurements) and a concrete basic floor construction with 14 cm thickness (laboratory measurements): the overall impact sound pressure level for the two structures is the same (L_{eq} ≈ 86.8 dB), but the results of the weighted normalized impact sound pressure level are different: $L_{n,w}$ = 83 dB for concrete slab, $L'_{n,w}$ = 85 dB for beam and pot basic floor structure (Figure 8).

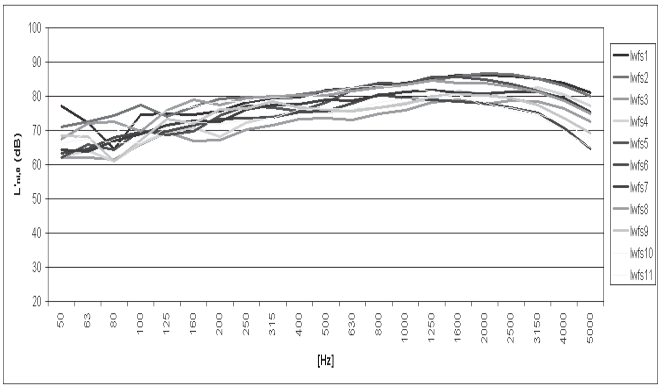

Figure 5. Frequency spectra of measured lightweight wood basic floor structures.

INFLUENCE ON THE SPECTRUM ADAPTATION TERM

The assessment of the impact sound pressure level by $L_{n,w}$ index does not take adequately into account the peak levels at individual frequencies. For this reason, the spectrum adaptation term C_I was introduced by ISO 717-2 standard, calculated as follows:

$$C_I = L_{n,sum} - 15 - L_{n,w} \quad dB \qquad (5)$$

where $L_{n,sum}$ is the measured level sum in decibels. The standard refers that the spectrum adaptation term will be slightly positive for the wood floors, without concrete slab, with low frequency dominant peaks.

For the measured *bpf* structures the spectrum adaptation terms

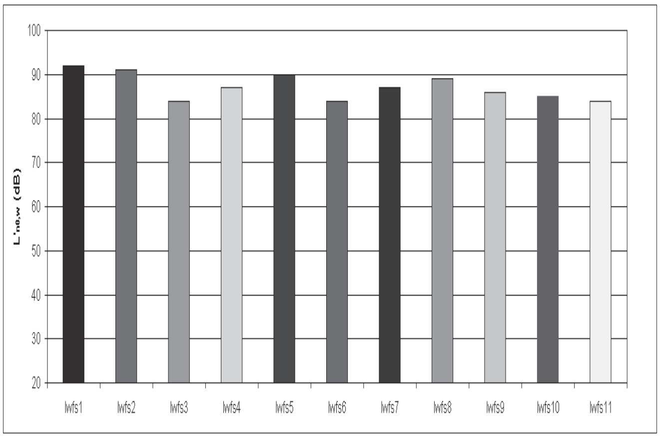

Figure 6. Comparison of the calculated evaluation index L_{nw0} for lightweight wood basic floor structures.

C_I values are included into the range [-11; -20,2] dB with a mean value of -17,2 dB and a standard deviation of 1,7 dB. This means that $L_{n,sum}$ ≈ $L_{n,w}$; in fact both quantities are influenced by the high frequency values.

For the measured *lwf* structures, with concrete slab, the spectrum adaptation terms C_I values are included into the range [-8; -12] dB with a mean value of -12,1 dB and a standard deviation of 1 dB. This fact doesn't agree with the ISO 717-2 standard. As specified in [7] the reason is that adding a concrete slab over the wood boarding reduces the $L_{n,w}$ obtained value because of the

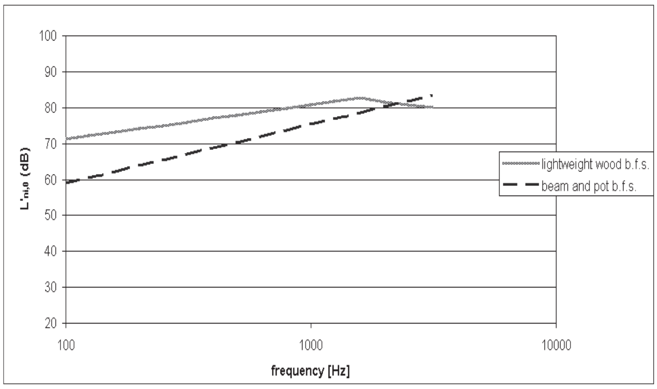

Figure 7. Comparison between the mean value of the frequency spectrum trend for both beam and pot and lightweight wood basic floor structures.

increase in sharp, high frequency sound due to the hard surface.

When using a floating floor as a solution in order to reduce impact noise, the employment of the spectrum adaptation terms C_I is unsuitable; it gives advantage to faulty floating floors, which are structures characterized by a spectrum with high frequency components.

REDUCTION OF IMPACT SOUND PRESSURE LEVEL REFERRED TO THE SAME FLOATING FLOOR TYPOLOGY

Applying the same ΔL theoretical curve of a generic floating floor both to the frequency impact sound pressure level values of all measured *bpf* structures ($L'_{n,eq(i)}$), and to the representative equation of the frequency mean spectrum trend of beam and pot structures (eq. 2), we could obtain differences, in terms of the weighted normalized impact sound pressure level of the complete horizontal structures ($L'_{n,W}$), included into the range ± 2 dB:

$$L'_{n,W} = L'_{n,w,eq(i)} - \Delta L_w = L_{n,w,eq,avg} - \Delta L_w \pm 2 \text{ dB} \qquad (6)$$

The attenuation of floating floors is greater at high frequency, which is the range where the *bpf* structures have more energy. Figure 9 shows an example of attenuation values obtainable at low, medium and high frequency (respectively 125, 500 and 2000 Hz).

Thus, eq. (2) could be used in order to estimate the performance of the complete floor structures. Enforcing the same calculation procedure to the frequency impact sound pressure level values of all measured lwf structures compared with the representative equation of the frequency mean spectrum trend (eq. 3 and 4) the differences are included in the range ± 3 dB (Figure 10).

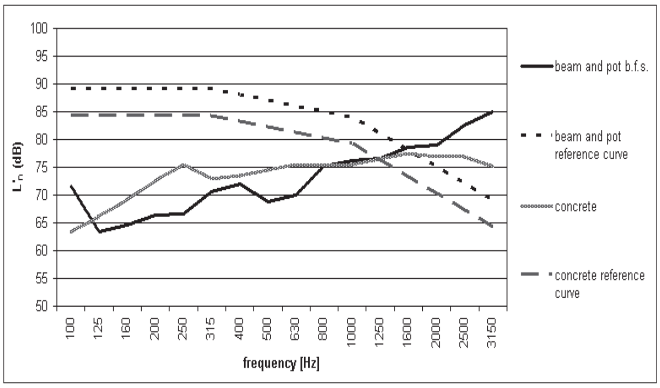

Figure 8. Comparison of the determination of Ln,w for different basic floor structures: concrete slab and beam and pot basic floor structures.

It is interesting to note that applying the same ΔL theoretical curve to the representative equation of the frequency mean spectrum trend calculated for *bpf* structures ($L'_{n0\text{-}bpf}$) and for *lwf* structures ($L'_{n0\text{-}lwf}$), the obtainable values of the weighted normalized impact sound pressure level for the complete floor structure (L_n) are very different: $L_{n\text{-}bpf}$ = 45 dB; $L_{n\text{-}lwf}$ = 53 dB. The difference in terms of the obtainable final value is about 8 dB; the results are shown in figure 11 and 12.

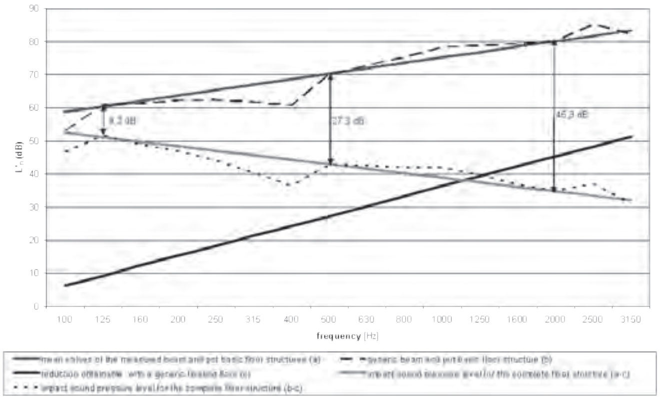

Figure 9. Reduction of impact sound pressure level applied both to the mean values of beam and pot floor structures and to a generic measured spectrum.

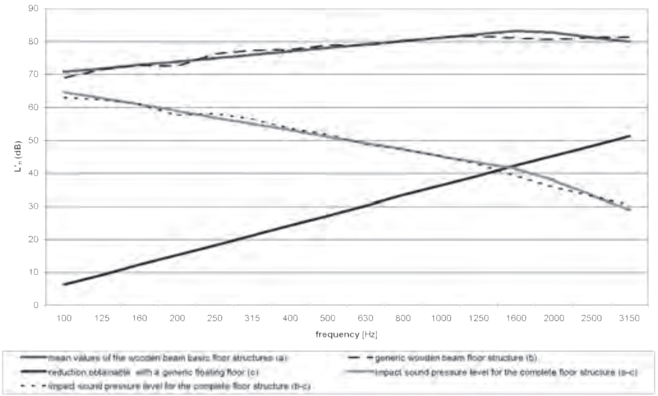

Figure 10. Reduction of impact sound pressure level applied both to the mean values of wooden beam basic floor structures and to a generic measured spectrum.

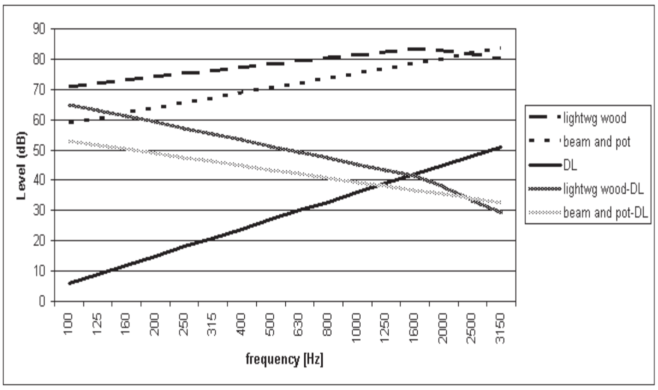

Figure 11. Role of the reduction of impact sound pressure level applied to the mean values of beam and pot basic floor structures and lightweight wood basic floor structures: comparison in terms of frequency trend.

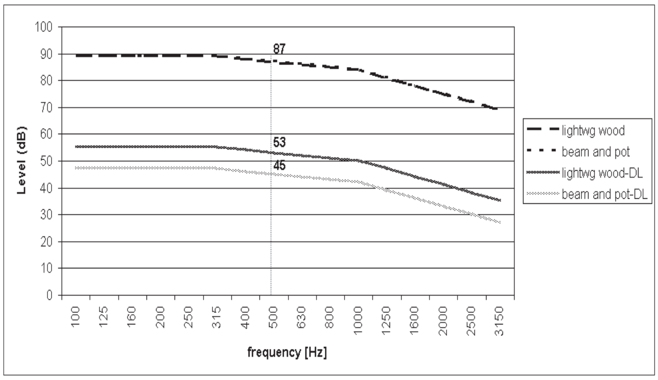

Figure 12. Role of the reduction of impact sound pressure level applied to the mean values of beam and pot basic floor structures and lightweight wood basic floor structures: comparison in terms of reference curve (ISO 717-2).

This means that, for *lwf* systems, higher performances for resilient materials within floating floors are needed. As said above, these structures have more energy at low frequencies; nevertheless in this region the floating floor has less efficiency and this involves a higher impact sound pressure level and index ($L'_{n,w}$), compared with the *bpf* structures and concrete slabs.

With equal contribution of the flanking transmission, the application of the simplified calculation method using only the index values ($L'_n = L'_{n0,w} - \Delta L_w$) would lead to a result of $L'_{n,w}$ = 57 dB for both *lwf* and *bpf* structures, with an underestimation of 4 dB for *lwf* structures and of 12 dB for *bpf* structures.

Applying the same ΔL theoretical curve to the characteristic frequency spectrum trend of a generic concrete laboratory slab (12 cm thickness) with an index value of $L_{n0,w}$ = 83 dB, the obtainable weighted normalized impact sound pressure level values (L_n) for the complete floor structures become Ln-conc=50 dB (Figure 13). The obtainable differences in terms of ΔL are about 33 dB, which is much lower than the previous structures ($\Delta L_{n\text{-}bpf}$ = 42 dB; $\Delta L_{n\text{-}lwf}$ = 36 dB). In fact, while the frequency spectrum of *bpf* and *lwf* structures increases with the frequency domain, the frequency spectrum of concrete slab is flat, so the efficiency of the floating floor at high frequency is much attenuated.

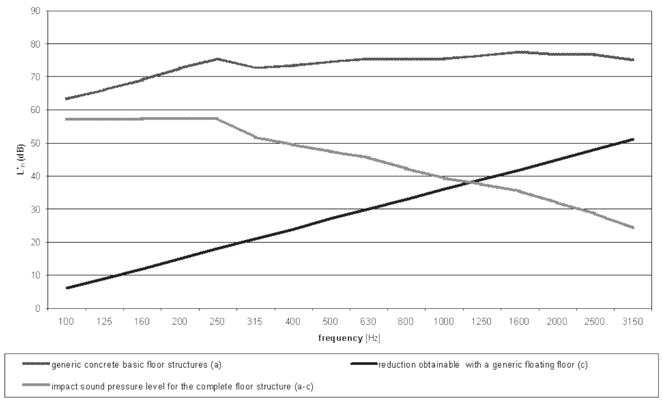

Figure 13. Role of the reduction of impact sound pressure level applied to a generic concrete basic floor structure.

CONCLUSIONS

The investigation of the equivalent weighted normalized impact sound pressure level on wooden beam and beam and pot basic floor constructions shows that there is no relation between the calculated evaluation index and the mass per unit area of each structure. Analyzing the trend of the frequency spectrum for both structure typologies, it was possible to develop an empirical law describing the average performances.

For beam and pot basic floor structures the frequency behaviour is characterized by an increase within the frequency domain; for wooden frame basic floor structures the frequency behaviour is characterized by an increase within the frequency domain until 1600 Hz and a decrease for frequencies up to 1600 Hz. Both structures are characterized by high energy at high frequency; the lightweight wood basic floors have a higher sound energy level at low frequency compared to the beam and pot basic floor structures.

For this reason the employment of the spectrum adaptation terms is unsuitable, in case of use of a floating floor, as a solution to better express the values of the impact noise. For achieving adequate standards of a complete horizontal partition, a more efficient floating floor is needed if the basic floor consists of lightweight wood structures. This analysis assesses the phenomenon of sound insulation for floors with increased accuracy and can therefore provide designers with the correct calculation tools to estimate and fulfil the acoustic requirements needed.

Acknowledgements

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Primal Sounds

An experiment using plastic tubes and puffs of air is helping to recreate the first sounds uttered by our distant ancestors.

All primates have an air sac except humans, in whom it has shrunk to a vestigial organ. Palaeontologists can date when our ancestors lost the organ, as the tissue attaches to a skeletal feature called the hyoid bulla, which is absent in humans. "Lucy's baby", an Australopithecus Afarensis girl who lived 3.3 million years ago, had a hyoid bulla; but by the time Homo Heidelbergensis arrived on the scene 600,000 years ago, air sacs were a thing of the past.

To find out how this changed the sounds produced, Bart de Boer of the University of Amsterdam in the Netherlands created artificial vocal tracts from shaped plastic tubes. Air forced down them produced different vowel sounds, and half of the models had an extra chamber to mimic an air sac.

The air sacs acted like bass drums, resonating at low frequencies, and causing vowel sounds to merge; Lucy's baby would have had a greatly reduced vocabulary. Even simple words - such as "tin" and "ten" - would have sounded the same to her.

De Boer found that air sacs interfered with the workings of the vocal cords, making consonants trickier.With air sacs our ancestors voices would have been different. For example, vowels tend to sound like the "u" in "ugg". But studies suggest it is easier to produce a consonant plus a vowel, and "d" is easier to form with "u". "Drawing it all together, I think it is likely cavemen and cavewomen said 'duh' before they said 'ugg'," says de Boer.

© Adapted from 23 November 2011 by Charles Harvey, New Scientist

Mechanical Sounds

Residents along the Johnsonville train line raised concerns recently about the noise coming from the new Matangi train horns and screeching brakes.

KiwiRail has confirmed that Matangi engineers would be checking on the sound of the horn and the noise of the train wheels. They would be trialling a quieter horn over the next few weeks to see if it would make a difference, balancing disruption with safety.

Tranz Metro manager Scott Brooks said: "With a busy line through a residential area like Johnsonville, this balance is all the more difficult. The Matangi horn is louder than the English Electric horn, so we'll be seeing over the next few weeks whether lowering the horn decibel level, without compromising safety, makes a difference."

The noise caused by wheels on the tracks would be more difficult to assess and solve, Mr Brooks said.

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January 2012

The purpose of the ICA is to promote international development and collaboration in all fields of acoustics including research, development, education, and standardisation.

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Dear Member Society, Dear International Affiliate

Please receive best wishes from the ICA for your organization for the New Year 2012.

As usual, the acoustics community will have numerous meetings, conferences and conventions again in 2012. This will offer excellent opportunities to discuss acoustics and to start collaboration between associations, societies, groups and individuals. And we need collaboration indeed for contributing to the solutions of problems in our acoustic environment and to the technological progress as far as sound and vibration is concerned.

For example, joint meetings will be held in Nantes, France, between the Acoustical societies of France and United Kingdom, in Hong Kong between the Acoustical Societies of America and China, and in Èvora, Portugal, between the Federation of Iberoamerican Acoustics, thus South America together with Spain and Portugal.

I take this opportunity to remind you to note the next ICA conference in your calendar: in June 2013 we will meet in Montreal, Canada. We are looking forward to visiting this beautiful city and discussing progress in acoustics. Please make all colleagues in your society aware of the next ICA conference in Montreal.
www.ica2013montreal.org/index.html

During 2011 the Board of the International Commission for Acoustics worked on key issues in internal business and in external relations. The vacant open seat in the board has been filled by Denmark and our new board member, Claus Møller Petersen, took part in the 2011 board meeting.

The 2012 Board meeting is scheduled for Thursday, May 17 in Hong Kong at the occasion of the joint meeting of the Acoustical Societies of America and of China and the meeting for Wespac.

To summarise some of the major activities:

a) Governance and internal business

I am happy to report that we are in contact with new societies for membership in ICA.

And we invited two more organizations to join ICA as International Affiliates.

In the board, the five executive officers (President, Vice-President, Past-President, Secretary General and Treasurer) developed a draft document dealing with the ICA governance and in particular the future voting for permanent and open seats and the representation of International Affiliates in the board.

This document is being distributed to the board with time for board member consultation within their organizations prior to our 2012 board meeting. The aim would then be to seek approval at the General Assembly 2013 for immediate application in selection of the 2014-2017 board

There are two changes in Board governance that we are considering:

• To change the current arrangement for permanent seats

• To change the current arrangements for representation from International Affiliates

As concerns the open and permanent seats, the ICA seeks to better represent the rapidly growing discipline of acoustics on the global stage, and to enhance the coordination of international acoustical activities. For the International Affiliates, the proposal adjusts the voting arrangement to allow for an increase in the number.

b) External relations

ICA is a commission of the International Union for Pure and Applied Physics, IUPAP, and an affiliated commission of the International Union for Theoretical and Applied Mechanics, IUTAM. And since 2006 we are a Scientific Associate of the International Council for Science, ICSU.

ICSU is a very important organization in our external relations. During an informal meeting at the ICSU headquarters in Paris, three delegates from the board (Burgess, Blanc-Benon and Vorländer) discussed with ICSU representatives the opportunities for ICA to increase its standing within ICSU. Also, the activities of the ICA were displayed at the ISCU conference in Rome by our board member Alippi. For this purpose a poster and an activity report were created which are now available for download and display at national, regional and international events and for inclusion on newsletters or other publications for your members:

www.icacommission.org/archive/ICA%20Outreach/

Please use this poster whenever there is any opportunity to emphasize the relevance of acoustics in the context of science and technology at all levels in academia and engineering.

Finally, let me wish a Happy and Prosperous New Year 2012 for your Society. Please stay in contact with the ICA Board, particularly with the Secretary General, Marion Burgess, with the Treasurer, Antonio Perez-Lopez, with Vice-President Charles Schmid, and with myself. We would be happy to receive your comments and suggestions.

Aachen, Germany Michael Vorländer

President ICA 2011-2013

Acoustics Standards Workshop

Notes on the acoustics standards workshop held on 9 March 2012 at Standards New Zealand

Attendees:

M. Borich: WLG City Council

S. Chiles: URS New Zealand Ltd

C. Day: Marshall Day Acoustics Ltd

G. Dodd: University of Auckland

V. Goodwin: Ministry of Health

M. Halstead: Marshall Day Acoustics Ltd

R. Hannaby: New Zealand Transport Agency

M. Hunt: Malcolm Hunt Associates

B. Johnson: Ministry for the Environment

N. Lloyd: Acousafe Consulting and Engineering Ltd

B. Taylor: Standards New Zealand

Purpose

The purpose of the half-day workshop on Friday 9 March 2012 was to discuss:

- Ideas to improve the development and use of acoustics Standards that will be relevant to and benefit a wide range of stakeholders; and
- Options for ongoing consultation on acoustics Standards, specifically the option of establishing an Acoustics Standards Advisory Group to advise Standards New Zealand.

Introductions

During introductions, attendees were asked to outline issues or interests they wished to have discussed. These included:

- Options for developing acoustics guidelines in a cheaper and more flexible way
- Clarification of processes and costs

Table 1. Comments on existing NZS.

NZS	Title	Comments from the workshop
6801:2008 6802:2008	Acoustics – Measurement of environmental sound Acoustics – Environmental noise	• Some errors need to be corrected. It is important to monitor use of Standards, identify errors and correct them, and notify users as soon as possible • Most district plans have not yet been updated to the 2008 versions, and a few have updated but continue to use L_{10} as their plans were notified before the 2008 revised Standard was published (e.g. Tararua DC) • Councils are required to keep copies of Standards that are referred to in district plans, especially those that refer to older, withdrawn versions Summary: corrections needed
6803P:1984 6803:1999	Measurement and assessment of noise from construction, maintenance and demolition work Acoustics – Construction noise	• The provisional Standard on construction site noise, NZS 6803P:1984, is still on Standards New Zealand's catalogue, but the workshop recommended its withdrawal as it has been replaced by the 1999 version. • The 1999 version is cited in the NES on Electricity Transmission • The 1999 version needs to be revised to introduce better techniques for managing construction noise based on a noise management plan framework rather than on set noise limits. The Standard needs to promote consultation with affected parties, and negotiation of limits taking into account the location, nature and duration of the works • Roading construction works have difficulty complying with the current Standard. NZTA and its contractors find the Standard difficult to work with especially in urban areas. NZTA has drafted its own guidelines. The latest draft (v0.4) of the NZTA State Highway Construction Noise Guide has now been released for comment. The guide was commissioned and scoped by NZTA's Environment and Urban Design Team and was produced by URS. A copy of the draft guide and a form for submitting comments to NZTA can be found at: http://acoustics.nzta.govt.nz/news/draft-construction-noise-guide-released-for-consultation. Summary: the 1984 provisional standard should be withdrawn and the 1999 Standard needs updating

6805:1992	Airport noise management and land use planning	• Views on this Standard were mixed, some finding that it works well, while others consider it needs adjustments. Ideas for improvements include areas such as single event limit in addition to L_{dn}, reverse sensitivity, engine testing, internal noise levels of buildings, definition of 'noise sensitivity' • The prohibition of development within an air-noise boundary should be outside the scope of an acoustics standard. Summary: some improvements needed, not urgent
6806:2010	Acoustics – Road-traffic noise – New and altered roads	• Some corrections have been identified by NZTA, SNZ and others (e.g. Table A19 figures). • 'Amenity' is not well defined (comment from Waterview BOI) Summary: other than minor corrections, it is too soon to determine if the Standard needs amending
6807:1994	Noise management and land use planning for helicopter landing areas	• The Standard has been used often and is cited in Environment Court proceedings. Views on NZS 6807 were mixed, with some suggesting that the method of measuring noise needs clarification, while others have experienced no problem with its implementation • Although the Standard is based on NZS 6805, airports that have both fixed wing and helicopter operations can present challenges for the measurement and assessment of noise. The Standard has been used together with NZS 6805 on only a few occasions, e.g. Queenstown and Whangarei • Measurement methodology in the Standard could be improved. Appendix A could be expanded to provide additional material for application to resource consents. These matters should be considering when the Standard is next revised. • Consideration should be given to revising NZSs 6805 and NZS 6807 together. Summary: no urgent changes needed
6808:2010	Acoustics – Wind farm noise	• Standard accepted in recent Environment Court hearings, and has been adopted by the State of Victoria, but still needs time to bed down. More guidance may be needed on application of 'high amenity areas' provisions. Summary: no urgent changes needed
6809:1999	Acoustics – Port noise management and land use planning	• The Standard has been applied in Environment Court cases relating to District Plan changes for ports including Bluff, Dunedin, Lyttelton and Nelson • Standards New Zealand has been approached by port company representative enquiring about the possibility of amending the Standard to incorporate the use of noise management plans as an alternative to noise boundaries. • Summary: more details will follow when proposal for amendments becomes clearer

of developing new Standards, and making small changes to existing Standards

- The role of guides, codes (e.g. Building Code), and national environmental standards (NES)
- Consideration of changes to the NZS 680X series
- Management of road traffic noise
- Guidelines on vibration

National Environmental Standards (NES)

Key points discussed at the workshop included:

- National instruments like NESs provide a regulatory framework for dealing with issues that need a consistent approach, for example, where the effects are known and assessments of effects need a consistent methodology, or there are cross-boundary issues. The NES's on air quality are examples where such criteria apply. The air quality NES cites a number of Standards related to methods of measuring air contaminants. The NES on telecommunications facilities makes reference to a number of New Zealand Standards, including NZS 6801 and 6802
- NESs are means to ensure that national policies are implemented. NESs may lead to changes required to district or regional plans
- The cost-benefit case needs to be made for any proposed NES
- Any Standard that includes assessment criteria (not just methodologies) is likely to be challenged. In some cases evidence of adverse health effects of environmental noise is inconclusive or non-existent. This highlights the importance of being clear about the type of criteria being applied and the reason
- Current MfE priorities are focused on RMA reforms and water issues. RMA reforms may result in development of local government 'unitary plans'. There will be opportunities to make

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Did I Say That?

A few blunders in acoustic reports. These are quotes taken directly from published documents within the acoustic fraternity. Contributions to this page, and comments, are encouraged.

"These schools are exposed to these transient noise levels on an almost continuous basis."

> It often feels like rare events are always happening.

Taken from a standard glossary of definitions:

"Impact Sound: Sound produced by an object impacting directly on a building structure, such as footfall noise or chairs scrapping on a floor."

> The first rule of Chair Fight Club is..

Taken from a test report:

"...Test specimen installed by the client. Curing time was hours..."

> These experiments always take ages...

From the minutes of a meeting regarding a proposed new residential subdivision:

"...Gunfire from the Gun Club can be heard [on] this site. This was considered part of the desirable character of the area, similar to church bells..."

> The bells are getting louder!..


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Nova Polyester Acoustic Insulation
• Novahush Acoustic Blanket
• Novahush Bafflestack
• Novahush Panel Absorber
Metal Ceiling Systems
• Renhurst Ceiling Systems
• I.C.E. Metal Acoustic Tiles
• Linear Coruline Perforated Metal Ceiling System
• ACS Linear Look Metal Ceiling Systems
• Lindner Metal Systems Acoustic Tiles
• Armstrong Metalworks Acoustic Tiles
Mineral Fibre Ceiling Systems
• Armstrong range of acoustic ceiling tiles
• Armstrong Ceiling Grid
Soft Fibre Ceiling Systems
• Eurocoustic range of acoustic ceiling tiles
• Parafon range of acoustic ceiling tiles
Basotect
• Open cell melamine acoustic foam
Rondo
• Quiet Stud Friction fitted acoustic wall system
• Ceiling Grid
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Continued from page 29...

submissions to the select committee that considers any proposed RMA changes.

Current AS/NZS joint Standards

A brief review of joint AS/NZS acoustics Standards on SNZ's catalogue raised the following comments:

- SNZ encourages the use/adoption of ISO Standards where they exist and meet NZ requirements
- Adopting an ISO Standard as a joint AS/NZS or NZS only Standard is useful if it meets NZ needs, and discourages the use of other, less suitable Standards
- AS/NZS 2107:2000 – design sound levels and reverberation times for building interiors – should be considered for improvement or revision
- Joint Standards AS/NZS 2460, 2499, 3817 and 4476 are duplicates of ISO Standards and could be replaced.

New Standards

Some suggestions for standardisation or other guidance material include (in no particular order):

- Noise labelling of appliances
- Traffic noise on existing roads
- Glossary of acoustical terms, etc
- Vibration – construction (e.g. provisions added to NZS 6803, and referencing BS 5228, Part 4)
- Vibration – general (e.g. roads, railways, mining, quarrying). Although some thought that criteria for exposure to vibration could be the same irrespective of the activity. It was suggested that references be made to existing German and British Standards on vibration
- Impulsive noise (e.g. gunfire from rifle ranges)
- Water craft noise
- Effects of noise on animals
- Protection of pristine natural environments (e.g. national parks) from intrusive manmade noise
- Acoustical environments in childcare centres.

Acoustical Standards Advisory Group

There was general support for the suggestion to (re)establish an advisory group that would provide technical advice to Standards New Zealand on existing or proposed new Standards. The ASAG could meet on a regular or as needed basis, depending on activities occurring in the national, joint AS/NZS, and international arenas.

Bruce offered to prepare a draft Terms of Reference for ASAG, as well as suggestions for nominating organisations that may be interested in being involved, and circulate the draft to workshop attendees for comment.

Vern undertook to provide Bruce with material from a previous ASAG, and information on the status of withdrawn Standards.

AS/NZS Joint Committees

Workshop attendees received a copy of the list of joint committees AV-001, AV-002, AV-003, AV-004, EV -010 and EV-011, and the names of NZ representatives on those committees.

In relation to AV-001 'Acoustics/vibration terms, units & symbols', George Dodd advised that he represents the Acoustical Society of NZ (not the University of Auckland) on this committee.

Stephen suggested that information on joint committee activities could be improved. None of the committees have joint projects active at present.

ISO Technical Committee TC 43 Acoustics Committees

New Zealand is a participating (P) member of sub-committee SC1 (Noise). George Dodd is the NZ convenor. Funding for participation on SC1 is provided by the Department of Building and Housing. We are observers only on SC2 (Building acoustics) and SC3 (Underwater acoustics), which means that we receive drafts and can comment on them, but New Zealand does not have a right to vote on the final ISO Standard.

George pointed out that he circulates drafts produced by SC1 to a number of NZ stakeholders for comment, but he usually receives very few responses. He abstains from voting if feedback is poor.

It was suggested that the ASAG, when established, should make recommendations on improving participation in joint and international standards.

Building Code Issues

Stephen Chiles raised the issue of field testing of sound insulation in buildings and accreditation of field testers. Stephen is trying to encourage the Dept of Building and Housing (DBH) to introduce an accreditation system to ensure proper testing of sound insulation. Stephen suggested that accreditation is necessary for quality control purposes, and recommended further investigation of the matter.

Wrap up and feedback on the workshop

Attendees commented on how useful and worthwhile the workshop was as an opportunity to discuss current issues and future options for improving acoustics standards.

There was support for Standards New Zealand establishing a standing Acoustics Standards Advisory Group (ASAG), which should have strategic as well as a technical advisory roles, including the ability to set up task-specific working groups where necessary.

Bruce will seek approval from Standards New Zealand to formally establish an ASAG, and draft a proposed terms of reference for ASAG for comment.

Among matters raised at the workshop that could be referred to ASAG for advice are:

- The withdrawal of the provisional construction noise Standard NZS 6803P:1984
- Combining the airport and helicopter noise Standards NZS 6805 and 6807
- Ways to improve New Zealand's participation in international Standards on acoustics ¶

Draft NZTA State Highway Construction Noise Guide (v0.4) Consultation

As mentioned at the Standards NZ workshop on the 9 March (opposite).

The latest draft (v0.4) of the NZTA State Highway Construction Noise Guide has now been released for comment. The guide was commissioned and scoped by the Environment and Urban Design Team in the State Highway Group (HNO) of NZTA and was produced by URS. A copy of the draft guide can be found at:

http://acoustics.nzta.govt.nz/news/draft-construction-noise-guide-released-for-consultation

The guide brings together a broad range of material to inform NZTA staff, contractors and the public about construction and maintenance noise. Information is provided on prediction, management, mitigation and documentation of construction noise.

We propose to expand the final version of the guide to include additional information on construction vibration. Any feedback on the issues that should be covered and extent of coverage relating to construction vibration would be appreciated.

If you or your team have any comments, could you please e-mail back to Rob Hannaby, (rob.hannaby@nzta.govt.nz) by 1 May 2012.

A Rose by Any Other Name

Opponents of the Flat Hill Wind Farm have branded an offer to rename the project Turakanui a Rua insulting, demeaning and tokenism.

A group of Bluff and Greenpoint residents will appeal the Invercargill City Council's decision to give the eight-turbine farm, planned by Energy^3, consent.

The decision requested Energy^3 consider renaming the wind farm in consultation with the Awarua runaka, because of the Maori attachment to the land.

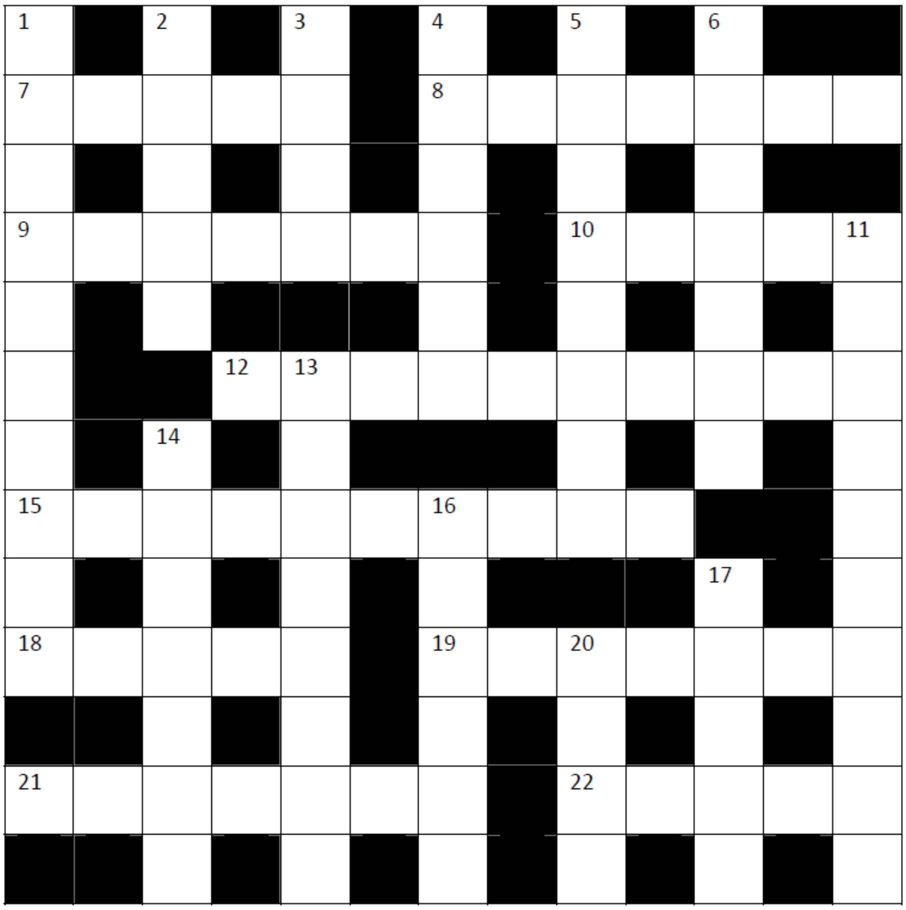
It included comments about the cultural significance of the area but said existing oral traditions were not enough to protect the site from development.

"If provision has to be made for the relationship of local Maori with the land on the basis of waahi tapu or other concepts of tikanga Maori then it is not sufficient for someone simply to assert a belief," it said.

Greenpoint resident Louise Fowler-Harnett and wind farm opponent Eve Fowler-Stockwell said ignoring the cultural history of the hill and then offering to give the wind farm a Maori name was a sop. "It's tokenism," Mrs Fowler-Harnett said. "They want to buy us off."

© Adapted from The Southland Times 29/03/2012 ¶

Acoustic Crossword #5



CLUES DOWN

1. Fools, males and a shirt just need a direction to find what the consultant may give.
2. An absence of 7?
3. Briefly Edward has it to shorten his recordings.
4. Press this to make one?
5. He or she who oversees the creation of 4?
6. Having a single twitch or ear.
11. Only if they do this will the choir's pitch be good.
13. Rodent, shirt, fish or snake noise.
14. He, she or it that examines all parts of the frequency spectrum successively and repeatedly?
16. Sounds like an unknown quantity being ejected under pressure that frequently describes an acoustician.
17. Spool in reverse spliced tapes for analysis.
20. We hear what the burglar stole for an instrument.

CLUES ACROSS

7. Do we hear it when plumbing the depths?
8. Will a ring in this alter your Head Related Transfer Function?
9. Will adding this to acoustics make it active?
10. Direct only one rear speaker initially to the audience entry points.
12. What's said before the consultant's calculation?
15. What sound must do to be heard?
18. A heavy weight and a metal can give sound a special audible characteristic.
19. Remove the plug to no longer take part and avoid pregnancy.
21. One who sings above the bass we hear for X pounds.
22. A piggy-back mains plug or what the acoustician does to floors to find $L_{n,W}$.

Crossword submitted by:

Dogged Doer

Solutions to Crossword #4

Across:

6. Scoffs; 7. Nebular; 8. Auralise; 9. Open; 10. Stereo; 12. Effect; 14. Accent; 16. Traces; 18. Star; 20. Occupant; 21. Clanger; 22. Snare

Down:

1. Acoustic; 2. Off Air; 3. Tenement; 4. Cut Off; 5. Café; 11. Outmoded; 13. Cleaners; 15. Eyring; 17. Append; 19. Talk

2012

13 - 18 May, Hong Kong, China. Joint meeting of the 183rd meeting of the Acoustical Society of America, 8th meeting of the Acoustical Society of China, 11th meeting of Western Pacific Acoustical Conference and Hong Kong Institute of Acoustics.
http://acoustics2012hk.org

2 - 6 July, Edinburgh, UK. 11th European Congress on Underwater Acoustics
http://www.acua2012.com

Internoise 2012
19 - 22 August, New York, N.Y., USA.
We hope you will join us at Internoise 2012 at the Marriott Marquis Hotel in New York City, USA, 19-22 August 2012. We are planning a large congress of over 1000 delegates, including:

- Three days of technical papers spanning many areas of noise and vibration, including our congress theme "Quieting the World's Cities™"
- A large vendor exposition (60+) of noise and vibration control materials, analysis software, and measurement systems and instrumentation
- Three plenary sessions on City Noise Codes, the Effects of Noise on Children, and Airport Noise
- A series of short courses on noise and vibration control

We will be issuing our call for abstracts (due 15 February 2012) shortly. In the meantime, please visit our website: www.internoise2012.com to learn more about what promises to be the premier vibration and acoustics conference of 2012.

Dr. Stephen A. Hambric

www.internoise2012.com

19 - 24 August, Beijing, China. 23rd International Congress of Theoretical and Applied Mechanics (ICTAM2012).
http://www.ictam2012.org/

9 - 13 September. Portland, Or. USA. Interspeech 2012.
http://interspeech2012.org

12 -15 September, Granada, Spain. 30th European Conference on Acoustic Emission Testing (EWGAE) and 7th International Conference on Acoustic Emission (ICAE)
http://2012.ewgae.eu/

17 - 19 September, Leuven, Belgium. ISMA International Conference on Noise and Vibration Engineering (ISMA 2012).
http://www.isma-isaac.be/conf/

2013

26 - 31 March, Vancouver, Canada. 2013 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)
http://www.icassp2013.com

1 - 4 May, Singapore 3rd International Congress on Ultrasonics (ICU 2013) concurrently organized with the 32nd International Symposium on Acoustical Imaging (AI 2013)
http://www.epc.com.sg/PDF%20Folder/ICU%202010%20Phamplet%20v1%20(12%20Jul%202010).pdf

02 - 07 June, Montreal, Canada 21st International Congress on Acoustics(ICA 2013)
http://www.ica2013montreal.org

RASD 2013, International Conference on Recent Advances in Structural Dynamics 1-3 July 2013

Colleagues,

RASD will be held at the University of Pisa, Pisa, Italy, 1-3 July 2013. The eleventh in the RASD series, the conference will bring together researchers working in all areas of structural dynamics. The ten previous conferences have been held every three years or so since 1980.

As on prevision occasions, this conference is devoted to theoretical, numerical and experimental developments in structural dynamics and their application to all types of structures and dynamical systems. It will be an opportunity to exchange scientific, technical and experimental ideas.

The Call for Papers will be made in June 2012 with the deadline for the submission of abstracts being 28th September 2012. Submission and Registration to the conference will be done through the University of Southampton Open Conference System (www.ocs.soton.ac.uk/index.php/rasdconference/RASD2013).

Dr Emiliano Rustighi (on behalf of the RASD2013 Organising Committee)

Further information is available at https://www.soton.ac.uk/rasd2013

26 - 28 August, Denver, USA NOISE-CON 13
ibo@inceusa.org

27 - 30 August, Denver, USAWind Turbine Noise 2013
ibo@inceusa.org

15 - 18 September, Innsbruck, Austria Internoise 2013
http://www.internoise2013.com ¶

CRAI Ratings

Auckland

215, Dominion Rd	(1)	★★★★½
Andrea (form. Positano), Mission Bay	(1)	★★★
Aubergine's, Albany	(1)	★★★★½
Backyard, Northcote	(1)	★★
Bask, Browns Bay	(1)	★★★
Bay (The), Waiake, North Shore	(1)	★★★★★
Bolero, Albany	(1)	★★★★
Bosco Verde, Epsom	(1)	★★★★½
Bouchon, Kingsland	(1)	★★
Bowman, Mt Eden	(1)	★★★★½
Bracs, Albany	(1)	★★★★
Brazil, Karangahape Rd	(1)	★★★
Buoy, Mission Bay	(2)	★★★★½
Byzantium, Ponsonby	(1)	★★★
Café Jazz, Remuera	(1)	★★★★½
Carriages Café, Kumeu	(1)	★★★★
Charlees, Howick	(1)	★★★★★
Cibo	(1)	★★★★★
Circus Circus, Mt Eden	(1)	★★
Cube, Devenport	(1)	★★

Del Fontaine, Mission Bay	(1)	★★★★★
Deli (The), Remuera	(1)	★★★★
Delicious, Grey Lynn	(1)	★★★★★
De Post, Mt Eden	(1)	★★
Dizengoff, Ponsonby Rd	(1)	★★
Drake, Freemans Bay (Function Room)	(1)	★★
Eiffel on Eden, Mt Eden	(1)	★★
Eve's Cafe, Westfield Albany	(1)	★★★½
Formosa Country Club Restaurant	(1)	★★★★★
Garrison Public House, Sylvia Park	(1)	★★★★½
Gee Gee's	(1)	★★★
Gero's, Mt Eden	(9)	★★★
Gina's Pizza & Pasta Bar	(1)	★★★½
Gouemon, Half Moon Bay	(1)	★★
Hardware Café, Titirangi	(1)	★★★★★
Hollywood Café, Westfield St Lukes	(1)	★★½
IL Piccolo	(1)	★★★★
Ima, Fort Street	(1)	★★★★
Jervois Steak House	(1)	★★★
Kashmir	(1)	★★★★
Khun Pun, Albany	(2)	★★★★★
Kings Garden Ctre Café, Western Springs	(1)	★★
La Tropezienne, Browns Bay	(1)	★★
Malaysia Satay Restaurant, Nth Shore	(1)	★★★★★
Mecca, Newmarket	(1)	★★★★★
Mexicali Fresh, Quay St	(1)	★★
Mezze Bar, Little High Street	(16)	★★★★
Monsoon Poon	(1)	★★★★★
Mozaike Café, Albany	(1)	★★
Narrow Table (The), Mairangi Bay	(1)	★★★★½
One Red Dog, Ponsonby	(1)	★★★
One Tree Grill	(1)	★★★
Orbit, Skytower	(2)	★★★★
Patriot, Devonport	(1)	★★★½
Pavia, Pakuranga	(1)	★★★★★
Prego, Ponsonby Rd	(2)	★★
Remuera Rm, Ellerslie Racecourse	(1)	★★★★★
Rhythm, Mairangi Bay	(1)	★★
Rice Queen, Newmarket	(12)	★★★★
Sails, Westhaven Marina	(2)	★★★★★
Scirocco, Browns Bay	(1)	★★★
Seagers, Oxford	(1)	★★★★
Shahi, Remuera	(1)	★★★½
Shamrock Cottage, Howick	(1)	★★
Sidart, Ponsonby	(1)	★★★★½
Sitting Duck, Westhaven	(1)	★★★½
Sorrento	(1)	★★½
Stephan's, Manukau	(1)	★★★★★
Tempters Café, Papakura	(1)	★★★★★
Thai Chef, Albany	(1)	★★★★★
Thai Chilli	(1)	★★★★★
Thai Corner, Rothesay Bay	(1)	★★★★★
Tony's, High St	(1)	★★★
Traffic Bar & Kitchen	(1)	★★
Umbria Café, Newmarket	(1)	★★★★½
Valentines, Wairau Rd	(1)	★★★★★
Vivace, High Street	(2)	★★½
Wagamama, Newmarket	(1)	★★★★½

Readers are encouraged to rate eating establishments which they visit by completing a simple form available on-line from www.acoustics.ac.nz, or contact the Editor.
Repeat ratings on listed venues are encouraged.

★ Lip-reading would be an advantage. ★★ Take earplugs at the very least. ★★★ Not too bad, particularly mid-week.
★★★★A nice quiet evening. ★★★★★The place to be and be heard. (n) indicates the number of ratings.

Watermark, Devonport	(1)	★★
Woolshed, Clevedon	(1)	★★½
Zarbos, Newmarket	(1)	★★
Zavito, Mairangi Bay	(1)	★★ ★

Arthur's Pass

Arthur's Pass Cafe & Store	(1)	★★★½
Ned's Cafe, Springfield	(1)	★★★★

Ashburton

Ashburton Club & MSA	(1)	★★★★½
Robbies	(1)	★★★
RSA	(1)	★★★★
Tuscany Café & Bar	(1)	★★★

Bay of Plenty

Alimento, Tauranga	(1)	★½
Imbibe, Mt Maunganui	(1)	★½
Versailles Café, Tauranga	(2)	★★

Blenheim

Raupo Cafe	(1)	★★

Bulls

Mothered Goose Cafe, Deli, Vino	(1)	★★

Cambridge

GPO	(1)	★★★★★

Christchurch

@Tonys, Ferrymead	(6)	★★½
3 Cows, Kaiapoi	(1)	★★★★
Abes Bagel Shop, Mandeville St	(1)	★★★★
Addington Coffee Co-op	(4)	★★★★
Alchemy Café, Art Gallery	(1)	★★★★★
Anna's Café, Tower Junction	(1)	★★★★
Arashi	(1)	★★
Azure	(2)	★★★
Bamboozle, Sumner	(5)	★★½
Becks Southern Ale House	(11)	★★★★½
Buddha Stix, Riccarton	(1)	★★★★
Bully Haye's, Akaroa	(1)	★★
Cashmere Club	(1)	★★★★★
Christchurch Casino	(1)	★★
Christchurch Museum Café	(1)	★★★★
Cobb & Co, Bush Inn	(1)	★★★
Coffee House, Montreal Street	(1)	★★
Cookai	(3)	★★½
Corianders, Edgeware Road	(11)	★★★
Costas Taverna, Victoria Street	(1)	★½
Decadence Café, Victoria St	(1)	★★★★★
Drexels Breakfast Restaurant, Riccarton	(1)	★★★★
Edisia, Addington	(1)	★★★
Elevate, Cashmere	(1)	★★★
Fava, St Martins	(1)	★★
Flying Burrito Brothers, Northlands	(12)	★★½
Foo San, Upper Riccarton	(1)	★★★½
Fox & Ferrett, Riccarton	(1)	★★★★★
Gloria Jean's, Rotheram St	(1)	★★★★
Golden Chimes	(1)	★★★★★
Governors Bay Hotel	(1)	★★★★
Green Turtle	(1)	★★★★
Harpers Café, Bealey Ave	(1)	★★★★★
Holy Smoke, Ferry Rd	(1)	★★
Indian Fendalton	(2)	★★
Kanniga's Thai	(1)	★★★
La Porchetta, Riccarton	(4)	★★½
Little India	(2)	★★★★★
Lone Star, Riccarton Road	(6)	★★★
Lyttleton Coffee Co, Lyttleton	(1)	★★★★
Manee Thai	(6)	★★½
Mexican Café	(6)	★★★
Myhanh, Church Corner	(4)	★★★½
Number 4, Merivale	(2)	★★★★
Oasis	(1)	★★★★½
Old Vicarage	(2)	★★★½
Phu Thai, Manchester Street	(1)	★★★
Pukeko Junction, Leithfield	(1)	★★★★
Red, Beckenham Service Centre	(1)	★★★★
Red Elephant	(1)	★★★★
Retour	(1)	★★★
Riccarton Buffet	(2)	★★★★½
Robbies, Church Corner	(2)	★★★★½
Route 32, Cust	(1)	★★★★
Salt on the Pier, New Brighton	(6)	★★★½
Speights Ale House, Tower Junction	(1)	★★★★
Spice 'n' Life, Church Corner	(4)	★★★★½
The Bridge, Prebbleton	(1)	★★★★★
The Bicycle Thief	(1)	★★★★½
The Sand Bar, Ferrymead	(2)	★★★½
Tokyo Samurai	(1)	★★★★★
Tutto Bene, Merivale	(2)	★★
Untouched World Cafe	(1)	★★★★★
Wagamama, Oxford Terrace	(6)	★★★
Waitikiri Golf Club	(1)	★★
Waratah Café, Tai Tapu	(1)	★★★

Clyde

Old Post Office Cafe	(1)	★★★★★

Dunedin

A Cow Called Berta	(1)	★★★½
Albatross Centre Cafe	(1)	★★★★★
Bennu	(1)	★★★★
Bx Bistro	(1)	★★★★
Chrome	(1)	★★★★½
Conservatory, Corstophine House	(1)	★★★★★

Fitzroy Pub on the Park	(1)	★★★★★
High Tide	(2)	★★
Nova	(1)	★★★★★
St Clair Saltwater Pool Cafe	(1)	★★★★½
Swell	(1)	★★
University of Otago Staff Club	(1)	★★

Feilding

Essence Cafe & Bar0	(1)	★★★★

Gore

Old Post	(1)	★★★
The Moth, Mandeville	(1)	★★★★★

Greymouth

Cafe 124	(1)	★★★

Hamilton

Embargo	(1)	★★★★★
Gengys	(1)	★★
Victoria Chinese Restaurant	(1)	★★★★★

Hanmer Springs

Laurels (The)	(2)	★★★★★
Saints	(1)	★★★★½

Hastings

Café Zigliotto	(1)	★★★

Havelock North

Rose & Shamrock	(1)	★★★½

Levin

Traffic Bar & Bistro	(1)	★★

Masterton

Java	(1)	★★

Matamata

Horse & Jockey	(1)	★★★★★

Methven

Ski Time	(2)	★★★

Napier

Boardwalk Beach Bar	(2)	★★★★★
Brecker's	(1)	★★★★★
Café Affair	(1)	★★
Cobb & Co	(1)	★½
Duke of Gloucester	(1)	★★★★½
East Pier	(1)	★★
Estuary Restaurant	(1)	★★★★★
Founder's Cafe	(1)	★★★★★
Napier RSA	(1)	★★★★★
Sappho & Heath	(1)	★★

Nelson/Marlborough

Allan Scott Winery	(1)	★★★★★
Amansi @ Le Brun	(1)	★★★★★
Baby G's, Nelson	(1)	★★★★★
Boutereys, Richmond	(1)	★★★★
Café Affair, Nelson	(1)	★★
Café on Oxford, Richmond	(1)	★★★
Café Le Cup, Blenheim	(1)	★★★
Crusoe's, Stoke	(1)	★★★
Cruizies, Blenheim	(2)	★★★★½
Grape Escape, Richmond	(1)	★★★★★
Jester House, Tasman	(1)	★★★★★
L'Affaire Cafe, Nelson	(1)	★★
Liquid NZ, Nelson	(1)	★½
Lonestar, Nelson	(1)	★★★★
Marlborough Club, Blenheim	(1)	★★
Morrison St Café, Nelson	(1)	★★½
Oasis, Nelson	(1)	★★★★★
Rutherford Café & Bar, Nelson	(1)	★★★★★
Suter Cafe, Nelson	(1)	★★
Verdict, Nelson	(1)	★★
Waterfront Cafe & Bar, Nelson	(1)	★★★
Wholemeal Trading Co, Takaka	(1)	★★★★★

New Plymouth

Breakers Café & Bar	(1)	★★★
Centre City Food Court	(1)	★★★★
Elixer	(1)	★★★★
Empire Tea Rooms	(1)	★★★★½
Govett Brewster Cafe	(1)	★★
Marbles, Devon Hotel	(1)	★★★
Pankawalla	(1)	★★★★★
Simplicity	(1)	★★★
Stumble Inn, Merrilands	(1)	★★★
Yellow Café, Centre City	(1)	★★★
Zanziba Café & Bar	(1)	★★★

Oamaru

Riverstone Kitchen	(1)	★★★★★
Star & Garter	(1)	★★★
Woolstore Café	(1)	★★★★

Palmerston North

Café Brie	(1)	★★★
Café Esplanade	(2)	★★★★
Chinatown	(1)	★★★★
Coffee on the Terrace	(2)	★★★
Elm	(1)	★★★★½
Fishermans Table	(1)	★★★★★

CRAI Ratings (cont.)

Gallery	(3)	★★★★
Rendezvous	(1)	★★½
Roma Italian Restaurant	(1)	★★★
Rose & Crown	(1)	★★
Tastee	(1)	★★★
Thai House Express	(1)	★★★★★
Victoria Café	(1)	★★★★

Queenstown

Bunker	(1)	★★★★
The Cow	(1)	★★★
Sombreros	(1)	★
Tatler	(1)	★★★★
Winnies	(1)	★★★★★

Rotorua

Cableway Rest. at Skyline Skyrides	(1)	★★★★★
Lewishams	(1)	★★★
Woolly Bugger, Ngongotaha	(1)	★★★
Valentines	(1)	★★★★★
You and Me	(1)	★★★★★
Zanelli's	(1)	★★

Southland

Lumberjack Café, Owaka	(1)	★★★★★
Pavilion, Colac Bay	(1)	★★
Village Green, Invercargill	(1)	★★★★★

Taihape

Brown Sugar Café	(1)	★★★★½

Taupo

Burbury's Café	(1)	★★★
Thames		
Thames Bakery	(1)	★★★
Waiheke Island		
Cortado Espresso Bar	(1)	★★★★
Cats Tango, Onetangi Beach	(1)	★★★★

Timaru

Fusion	(1)	★★★★★

Wanganui

3 Amigos	(1)	★★★½
Bollywood Star	(1)	★★★½
Cosmopolitan Club	(1)	★★★★
Liffiton Castle	(1)	★★½
RSA	(1)	★★★½
Stellar	(1)	★★★★½
Wanganui East Club	(1)	★★★★

Wellington

162 Café, Karori	(1)	★★★★★
180º, Paraparaumu Beach	(1)	★★
88, Tory Street	(35)	★★
Anise, Cuba Street	(1)	★★
Aranya's House	(1)	★★★★★
Arbitrageur	(2)	★★★
Arizona	(1)	★★
Astoria	(2)	★★★
Backbencher, Molesworth Street	(1)	★★★
Bordeaux Bakery, Thorndon Quay	(1)	★★
Brown Sugar, Otaki Railway Station	(1)	★★★
Buzz, Lower Hutt	(1)	★★½
Brewery Bar & Restaurant	(5)	★★★★
Carvery, Upper Hutt	(1)	★★★★★
Chow	(1)	★½
Cookies, Paraparumu Beach	(1)	★★★½
Cosa Nostra Italian Trattoria, Thorndon	(1)	★★★★
Gotham	(6)	★★★½
Great India, Manners Street	(2)	★★★★★
Habebie	(1)	★★
Harrisons Garden Centre, Peka Peka	(1)	★★★★
Hazel	(1)	★★
Katipo	(1)	★★★★★
Kilim, Petone	(4)	★★★★½
Kiss & Bake Up, Waikanae	(1)	★★★
La Casa Pasta	(1)	★★★★½
Lattitude 41	(3)	★★★★
Legato	(1)	★★
Le Metropolitain	(1)	★★★★★
Loaded Hog	(5)	★★★★½
Manhatten, Oriental Bay	(1)	★★★★
Maria Pia's	(1)	★★★
Matterhorn	(1)	★★★
Mungavin Blues, Porirua	(1)	★★★★★
Olive Cafe	(1)	★★★★★
Olive Grove, Waikanae	(1)	★★★½
Original Thai, Island Bay	(1)	★★★★
Palace Café, Petone	(1)	★★½
Parade Café	(1)	★★
Pasha Café	(1)	★★★★
Penthouse Cinema Café	(2)	★★★½
Pod	(1)	★★½
Rose & Crown	(1)	★★★★★
Shed 5	(1)	★★
Siem Reap	(1)	★★
Speak Easy, Petone	(1)	★★
Speights Ale House	(1)	★★
Sports Bar Café	(1)	★★★★
Stanley Road	(1)	★★★
Stephan's Country Rest., Te Horo	(1)	★★★★★
Wakefields (West Plaza Hotel)	(1)	★★★
Windmill Café & Bar, Brooklyn	(1)	★★
Yangtze Chinese	(1)	★★★★½
Zealandia Café, Karori Sanctuary	(1)	★★★½

In a Class *of its Own*

The unmistakable look of Hand-held Analyzer Type 2270 can overshadow a number of discrete yet significant distinctions which make this powerful instrument the complete toolbox for sound and vibration professionals. These include:

- Integrated digital camera
- Two-channel measurement capability
- Integrated LAN and USB interfaces for fast data transfer to PC and remote control and monitoring of Type 2270
- Environmental protection IP44

Versatile in the Extreme

Type 2270 also boasts a wide range of application software modules that can be licensed separately so you get what you need when you need it.

Currently available measurement software includes:

- Sound Level Meter application
- Real-time frequency analysis
- Logging (noise level profiling)
- Sound and vibration recording
- Building acoustics
- Tonal assessment

Type 2270 meets the demands of today's wide-ranging sound and vibration measurement tasks with the accuracy and reliability associated with Brüel & Kjær instrumentation.

To experience the ease-of-use of Type 2270, just go to www.bksv.com and view the on-line video demonstrations.

For more information please contact your local Brüel & Kjær representative

Hand-held Analyzer *Type 2270*

Brüel & Kjær

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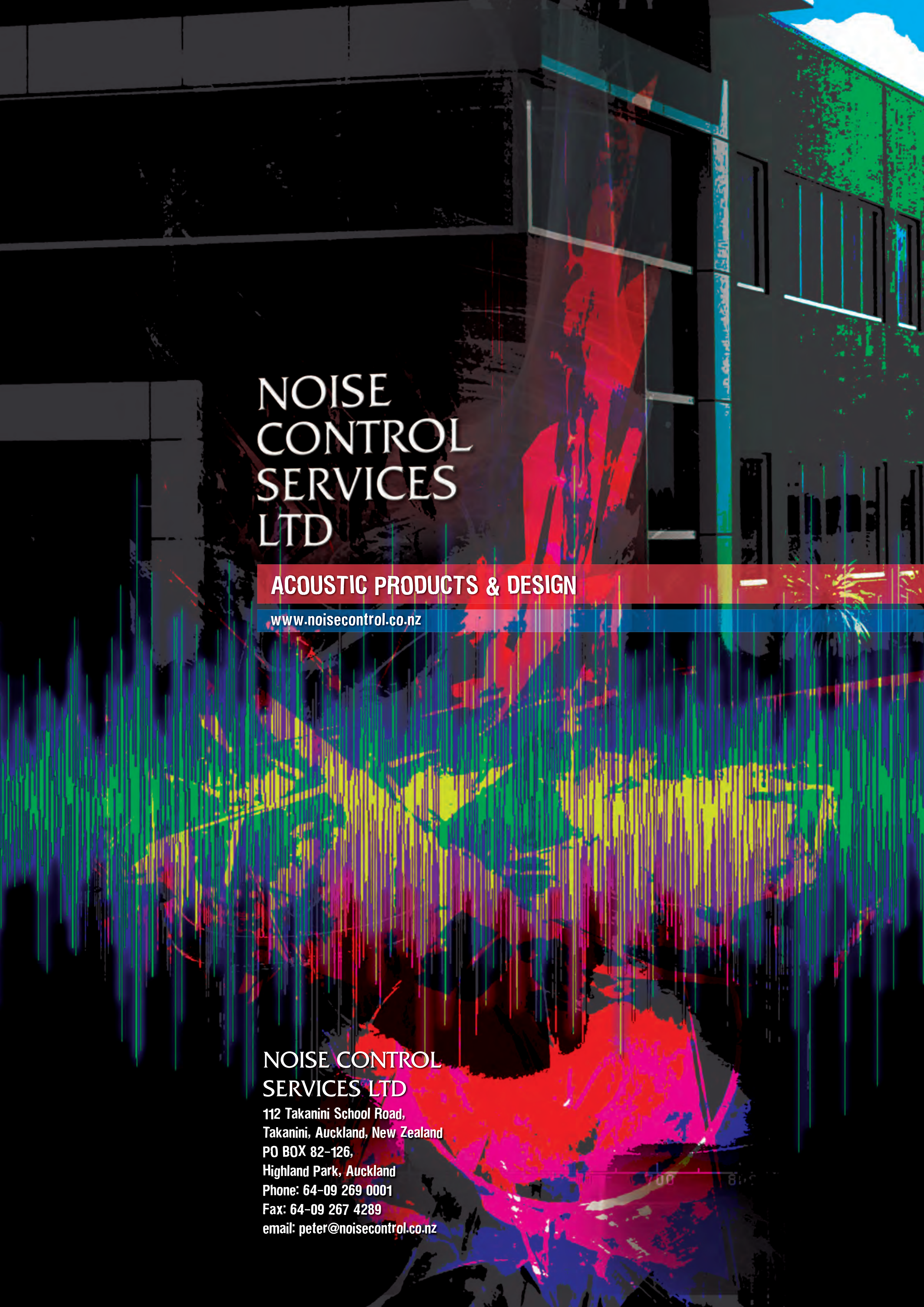
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