New Zealand Acoustics

Volume 31, 2018 / # 1

The Acoustical Society of NZ
Conference 2018
Auckland

Making the Building Boom Quiet!

The Maritime Room — Princes Wharf — 12 to 14 November 2018

Better spatial acoustics in acute clinical environments: overcoming the infection control challenges in material selection

Acoustical design of medium-density housing: New Zealand Research Summary

Method to predict airborne flanking through concrete floors with nibs at the base of lightweight walls using ISO 12354-1

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Features

Regulars

Cover Image: Logo for the ASNZ Conference 2018

Source: James Whitlock

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President's Column

Dear ASNZ Members, Associates and Fellows,

Welcome to the first Journal issue of 2018 - another sterling effort by the editorial team. The 15th World Congress on Environmental Health was recently held in Auckland, hosted in fantastic fashion by the New Zealand Institute of Environmental Health. The Congress brought together a most prestigious congregation of environmental health professionals from around the world to our most wonderful wee corner of the globe.

Having spoken at the Congress, and having spoken with a number of the delegates, it seems appropriate to talk about the health issues associated with acoustics here too, as it really is a core component of the work and study that a lot of the ASNZ membership undertakes every day. Even if not at the forefront of our daily work or cited in every report or paper, the excellent research that has been undertaken on health effects around the world is often underpinning our findings and opinions.

In many towns and cities we are striving to cope with significant population growth; building roads, railways, sea ports, airports, schools, houses, hospitals and hotels, all of which are designed to comply with a myriad of different standards and statutes. Sometimes those standards and statutes are inconsistent or they might not always be suited precisely to the job at-hand, and sometimes they fail to deliver their intended outcome if applied too rigidly. In those cases we owe it to ourselves and to those who might be affected to get the problem out in the open to see if it can be dealt with. Sometimes the rules don't allow for discretion, but sometimes they do. For example, it is no good specifying fancy thick glass to insulate a house from high levels of transport noise to meet a rule in a District Plan if the families that live in them have little choice but to keep the windows open all summer (and half of winter in many places) just to stay cool – but letting all the noise in – all because the District Plan rules didn't get the ventilation and cooling requirements quite right.

Attending the Congress has reminded me of the significance of adverse noise-related health effects that we often deal with or give advice on as professionals, whether it is the assessment of occupational noise exposure in a print shop, or helping a Council decide on the appropriateness of residential noise limits in a District Plan that could affect hundreds of thousands of people. The World Congress on Environmental Health has been attended by a large number of esteemed professionals, all motivated to protect the health and wellbeing of our populations in what are often some pretty challenging circumstances. It seems so appropriate that in the various offices and positions held by members of the Acoustical Society of New Zealand, we too should be motivated to do what we reasonably can to protect the health and wellbeing of those who are exposed to the effects of our advice.

The ASNZ is hosting its biennial conference in November 2018 and the organising committee are working hard to put together a thoroughly interesting and informative program. Let's get in behind them, write some papers, book your flights and we can make it a cracker.

Best wishes, *Jon Styles*

Editor's Column

Welcome to the first New Zealand Acoustics Journal of 2018 (Volume 30, 2018 #1). We hope you all have had a great break away and by now will be well back in the swing of things with winter quickly approaching. We know from recent events in the news that the South Island has had snow fall and storms and in a similar vein that Auckland has recently had storms with extreme winds resulting in wide spread power cuts. Extreme weather seems to be a normal part of everyday life now and winter is not looking too promising!

In this edition we have a host of papers that we hope will interest you. Staring with one on better spatial acoustics in acute clinical environments.

This edition also has its regular pieces including News, Future Events, Quiz and our recent Member Profile with Dr George Dodd from Auckland University. We note, if you're interested in taking part in the Member Profile, please contact us, as we want to try and cover a broad spectrum of all the membership. Don't be shy!

You will see the cover of this issue has the up and coming ASNZ Biennial Conference. As noted by Jon we would also encourage all members to take part in the conference and consider preparing a paper, which of course we would love to then publish for the wider membership in New Zealand Acoustics. A lot of time goes into preparing the conferences so your support is always welcome.

All the best, Lindsay & Wyatt journal@acoustics.org.nz

News, Reviews, Profiles & Events

Obituary – Professor Neville Fletcher

Neville Fletcher passed away on 1st October 2017.

Neville was born in Armidale, NSW in 1930. He was educated at Armidale Demonstration School (1935-41) and at Armidale High School (1942-46). He attended New England University College, which was part of Sydney University, receiving a BSc in 1951. Fletcher then went to Harvard University where he gained a PhD in 1955 for his research on impurity levels in semiconductors.

Neville returned to Australia in 1956 to work in the Radiophysics Division of CSIRO. After 4 years at CSIRO, Fletcher moved to the University of New England where he was a senior lecturer in physics (1960-63) and then professor of physics (1963-83). Here Neville's research interests included musical acoustics and studies on the physics of ice and water. In 1983 Neville was appointed director of CSIRO's Institute of Physical Sciences, a position he held until 1987. When he completed his term as director, he remained at CSIRO as a chief research scientist until 1995.

Neville made significant contributions to other aspects of acoustics. For about ten years he was Associate Editor for Musical Acoustics for JASA, and also acted for much of the same time as chair of the three person Editorial Committee for the local journal Acoustics Australia.

Neville's many awards recognise his outstanding contribution to acoustics and include fellowship of two academies, the Silver Medal of the American Acoustical Society, lifetime membership as Fellow of the Australian Acoustical Society and membership in the Order of Australia.

The Acoustical Society of New Zealand passed on their condolences to Professor Fletcher's family. Neville was the loving husband of Eunice (dec), father of Robin, Anne and John, father-in-law of Ben and Kelly, grandfather of Joseph and Martin (Schutte), Claudia and Anna, great-grandfather of Greta

Journal Feedback and Comments

If you have any feedback on what you would like to see in future issues or even things you don't like to see, please share with us via email to journal@acoustics.org.nz, we would like to hear from you! All comments and feedback is treated as confidential by the Editors.

New ASNZ website soon...

Dr Emms the NZ Acoustics Journal Sub-editor in charge of technology, which includes our website, has been over the last few months working in the background to update the website, including work to the CPD Scheme for continuing development to allow CPD forms to be submitted on-line. The updated website will go live later this year. We thank Grant for all his hard work on this to date and look forward to seeing the new improved website.

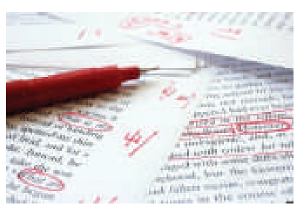
The Acoustical Society of New Zealand

www.acoustics.org.nz

The ASNZ webpage contains a host of information including information on Membership, Journal Information and Journal Articles, Continuing Professional Development, Cafe and Restaurant Acoustic Index, Standards Committees and Standards, the Latest News and Discussion and Contact details of the Society.

Why not visit for yourself?

Journal Sub-Editor Required



Later this year Dr Stuart McLaren the NZ Acoustics Journal Sub-editor will be stepping down from this position due to retirement. We are actively looking for a replacement for this position. If you are interested please contact Lindsay and Wyatt at journal@acoustics.org.nz

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Better spatial acoustics in acute clinical environments: overcoming the infection control challenges in material selection

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Abstract

Published research has established that noise creates adverse effects on patients and staff in acute clinical areas. While the extent of building insulation in the form of walls and doors is frequently not that critical to patient care, the operational noise produced by actual healthcare activities has much more acute effects on patient and staff wellbeing. Evidence exists to show the genuine benefit that acoustic absorbers can have on staff attitudes, patient care and actual medical outcomes. However the actual implementation of absorptive surfaces to reduce reverberation and operational noise is commonly assumed to be an infection risk due to porosity of the surfaces and absorption is subsequently omitted.

Through surveys of infection specialists, designers and literature review, evidence suggests that concerns about infection spread via acoustic ceilings and well designed panels are not well founded for most clinical spaces. Cleaning and infection specialists expectations and procedures do not always align with architectural and acoustic design approaches. The result is missed opportunities to improve patient care without inheriting undue risk for spread of infection.

Common ground exists between improved clinical outcomes, infection control needs (as set out in the Centre for Disease Control and Australasian Health Facility guidelines) and absorptive acoustic products. To reach this common ground, acoustic designers must be conscious of how the personal experience of key healthcare stakeholders can have significant influence on the assumptions and expectations. Acoustic designers need to actively seek guidance from key stakeholders to get an understanding of their specific goals to determine if absorbers can help achieve these goals. For facilities managers, designs that improve re-admission rates are critical. For cleaning and infection control managers, continuity of established cleaning processes and materials that can be wiped down are critical. Failure to convince these stakeholders of the proven benefits for better spatial acoustics will mean more missed opportunities to improve genuine healthcare outcomes.

Keywords: hospitals, infection control, absorbers, AUSHFG, CDC, ceiling tiles

Originally published in the Proceedings of Inter-noise 2017, Hong Kong.

1. Introduction

The need to control the passage of infection is well understood when designing new healthcare projects. However design consultants seem to have a lesser level of understanding among of how to effectively balance this requirement in conjunction with other important aspects. The author's experience of continual involvement in multiple healthcare projects across 13 different hospital sites across New Zealand and Australia over 15 years is that very few design team members have a detailed understanding of which acoustic products will actually pose an infection control risk and which will not. On one hand, this is not surprising as the design team members have their own specialties which are focused in other areas such as architecture, building services or acoustics. At the same time however, good design teams will avoid making assumptions about design requirements when it comes to key user group decisions and requests. The user group consultation and costing processes should ensure that the design team makes no assumptions in understanding the user expectations while balancing the costs of the design with available capital budget.

It is common for acoustic designers to find stiff resistance from healthcare stakeholders or design team members to their ideas of introducing absorptive products in acute care or other spaces because of perceived infection control risks. Yet the question about what those risks may actually be and how they can be managed seems to generally go unanswered in any detail. The general industry understanding appears to be relatively limited to an expectation that anything less than a hard and impervious surface such as. plasterboard, vinyl or glass, represents a degree of compromise for infection control. While this is certainly the author's experience, a review of available publications advocating for hard surfaces out of caution shows a similar trend elsewhere. Some typical advice for design teams is:

Acoustics in Healthcare Environments[1]:

- Understand that many of the design strategies used for infection control in healthcare environments can have a negative effect on the acoustic environment if not carefully considered. For example, hard surfaces are often specified for their cleanability but these

1 Ceilings and Interior Systems Construction Association

surfaces often reflect sound, creating reverberation -

UK Health Technical Memorandum:08-01

- Appropriate acoustic treatments can have a dramatic effect on the acoustic comfort in a room. However, the treatments have to be used with care because of the potential implications of infection control, cleaning, impact damage etc. Sound-absorbent treatment should be provided in all areas (including all corridors), except acoustically unimportant rooms (for example storerooms etc), where cleaning, infection-control, patient-safety, clinical and maintenance requirements allow.

Thus, a contentious designer, who wishes to advocate an absorptive treatment to an acute care space, knows infection control is important but has very little guidance on how to demonstrate they have addressed these valid concerns.

The acoustic designer advocating for a well considered sound absorber is likely to be challenged about their recommendation due to historical bias, uncertainty or concern of additional costs. This may occur across a range of key decision makers both in the design team and the wider project team. Because of the real risks that infections pose to patients and healthcare staff, these decision makers are rightly cautious about untried techniques and designs. They perhaps view acoustics as significantly less important to the project's successful outcomes than the need to prevent any possible risk of infectious growth in the absorber. Without understanding these valid concerns, the acoustic advisor or other key design team members cannot address them. Without the concerns addressed, architects and project teams will understandably avoid documenting a 'risk item', preferring to defer to a safer solution of hard finishes that are known to be cleanable.

But this level of understanding does a disservice to previously published acoustic research. This forms a significant basis for justifying the benefits of spatial acoustic treatments that are often omitted, possibly ahead of many other sound insulation items that incur much more significant capital costs but are potentially less warranted. It is not the author's intent in this paper to further add to the objective evidence base to argue for better spatial acoustics outcomes, but rather to provide guidance on how to translate these conclusions into more facilities in a way that still addresses concerns around infection control.

Therefore, if acoustic designers are to successfully engage key decision makers to build an appropriate facility that properly balances acoustic finishes and infection control, they need to:

1. Understand the basic principles of infection control and cleaning to identify appropriate products
2. Gain a greater understanding of where these recommendations will be appropriate
3. Make the decision makers aware of the significant number of studies that show genuine healthcare benefits for improved absorption.
4. Ensure they understand who the key decision makers are and what their concerns are. Specifically, what is the healthcare provider's approved cleaning regime for wall and ceiling finishes.
5. Answer the concerns of key decision makers in a way that clearly states the benefits and manages concerns.

2. What evidence exists?

Some acoustic designers may feel the level of engagement outlined above is excessive when compared to their usual scope on similar sized projects in the residential or commercial building sectors. Accordingly, it is worth considering the reasons why acoustic designers should embark on such a process at all. The answers lie across a number of previously published paper's however an extensive summary of building aspects by Salonen et al (2013) noted the following:

> *Among patients, noise is one of the features of the ambient environment that patients complain about most frequently (Ulrich et al. 2008). Studies have found that among patients, reduced noise levels (e.g. by using noise-reducing finishes such as high-performance sound absorbing ceiling tiles or by using architectural features such as single-bed patient rooms and short corridors (Joseph and Ulrich 2007; Ulrich et al. 2008)) improve sleep, reduce annoyance, improve satisfaction, reduce both pain and the use of pain medications, decrease psychological and physiological stress, reduce emotional exhaustion, reduce headaches, promote better communication between patients and family members, enhance patient privacy and confidentiality, improve safety (reduce medical errors committed by staff), decrease heart and respiratory rates, decrease blood pressure, increase oxygen saturation, decrease confusion and disorientation, shorten recovery time and hospital stays, and reduce re-hospitalization.*

A summary of the specific benefits of absorptive surfaces from Ulrich and Joseph (2007) has further collated some previous evidence noting in summary:

> *At least three studies have shown that installing high-performance sound-absorbing ceiling tiles and panels results in reduced noise levels and perceptions of noise and impacts other outcomes such as improved speech intelligibility and reduced perceived work pressure among staff (Berens and Weigle 1996; Blomkvist et al. 2005; MacLeod et al. 2006; Hagerman et al. 2005). Though decibel levels were not greatly reduced as a result of the ceiling-tile intervention in these studies (reduction of 3 to 6 dB(A)), reverberation times and sound propagation were significantly reduced. This impacted the perception of the unit being less noisy and also improved speech intelligibility, which has implications for*

staff communication (Blomkvist et al. 2005).

2.1 The evidence for acoustic absorption

Acoustic designers for healthcare space are encouraged to review the extensive range of papers available prior to embarking on the design of any sort of acute facility. While there is a particular need to do so to understand the specialist requirements such as Neonatal Intensive Care Wards (NICU), Audiology, Burns, Birthing, and MRI, designers should not lose sight of the need to still actively design for good patient outcomes in more typical inpatient areas.

Extensive survey work has been completed by a number of authors. A comprehensive and consistent survey of 4 UK hospitals' inpatient areas was documented by Shiers (2011). Her conclusions about the worst noise issues are consistent with other reviews that identified difficulty sleeping due to excessive noise events that is a regular complaint in many hospitals. The sources of noise in question are invariably related to operational effects such as staff, clinical equipment, patients and visitors. The Building Services noise, room to room sound isolation (provided doors are closed) and even external environmental noise sources rarely, if ever, make it onto complaint lists. It is informative to note that the hospitals surveyed were all completed prior to the HTM 08-01 document being published so are highly likely to represent a much lower level of sound isolation than this document requires.

From a purely building design perspective, the simple acoustic solution to reduce the disturbing effects of many of these internal sources would be to introduce acoustic absorption. However adding new finishes incurs capital costs that may not have been budgeted for and may raise concerns if there is a lack of information about how to introduce absorption safely. Professional architects and acoustic engineers are likely reluctant to advance an acoustic design where they suspect patient safety may be compromised. Therefore, acoustic designers engaged to minimize the cost and maximize the health benefits of their designs should have a keen desire to introduce absorptive surfaces as a top priority.

Within reason, the survey evidence of patient annoyance indicates that improving spatial acoustics should take precedence over some of the more traditional sound isolation goals that are often set. For example, HTM 08-01 recommends a sound isolation rating of DnTw 47 between single bedrooms. This requires a substantial wall in the order of STC/Rw 52-55, heavy upgrades to in-ceiling services, upgrades to façade connections and improvements to the corridor walls/doors. All of these are a significant capital expenditure but will be rendered largely useless if the typical nursing practice of maintaining open doors is followed. By contrast, improvements to absorption will reduce the noise levels of all manner of activities, staff and other patients. The Hagerman et al study (2005) of a Coronary Care Unit that simply switched from reflective tiles to absorptive tiles also noted among a range of other subjective improvements that patients treated during the period that the unit had absorptive tiles considered that the staff attitude was much better than the reflective tile period.

3. Project decision makers: Who are they and what are their key concerns

Just as there is no fixed staff structure that applies to all health care projects there is no specific person that needs to make the decision on the wall and ceiling finishes. Most designers will be engaged via the department of the health care provider that deals with projects. This arm often goes by different names including:

- Capital works
- Facilities
- Projects
- Estates
- Assets

Interviewees for this research indicated that the Project decision makers (the lead client contact at the hospital and the wider group they report to) will be looking most closely at re-admission rates, bed days and the balance of capital vs operational expenses. Hagerman et al's 2005 study noted significantly reduced re-admission rates attributable to absorptive ceilings.

By contrast, the key people that best understand infection control and cleaning procedures will generally be in a different department that consults with the projects department. During this research, it was noted that the infection control and cleaning teams were found to be part of any one of the following departments depending on the particular hospital structure.

- Pathology
- Product Safety Infrastructure Group
- Clinical Support or Operations
- Laboratories
- Chief Nursing Officer
- Community/Commercial/Support Services

Interviewees for this research indicated that the infection and cleaning specialists will be looking most closely at how the acoustic product will be cleaned and whether it will require any specialist approaches.

However, during the interviews, a trend was noted that the extent and, more crucially, the timing to which infection control advice is provided on a new project can vary greatly. Some interviewees noted examples (unrelated to acoustics) of late identification of an issue at construction stage had the potential for significant disruption to the project whereas early queries could have streamlined resolution. For the acoustic advisor who is considering recommending a spatial absorber that may be contentious, it is recommended that they actively seek out any potential concerns during the preliminary design stage. This should firstly be sought from the health care planner and then secondly from the operations/cleaning team. It should be noted that if the health planner is not able to be convinced of the benefits and means by which concerns could be allayed, the remainder of the economic and user group decision makers are likely to be similarly unenthusiastic about the proposal.

3.1 Approved cleaning regimes

A key aspect that acoustic advisors must appreciate is that hospitals need rigid cleaning procedures so as to ensure all necessary cleaning occurs. Therefore new products that require different cleaning methods are likely to be harder to obtain approval for, if it means a new procedure is required. Acoustic advisors finding resistance to the introduction of wall panels should enquire with the project's Health Planner first and foremost who can advise on the cleaning procedures that will be used for the walls. Some hospitals may stipulate the cleaning methods that will be used and the infection control team will advise on whether products can be accepted by comparing proposals to the cleaning methods. Conversely other health care providers will take a less prescriptive approach and may simply want to know from the project team what the cleaning requirements will be.

4. How do designers avoid possible 'negative effects'?

Interviewees for this paper noted that the personnel in cleaning or infection control specialist roles often come from a wide variety of backgrounds. This in turn brings a wide variety of responses to new concepts such as softer finishes in clinical areas that have traditionally been plasterboard. If infection and cleaning specialists appear to be resisting the use of soft finishes, it should be remembered that there can never be a zero risk in any patient space because of the necessary movement in and out of the room of healthcare staff and visitors etc.

Successful healthcare is known to not solely rely on good medical procedures and infection control but also getting the right balance on a wide range of environmental[2] (acoustics, HVAC, thermal, lighting, "*views of nature*", ergonomic conditions and furniture), and psychological factors. Accordingly, a pragmatic approach to cleanable acoustic products in patient areas should not require the design to meet an unrealistically high standard of zero risk when the overall patient space is already somewhat compromised. Thus good health care design remains a compromise even as far as infection control is concerned

2 per Salonen et al 2013

to enable the patient to recover the quickest.

Further complicating the introduction of absorptive finishes are the conflicting recommendations for what is appropriate. Eg: Australasian Health Facility Guidelines, U.K. HTM-60 and hospital specific guidelines

Many of these documents will suggest smooth plasterboard ceilings but this is not because of any particular evidence that a more absorptive finish represents an unmanageable infection risk or burden. Indeed; "*The potential for transmission from contaminated hard-surface floors and walls is small unless there is existing moisture or residual stickiness present*"[3].

Where suspended tile ceilings are concerned and wipeable finishes readily available, cleaning and infection control advisors are most likely to be concerned about any gaps that the tile system could create if not properly seated. In that sense, a plasterboard tile is overall a worse solution than a well built acoustic tile as the need to manage the gap risk is introduced but no acoustic benefits are realized. Concerns about tile gaps appear to be manageable through proprietary clips if necessary. However, a number of hospitals have adopted absorptive ceiling tiles in patient ward spaces without any known issues related to that configuration (refer 5.4.1).

5. What do infection control regimes really do?

Infection control is now a key component with a dedicated team for all modern healthcare providers. It is typically their role to advise on a wide range of topics including cleaning procedures and design requirements. The USA based Centre for Disease Control is frequently referenced for infection control matters. It notes that what lay people would consider 'cleaning' is in fact comprised of two separate processes: cleaning and disinfection.

- Cleaning is the removal of foreign material (e.g. soil, and organic material) from objects and is normally accomplished using water with detergents or enzymatic products. Thorough cleaning is required before high-level disinfection and sterilization because inorganic and organic materials that remain on the surfaces of instruments interfere with the effectiveness of these processes.
- Disinfected means free of pathogens e,g no viruses, bacterium, protozoa, prion, fungi, or other micro-organisms on the surface.

Operations and infection control representatives from two District Health Boards in the Auckland region of New Zealand were interviewed to understand more about the specific cleaning considerations that are relevant when considering introducing softer wall and ceiling finishes into clinical spaces. Auckland District Health Board (ADHB) operates the central Auckland Hospital base hospital for central Auckland. Counties Manukau District Health Board (CMDHB) operates Middlemore Hospital, the base hospital for south Auckland.

5.1 How does a wall or ceiling get cleaned?

Both ADHB and CMDHB representatives advised that their approved cleaning procedures for walls and ceilings will only ever involve soft cloths rather than scrubbing with a coarse brush. Coarse brushes are avoided so that the surfaces do not become scratched as microscopic grooves are better at harbouring pathogens than those that are smooth. If wiping the surface of a ceiling tile was insufficient to remove visible soiling, cleaning specialists have advised that the tile would be replaced. As with any non-porous item that gets splashed with an infectious substance, if that undesirable substance is removed in a timely manner before it becomes caked on, wiping the surface with an appropriate cleaner will generally be sufficient to remove the undesirable matter.

CMDHB and ADHB respondents noted that it is a widely accepted fact that a clean surface that has not been disinfected can only make someone sick if the pathogens can get transferred off that surface and make it past the human body's natural defences such as skin. In other words, a surface may not need disinfection if it is not going to come into contact with anyone or anything that may subsequently touch someone.

Cleaning products are distinct from disinfectants. Surfactants are cleaners with detergent basis that break up the matter to be cleaned. Only once the visible matter is removed with a surfactant can a disinfectant be used to kill any non-visible pathogens.

CMDHB representatives noted that the primary disinfectants used in New Zealand for hospital cleaning purposes come in three grades for different purposes.

- **Quaternary ammonium** – the lowest strength disinfectant which is appropriate for items that may come into direct skin contact.
- **Alcohol based** – medium strength disinfectants which have the advantage of drying quickly which is useful for a patient contacting non-critical items such as pressure cuffs. Alcohol disinfectants either dry themselves in a short time or are wiped off.
- **Vaporizing Hydrogen peroxide** – The strongest disinfectant used to clean patient areas. Due to its very strong odor and potential for harm to humans if inhaled, it is only used when people are not present in the room. The two largest hospitals in Auckland city, Auckland Hospital and Middlemore Hospital, utilize automated vaporizing systems that are left unattended to release Hydrogen Peroxide vapour that is then left for sufficient time until all room surfaces

3 refer Alyffie per *Limiting the Spread of Infection in the Health Care Environment*

are contacted. CMDHB representatives noted that these systems are also used extensively in other large hospitals in Australasia and have the advantage of not relying on a staff member to be vigilant with their disinfection regime. While these systems would disinfect walls and ceilings, the main driver for their use is understood to be the consistently high quality of cleaning on surfaces that would be disinfected manually.

5.2 When does a wall or ceiling need to be cleaned?

There appears to be no well published guidance for Australasian facilities that a wall or ceiling with soiling that harbours typical pathogens (e.g. not in a critical isolation setting) can lead to illness unless the infectious substance gets transferred to a semi-critical surface through contact. However, regardless of the actual infection risk, it is standard practice in hospital settings for any visible dirt or soiling to be cleaned off immediately. This is partially because it is naturally unsightly to a patient but also because soiling from body fluids etc is an excellent growth medium for any residual pathogens. As such, walls and ceilings in typical patient spaces need to be able to be wiped clean.

5.3 Center for Disease Control guidance

The Center for Disease Control (CDC) in the USA published the *Guideline for Disinfection and Sterilisation, 2008* (CDC Guidelines) which contains heavily researched information on best practice for hospital cleaning. Health planners and operations/infection control staff interviewed for this research noted that this guideline document is regarded as an accepted source of guidance. It is informative to note how these guidelines categorize walls and ceilings as 'non-critical environmental surfaces".

Of particular interest are the following **with emphasis added**:

- Non critical-items: Noncritical items are those that come in contact with intact skin but not mucous membranes. Intact skin acts as an effective barrier to most microorganisms; therefore, the sterility of items coming in contact with intact skin is "not critical." In this guideline, noncritical items are divided into noncritical patient care items and noncritical environmental surfaces *Examples of noncritical patient-care items are bedpans, blood pressure cuffs, crutches and computers. In contrast to critical and some semi critical items, most noncritical reusable items may be decontaminated where they are used and do not need to be transported to a central processing area.* **Virtually no risk has been documented for transmission of infectious agents to patients through noncritical items when they are used as noncritical items and do not contact non-intact skin and/or mucous membranes.**
- *Non- critical environmental surfaces include bed rails, some food utensils, bedside tables, patient furniture and floors. Noncritical environmental surfaces frequently touched by hand (e.g., bedside tables, bed rails) potentially could contribute to secondary transmission by contaminating hands of health-care workers or by contacting medical equipment that subsequently contacts patients /or mucous membranes.*

Earlier publications note similar recommendations around the actual level of risk from walls. For example, Alyffie 1999 notes "*The potential for transmission from contaminated hard-surface floors and walls is small unless there is existing moisture or residual stickiness present*".

The CDC Guidelines provide detailed recommendations [4]on the cleaning of walls and ceilings as follows:

4 **Selection and Use of Low-Level Disinfectants for Noncritical Patient-Care Devices**

a. Process noncritical patient-care devices using a disinfectant and the concentration of germicide listed in Table 1. Category IB.

c. Ensure that, at a minimum, noncritical patient-care devices are disinfected when visibly soiled and on a regular basis (such as after use on each patient or once daily or once weekly). Category II.

5 **Cleaning and Disinfecting Environmental Surfaces in Healthcare Facilities**

d) Clean walls, blinds, and window curtains in patient-care areas when these surfaces are visibly contaminated or soiled.

It is interesting to note that where there is a recommendation of disinfection and cleaning for non-critical patient care devices (4A & 4C) that will touch skin, the recommendation is only for cleaning of walls (5D). Furthermore, it is relevant that there is no recommendation for cleaning or disinfection of ceilings anywhere in the extensive CDC guidelines. That is not to suggest that wall and ceiling surfaces do not need the ability to be effectively disinfected if circumstances require, but it is highly unlikely to form part of regular procedures.

5.3.1 New Zealand specific examples

Both ADHB and CMDHB procedures are essentially consistent with the CDC recommendations where walls and ceilings in normal inpatient areas such as ward spaces, consulting rooms and treatment rooms are actively cleaned and disinfected by hand only when visibly soiled. However they are not wiped or disinfected on a regular basis.

The exceptions to this would be if patient immunity was lower or a patient presented with a particularly infectious disease in which case the walls would be disinfected at the end of the patients time in that room.

4 page 83, Recommendations for disinfection and sterilization in healthcare facilities

5.4 Australasian Health Facility Guidelines

The Australasian Health Facility Guidelines (AUSHFG) are frequently referenced for new healthcare fit outs and buildings as a design requirement in the Australian and New Zealand marketplace. In the Australian healthcare industry where the guidelines originated from, compliance with these guidelines often forms a mandatory requirement for funding approval. In New Zealand these are not likely to be mandatory for projects at the current time but the expectations for general compliance are increasing. The following excerpts represent the relevant portions that acoustic advisors should be aware of if they need to comply with these guidelines:

PART C

03.12 CEILINGS AND CEILING FINISHES - INFECTION CONTROL

- *Each area within a facility will require a different degree of infection control management or standard of hygiene. Collaboration with the facility infection control representative and compliance with the current infection control policy in each jurisdiction is a required part of the risk management process.*
- *Select and design ceilings to support the level of infection control management required in each space.*
- *Ceilings are covered by AS Handbook 260 Hospital acquired infections - Engineering down the risk (Stds Aust 2003a) as follows. In Section 5 - Rooms suitable for Infection Control purposes - recommendations for ceilings for Type 4 and 5 rooms (standard isolation and respiratory isolation) include:*
  - *ease of cleaning and suitability for cleaning methods to be used;*
  - *continuous, impervious and durable finishes;*
  - *elimination of joints, gaps and features supporting microbial growth;*
  - *ability to withstand disinfecting and cleaning agents without deterioration; and*
  - *sealed penetrations for fittings in walls and ceilings e.g. pipes, light fittings, for Type 5 rooms for respiratory isolation.*
- *Although ceilings rarely become soiled with any hazardous matter, use a smooth washable finish in areas where splash or spillage might occur e.g. Resuscitation Rooms in Emergency Departments, Operating Rooms or where routine wash down or isolation is required.*

Use of Acoustic Finishes

- *Most acoustic ceiling tile products consist of absorbent materials with a porous surface and are generally used with a suspended grid system either exposed or concealed. Both of these factors usually exclude their use in areas where infection control or hygienic conditions are required.*
- *Acoustic products specifically produced for use in clean areas should be assessed on their tested performance.*
- *The use of acoustic tiles should be avoided in areas where splash spillage can occur.*

PART 3.14 WALLS

(No specific provisions are given here other than the following general requirement to select wall finishes to adequately address the following):

- *durability and resistance to impact from furniture, trolleys, aggressive patients, etc;*
- *ease of cleaning and retention of appearance over time;*
- *fire hazard properties; and*
- *requirements for infection control.*

Part D

04 SURFACES AND FINISHES

04.01 General

- *All surfaces in patient care areas should be smooth and impervious, and easily cleanable.*
- *Where there is likely to be direct contact with patients, or with blood or body fluids, floors and walls should be surfaced with smooth, impermeable seamless materials such as vinyl.*

04.02 Ceilings

- *Ceilings in operating and delivery rooms, isolation rooms, nurseries and sterile processing rooms should be monolithic from wall to wall without fissures, open joints or crevices that may retain or permit the passage of dirt particles.*
- *Acoustic and/or lay-in ceilings should not be used where particulate matter may interfere with hygienic environmental control.*

04.06 Walls

- *Other than special treatments included as feature face work in public or staff recreation areas, wall finishes should be smooth and easily cleaned, and where in the immediate vicinity of plumbing fixtures, water resistant.*

5.4.1 Discussion of AUSHFG requirements

While the AUSHFG guidelines require cleanable surfaces, they do not preclude the possibility of appropriate impermeable materials being used on walls provided they can be cleaned. For manufacturers looking to provide products into healthcare environments, it will be important to provide a high level of robust technical documentation that evidences the ability of normal cleaning products and methods (refer 5.2) to result in a clean and infection free surface in the event it becomes soiled. Similarly, manufacturers of absorptive panels need to develop details and fittings that secure the panels without introducing problematic edges, gaps or ledges that will gather dust.

Likewise, the possibility of ceiling tiles is not precluded in most spaces other than via Part D 4.02 for "*operating delivery rooms, isolation rooms, nurseries and sterile processing rooms*" unless there is a risk of particulate matter interfering with "*hygienic environmental control*". The AUSHFG do not expand on the extent of interference deemed appropriate but it is informative to note that many ward spaces such the new Royal Adelaide Hospital, the Royal Children's Hospital (Melbourne) and the Edmund Hillary Block (Middlemore Hospital, Auckland) all feature acoustic ceiling tiles. In other words, precedents exist at major hospitals for appropriate ceiling tile applications in patient areas. It is expected that particulate matter concerns relate more to degradation of the tile surface or if tile removal and exposure of the ceiling void would be overly problematic to the use of the room. Operations personnel at ADHB and CMDHB both noted that removal of acoustic tiles is relatively rare (more often due to water damage rather than soiling) but not problematic in ward spaces as this is typically done with the patient out of the room. Possible scenarios where particulate matter concerns would exist may be those that are required to be clean and dust free 24-7 such as clinical sterilization spaces.

6. Conclusions

The use of acoustic absorbers tiles has been evidenced to provide genuine improvements to the patient environment. Where these are in the form of wipeable absorptive wall panels at high level or wipeable absorptive ceiling tiles that cannot readily be touched, the cleaning requirements should not be particularly onerous for compliance with the CDC or AUSHFG guidelines. Local hospital or regional guidelines may exist that are prioritised above the CDC or AUSHFG requirements but evidencing compliance with these internationally recognized documents will strongly aid the case for including absorbers.

With a well thought out wipeable panel and system that has no gaps which are hard to clean around the panels, there appears to be no evidence that would preclude the use of absorptive panels on plasterboard ceilings even in acute spaces such as surgeries or bone marrow transplant wards. However, such an approach is not the norm and acoustic designers will need to champion the benefits to the project team to see the change occur. Manufacturers will need to provide a well researched and evidenced system that can meet the normal cleaning procedures used in hospitals to get buy-in from cleaning and infection control specialists.

7. Acknowledgements

The author would like to thank the following individuals for their valuable insights: Elizabeth Bryce and Terry Rings – Counties Manukau District Health Board; Shankara Amurthalingam – Auckland District Health Board; Paul Longridge and Tonya Hinde – Billard Leece Partnership;

...Continued on Page 17

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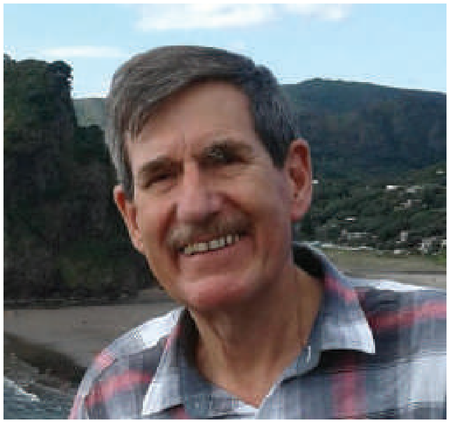
A conversation with Dr George Dodd



Location: The University of Auckland

Position: Senior Lecturer

Expertise: Building acoustics; noise control; measurement methods and techniques; noise and building standards; Psychoacoustics.

Qualifications: BSc, MSc, PhD, DipAud, FNZACS

George Dodd has had four decades of experience in teaching acoustics and in research. Increasingly his research has concerned criteria for predicting subjective reactions from objective measurements and advocating for increased insulation requirements for dwellings. Complementing this work on subjective aspects was George's work as head of the Acoustics Testing Service which uses the acoustics chambers of the Acoustics Centre in The University of Auckland as a National Testing Facility for materials and equipment. Currently George's chief research interests are in meta-materials and their applications. In 2010 George was awarded the highest honour of the Acoustical Society of New Zealand, a Fellowship, of which the Society has only four. Throughout his academic career George has taught at both undergraduate and postgraduate levels in Architecture, Engineering, Music and Audiology and has qualifications in mathematics, physics, audiology and a PhD in electro-acoustic. George was chief editor of the Journal of Building Acoustics for eight years and also a past editor of New Zealand Acoustics

1. What would you describe as the principal accomplishment of your career to date and why? *Introducing and promoting the use of rigorous scientific definitions for foundational acoustical quantities e.g. objective sound, subjective sound and noise, plus coining the word ACROMA as a technical term for non-noise subjective sounds. Establishing definitions for such quantities at the beginning of a course on acoustics is necessary to avoid woolly thinking and confusion. It is important for people to understand that we can define noise and therefore establish a scientific and logical basis for setting noise control criteria and noise limits.*

2. What are some of the challenges you face when teaching students about acoustics for the first time?
   1) *Teaching in a discipline where students are required to do the subject (e.g. it is a core component of a larger compendium course) but they are not interested or they fear it is going to include MATHS!*
   2) *Resisting pressures to teach it purely as a technical subject with – depending on the discipline – simple procedures or recipes to be followed.*
   3) *The decibel!*
   4) *"Sound absorbing materials" being thought of, and described, as "insulating materials".*
   5) *Countering the view that all that is required is knowledge of available software.*
   6) *Not showing my personal irritations of some modern usages (e.g. 'speaker' for 'loudspeaker').*

3. Why did you become an acoustician/teacher? *As a child I'd been fairly successful as a player of the clarinet and to continue as a musician I needed to attend music college but at that stage I was too young (and immature!) to do that. However, my second love at school was science and so I looked for some avenue which could combine these two interests and acoustics, when I learned what the word meant, seemed an obvious choice. As early as my first year at secondary school I put down being an 'acoustical engineer' as my preferred career. Teaching acoustics was not something I specifically chose but more the result of taking opportunities that presented. The fact that my siblings and mother were all teachers was no doubt influential too.*

   The first course I taught was on Musical Acoustics at Southampton University when I was a PhD student. However, looking back on my teaching career and my original aim of being an acoustical engineer, I am mindful there is some truth in George Bernard Shaw's famous line "He who can, does. He who cannot, teaches."

4. What are your hobbies and interests outside of academia and acoustics? *Growing up in UK I was fortunate to be surrounded by animals and to have pets. As a result I grew to respect and love them. This developed into a passion for vegetarianism about which I was quite fanatical. I'm not so vocal about it these days but, as I still*

believe the world and its people would benefit if we didn't depend on killing for our food, I am active in promoting vegetarianism and trying to set an example by living a gentle and non-aggressive way of life.

Along with this has been an interest in the religious culture that I was brought up in, and looking at the values and insights contained in other religions. One of the enormous benefits for me of living in New Zealand has been meeting and learning from Sir Lloyd Geering. I still attend church – although I have great difficulty with the liturgy – because the community, music, ritual, and many of its values continue to nourish my life.

I find listening and performing music essential for my life (although I fear what truth there might be in another of George Bernard Shaw's claims that "music is the brandy of the damned"). But this depends very much on what is embraced by the term music, and I readily admit that some recent genres of 'patterned sound' that are referred to as music have only a negative impact on me.

I am an avid reader of fiction and my favourite authors are Robert Goddard and Dick and Felix Francis.

5. If you were able to drop and leave everything you're doing right now and travel to anywhere and anytime, where would you go and why? *This would depend on whether I could come back to the present when I chose. Assuming I could then, apart from some nostalgic visits back to my childhood environments (especially the Peak District of Yorkshire and Derbyshire), I would love to jump way into the future to experience what life will be like for humans when – as I firmly believe – we have become 'universal' beings occupying extra-terrestrial sites.*

6. What acoustics text book would you recommend someone starting out in the field read? *Engineering Noise Control by D A Bies and C H Hansen.*

7. How would you describe sound to someone who is hearing impaired? *As there are the two types – 'Objective Sound' and 'Subjective Sound' – two descriptions are needed. The descriptions would be tailored to the age, knowledge and ability of the person but would, in one form or another, contain the following:-*

   <u>Objective sound</u> is a flow of mechanical vibrational energy – created when a transmitting material is vibrated by a source – which, importantly, can do useful work when this flow of vibrational waves encounters objects.

   There are important uses and applications for objective sound. For example in medicine it provides a means for imaging inside our bodies (e.g. ultrasound scans), for destroying of kidney stones, and for cauterisation and ablation in surgery. But the most common and widespread use is when it works our ears to produce <u>subjective sound</u>.

   If the person we are providing the description for is hearing impaired (i.e. still has some residual hearing) as opposed to being completely deaf our description of subjective sound is easy. Then subjective sound is simply the audible sensation they are familiar with when they receive a suitable objective sound - the suitability being determined by strength and frequency content. To be complete a discussion of tinnitus would need to be included as that is also a subjective sound – but not one resulting from the presence of an objective sound.

   If, on the other hand, the person, perhaps for congenital reasons, has no working hearing system and therefore is completely unfamiliar with an audible sensation we'd begin with the description of objective sound and explain that, like vision, it offers a means by which hearing persons can gather information about their surroundings and receive messages. A normally hearing person gets this information when objective sound activates their hearing system which then transmits signals directly to their brain which interprets the message as subjective sound. Most often objective sound arrives via the air hence it is invisible and can happen whether it is day or night, also its waves can easily bend around everyday objects including our heads. Thus we can hear sound from behind us and from sources we cannot see. So it is a valuable supplement to our vision for receiving warnings and information.

8. If an eight-year-old child asked you to describe to them what you do as an occupation, how would you explain this to them in less than a paragraph? *I teach students about everything to do with sound. Although sound can do things that are useful other than letting us hear, I mainly spend my time teaching about sound that we can hear. This is either about how to make it louder and clearer when that is needed or, more often, about ways of reducing its loudness when we don't want to hear it, i.e. when it is being a noise. Part of my time is also spent on research i.e. working out ways of doing these two things more easily and efficiently.*

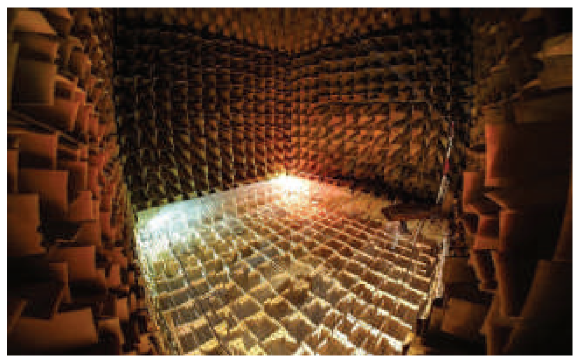
9. You are a well-respected teacher and acoustician in your own right with many people admiring your contribution to acoustics in New Zealand, however everyone has somebody they respect and admire professionally, who is that particular person for Dr George Dodd and why? *In fact there are a number of*

New Zealanders in both academia and professional practice that I admire enormously for their work in acoustics. I don't wish to put any one of these above the others so I'm going to choose a non-kiwi - Manfred Schroeder – as my admired acoustician. Schroeder's work on the detailed behaviour of sound fields and frequency responses in rooms made a massive contribution to our understanding and has had an enduring influence on the ways we measure the performance of auditoria.

10. With a rapidly changing technology and World, what are some of the issues and challenges you foresee for academia and teaching acoustics in New Zealand over the next 10 years or so?

    1. *I'm not convinced that high density urban living presents a desirable quality of life for New Zealanders but we, as responsible specialists, must try to ensure that the acoustical conditions in our dwellings and their surroundings are not a reason for diminished quality of life. This means not accepting that space and financial considerations justify compromises. We need to advocate, teach, explain and research the importance of acoustic privacy. It is necessary to strengthen our lobby for increased performance requirements in our building code and at the same time educate the general public to understand that satisfying code requirements doesn't ensure good isolation from neighbours nor allow them freedom for the modern lifestyle that they might expect. It is time to introduce quality ratings for "acoustical comfort' in dwellings.*
    2. *The primary feature of a dwelling that distinguishes it from any other form of living environment, e.g. hotel or hostel, is that it is PRIVATE. In my view, however, there is insufficient appreciation of what this means and requires. True privacy implies that we (the owners or occupiers) can control access to our dwelling - its facilities, its occupants, and information concerning those occupants and their activities. Access here clearly includes not only physical entry but also access to information transmitted acoustically through the dwelling's structure. In addition true privacy means being free from any awareness of, and interruption by, activities outside the dwelling if and when we choose it! Thinking about what we need and expect for visual privacy (i.e. windows connecting us to the outside yet being able to control this connection by using curtains and blinds or shutters) makes it obvious that true acoustical privacy similarly requires*
        - *i) two-way control – inward and outward, and*
        - *ii) the ability to vary that control.*

        We cannot provide this with present technology. So it sets us a research agenda. We must seek out and develop new ways of providing very high levels of sound insulation that can be readily varied. Ideally these should require only lightweight and sustainable materials. Perhaps this is mainly an agenda for academia but practitioners and CRIs are driving and undertaking important research too.
    3. *I'm sad that the concepts and possibilities introduced by the advent of meta-materials have emerged at the tail end of my career in acoustics. I truly feel that research and development in this area is the most exciting thing happening! If we can use these ideas to develop cloaking for buildings (and, even, individual spaces within buildings) then we will have the perfect tool for acoustic privacy. Teaching and research into meta-materials will be an engaging challenge for the next few years.*



AAAC Reflects on 2017

It's been a busy year for the Board of the Association of Australasian Acoustical Consultants (AAAC). The biggest achievement for the team has been the move to embrace our Kiwi partners and represent acoustical consultancies in New Zealand, which has led to seven new consultancies joining us. In November, the AAAC AGM and the executive committee were elected for another two-year term with only one change, Stephen Gauld now taking the reins from Neil Gross concentrating on communications and our website. To hear updates and news from us in 2018 head over to our Company Page on LinkedIn. (Summarized from Acoustics Australia Vol.45, No.3).

...Continued on Page 35

We hope 2018 has started well for you. In this issue we have details of a recent Environment Court decision in February 2018 concerning an appeal against provisions of the Proposed Invercargill City District Plan as it related to the operation of Invercargill Airport.

Following is a summary of this decision, while a full copy can be found on the RMA Net website at www.rma.net

In the Environment Court

INVERCARGILL AIRPORT LIMITED - Appellant

INVERCARGILL CITY COUNCIL - Respondent

[2018] NZEnvC 9, 29p, [57] paras, 8 February 2018

Summary of Facts

Invercargill Airport Ltd (IAL) appealed several provisions of the proposed Invercargill City District Plan as it related to the operation of the Invercargill Airport, to ensure that the Airport was appropriately protected from reverse sensitivity effects and people living near the Airport had an appropriate level of internal amenity. Parties reached an agreement, as set out in Annexure A, concerning issues including the recognition of the benefits of the airport; prohibiting certain activities within the Business, Industrial, Residential, Otatara and Rural zones; assessment matters prohibiting subdivision within the Airport's noise boundaries in the Residential and Otatara zones and allowing a conference facility in the Airport zone. During mediation, the requirements of Appendix VI - Noise Sensitive Insulation Requirements - of the Proposed Plan were highlighted not to be the most appropriate for the Invercargill context. However, neither IAL's submission nor its appeal provided scope to amend Appendix VI, as such the parties asked the Court to make the amendments sought under s 293. The Court found there was sufficient nexus and rational connection between the appeal and changes sought to Appendix VI under s 293.

Appendix VI applied to properties located within the noise boundaries for the Airport which could in the future be affected by moderate levels of aircraft noise and as such owners may be required to close their windows and door. The purpose of the Appendix was to describe the requirement to provide a mechanical ventilation system to provide fresh air to a dwelling to achieve a comfort amenity that was similar to that which could be experienced if the home owner was free to open their windows and doors. The Appendix stipulated outdoor air ventilation rates with requirements relating to noise and temperature levels of the employed systems. The evidence showed there were several practical difficulties and inefficiencies with implementing the mechanical systems in accordance with Appendix VI, as well as significant associated financial implications. The experts noted that the requirements seemed to be designed for warmer climatic conditions than experienced in and around Invercargill and air change rates were relatively high which might result in draughty, cool internal environments.

The key guiding document for managing aircraft noise at New Zealand airports (NZS 6805:1992 - 'NZS') was applied in the Proposed Plan which contained three air-noise boundaries for Invercargill Airport:

(a) Air Noise Boundary ('ANB');
(b) Outer Control Boundary ('OCB');
(c) Single Event Sound Exposure Boundary ('SESEB').

The parties proposed five changes to Appendix IV in order to achieve appropriate internal sound levels with insulation and ventilation which utilised readily available equipment that was more cost efficient to install and operate.

Specifically, the parties proposed;

(a) Acoustic treatment to apply to 'buildings' not 'activities' - making it clear that the method related to new buildings or additions or alterations to existing buildings containing noise sensitive activities and not the noise sensitive activity itself.
(b) Insulation Guideline Tables 1 & 2 - Appendix VI specified the internal noise environment to be achieved within habitable rooms (including bedrooms) within the SESEB and the OCB. The Appendix then provided a set of 'guidelines for insulation' (Tables 1 and 2).

Table 1 described the sound insulation requirements for bedrooms inside the SESEB, but there was no equivalent table for insulation of other habitable rooms within the SESEB or the OCB. As advised by Marshall Day Acoustics, modern construction methods and typical dwelling designs were held to achieve the L_{dn} internal noise criterion within the OCB and SESEB, provided windows remain closed (although alternative ventilation would need to be provided).

As such Parties suggested Appendix VI should be amended to clarify that:

(i) Table 1 only applied to bedrooms within the SESEB; and
(ii) Table 2 applied to all new and/or additions or alterations to existing buildings containing ASAN.

(c) Guidelines - Appendix VI referred to 'guidelines' for insulation, however Parties felt they were akin to rules due to their mandatory nature. As such they recommended that to ensure clarity the word 'specifications' be used instead of 'guidelines.'

(d) Achieving compliance - Appendix VI and the methods which trigged its implementation did not provide any direction or guidance around how to demonstrate compliance with the requirements set out in the Appendix, thus creating uncertainty. Parties suggested it would be appropriate to allow compliance with the requirements of the Appendix to be demonstrated by way of a compliance certificate provided by a person suitably qualified in acoustics, stating that the proposed construction would achieve the specified internal noise environment.

(e) Ventilation specifications – Parties proposed changes to Table 2 to ensure the mechanical ventilation specifications were achievable, appropriate for Invercargill and account for recent advances in technology. The amended specified noise mitigation treatments would ensure that an appropriate internal design sound level of 40dB L_{dn} was achieved within habitable rooms and SEL 65dB L_{AE} within bedrooms within the SESEB. This would maintain the amenity of persons residing in these areas while at the same time reducing the potential for adverse reverse sensitivity effects on IAL. The changes to the mechanical ventilation provisions would also enable residents within the SESEB and/or OCB to keep their windows closed to reduce the effects of aircraft noise, while still maintaining an appropriate level of outdoor air exchange and utilising readily available equipment.

Overall, the Court held the proposed changes were efficient and ensured that the requirements of Appendix VI were effective and provided greater certainty for Plan users and the consent authority and would better achieve the purposes of the Act.

Court held:

By consent under s 279(1)(b), appeal allowed to the extent that the Court directed the Council to amend the proposed District Plan in accordance with the Annexure A and B.

No order as to costs.

Disclaimer - *This article has been provided to help raise an initial awareness of some recent cases involving acoustic issues. It does not purport to be a full listing of all decisions which have acoustic issues, nor does it replace proper professional advice.*

...Continued from Page 11

Jeremy Kelly – Silver Thomas Hanley; Adam Flowers - CCM Architects; Nicholas Wedde and Sandee Stanley – Klein Architects.

Bibliography

1. Lankford G, Collins S, Youngberg L, Rooney D.M, Warren J.R., Noskin G. Limiting the Spread of Infection in the Health Care Environment Assessment of Materials Commonly Utilized in Healthcare: Implications for Bacterial Survival and Transmission. Coalition for Health Environments Research (CHER) and The Center for Health Design. 2007
2. Ayliffe GAJ, Babb JR, Taylor LJ. The hospital environment. In: Hospital-acquired infection: principles and prevention. Oxford: Butterworth-Heinemann; 1999. P.109-121.
3. Salonen, H., Lahtinen, M., Lappalainen, S., Nevala, N., Knibbs, L. D., Morawska, L., & Reijula, K. Physical characteristics of the indoor environment that affect health and wellbeing in health-care facilities: A review. Intelligent Buildings International, 5(1), 3-25. 2013.
4. Ulrich, R. S., C. Zimring, X. Zhu, J. CuBose, H.-B. Seo, Y.-S. Choi, X. Quan, and A. Joseph. "A Review of the Research Literature on Evidence Based Healthcare Design." Health Environments Research & Design Journal 1 (3): 61–125. 2008.
5. Rutala W, Weber D, Healthcare Infection Control Practices Advisory Committee (HICPAC) Guideline for Disinfection and Sterilisation, The Center for Disease Control, 2008
6. Shiers NJ. Acoustic design for inpatient facilities in hospitals, Thesis for London South Bank University, 2011.
7. Hagerman I, Rasmanis G, Blomkvist V, Ulrich R, Eriksen CA, Theorell T. Influence of intensive coronary care acoustics on the quality of care and physiological state of patients. Int J Cardiol. 2005 Feb 15;98(2):267-70.

Acoustical design of medium-density housing: New Zealand Research Summary

Tessa Phillips, Marshall Day Acoustics, December 2017

This article provides an overview of the research project "Acoustical design of medium-density housing", funded by the Building Research Levy.

The article is based on the summary at the start of the full research report, which is available free on the BRANZ website (www.branz.co.nz) *as report ER30 (parts A and B).*

1. Introduction

Population growth, demographic change, and environmental considerations, are leading to increasing densification of housing in urban New Zealand. BRANZ, New Zealand's key independent building research organisation, is currently undertaking a research programme to help ensure future medium-density housing (MDH) meets the needs of New Zealanders (for more see www.branz.co.nz/mdh). Previous feedback to BRANZ highlighted noise control as an important consideration for MDH developments.

The collaborative research project "*Acoustical Design of Medium-Density Housing*" was proposed, and funded by the Building Research Levy, to help BRANZ better understand this area and help address the following BRANZ research goal and questions:

BRANZ 2016/2017:Goal and Research Questions as listed for Research Programme 1 / Question 1 of [1]:

"*Providing the building industry with the technical information to design quality, affordable and desirable medium-density housing (MDH) in relation to noise control:*

- *What are the key issues around acoustics and noise control that will need to be addressed to provide for quality, affordable and desirable MDH?*
- *What existing information exists that can support good acoustic performance in MDH?*
- *What gaps are there with this information? Where is there a need for new knowledge? Where is there a need for improved access/uptake of existing information?*"

This summary paper provides a brief overview of the Project and its findings.

2. Research team

To provide a multidisciplinary viewpoint, the core research team included expertise in acoustics, architecture, and engineering from both consultancies and research organisations, specifically: Malcolm Dunn and Tessa Phillips – Marshall Day Acoustics; Prue Fea – Jasmax Architects; David Fullbrook – eCubed; Michael Newcombe – Enovate; Grant Emms and Andrea Stocchero – Scion; Mike Kingan and Brian Mace of the University of Auckland - Acoustic Research Centre, Department of Mechanical Engineering.

3. Research methodology

The Project was broken down into three stages.

Stage 1: Literature review of the current state of play both in New Zealand and overseas, including: information currently available, regulations, and relevant research underway.

Stage 2: Consultation with a broad cross section of building industry participants on perceptions of the key issues, information needs and how to address them. This was achieved primarily through an in-depth building industry online survey "Towards quiet housing" (over 600 respondents), but also through interviews, discussions and practical examples. Participants included those in housing design and construction, as well as those in planning, management, compliance, education and product development / supply.

Stage 3: Analysis of the Stage 1 and 2 findings to provide a comprehensive picture of the key issues and information needs, along with recommendations for solutions that could address them.

The final Project report, completed 30 June 2017 for BRANZ, detailed the full findings from all three stages. The focus was on providing reasonable protection from everyday noise through the design and construction of attached dwellings, rather than the design of planning / zoning requirements.

4. Background concepts

As housing density increases, the possibility of occupants being annoyed by sound related issues increases. This includes potential annoyance due to noise (unwanted sound) from neighbouring activities, as well as a reduced sense of acoustic privacy from increased proximity (including the need to curtail noisier social activities). Noise can come from neighbouring dwellings, other sources in the same building, and the broader environment (e.g. traffic noise and nearby external activities).

Excessive noise levels can significantly affect the health and wellbeing of occupants, as per World Health Organisation research [2], [3],and [4], as well as the amenity of a dwelling. Designing dwellings to provide a reasonable level of acoustic comfort (quietness and privacy) is very important to the long-term desirability of MDH - this was overwhelmingly agreed on during consultation.

The key areas that need consideration in the design of attached dwellings are:

- **Inter-tenancy noise:** reducing transmission of airborne and impact noise (e.g. footfall) from other attached occupancies and from common spaces such as corridors, foyers and internal carparks;
- **Environmental noise:** protection from external noise through the building envelope (including façade, windows/doors, roof, external vents etc.);
- **Building Services noise:** mitigating noise from plumbing, HVAC equipment and other building services (e.g. lifts, mechanical doors).

Acoustical design needs to balance cost against providing reasonable levels of occupant satisfaction without over-engineering or producing difficult-to-build designs.

5. Key findings

The consultation process revealed that the biggest issues centre around knowledge levels across the whole NZ building industry. Key issues identified included:

1. **Needing to raise baseline knowledge across industry:** Although there is a general industry-wide awareness that noise needs to be addressed, there is less awareness about how to address it with failures at any stage in the dwelling's planning/design/construction, having a significant effect on overall outcomes. Feedback indicated this was a big issue.

   This is especially an issue in NZ where residential building has largely focused on detached low-density housing, for which mitigation of noise as part of building design has not been so relevant. Education, training, and ready access to information to help boost base level knowledge across all sectors of the building industry, is therefore a key requirement, especially for those in the residential building industry who are moving from the design/construction of detached housing to attached MDH.

   As an example, even when those involved in a building's design do have a good knowledge of designing for acoustics:

   a) if developers / project managers don't give acoustics sufficient priority or early consideration (or understand the cost benefit) it cannot be well integrated into the whole building design, which is critical for good outcomes. This can lead to acoustics becoming a costly after thought and/or only addressed to low standards;

   b) if installers aren't aware of basic concepts or provided sufficient construction details, simple workmanship errors or substitutions, can significantly reduce the actual performance outcome of any design.

2. **Regulations:** Currently there is a lack of clarity and consistency around NZ acoustic regulations and there is room for additional coverage. However, updates to the New Zealand Building Code (NZBC) to address some of these issues have yet to occur, despite several attempts over the past 15 years.

   Currently residential inter-tenancy noise is addressed through the NZBC Clause G6 (G6) introduced in 1992 with G6 and its supporting compliance document [5] unchanged since 1995. G6 addresses some aspects of airborne and impact noise between abutting occupancies, with interpretation and compliance requirements varying significantly across the country. For example: Auckland Council requires design signoff as well as on-site acoustic testing of a representative sample of completed multi-storey units, whereas other councils may rely on building element design / product specifications.

Protection from environmental noise is provided for in some noisy areas in some NZ district plans, but not in a consistent way. It is managed through a range of different requirements relating to façade performance, internal noise levels to be achieved and ventilation design. Better consistency would be beneficial through inclusion in G6 or as part of new National Planning Standards (part of 2017 amendments to the Resource Management Act).

Industry feedback revealed a wide mix of feelings about existing regulations, though only a tiny proportion felt they were excessive, and many wanted improvement. For example, in relation to G6, the "Towards Quiet Housing" survey question 7 indicated that amongst those with an opinion, less than 2% thought the current minimum performance requirements were too high, and over 55% felt that either additional areas needed to be included and/or minimum performance levels raised.

Even where the regulations were thought satisfactory as a minimum to help address affordability, better support was wanted to help understand the criteria and how to meet and/or exceed them cost effectively. There was also a desire for better understanding of end-user (occupant) needs and what satisfaction levels NZ's current minimum regulations provide.

3. **Lack of readily accessible, NZ specific, independent information:** Although there is a great deal of technical information on acoustical design scattered internationally, there is little independent information on meeting NZ specific requirements, such as local regulations, geographic considerations (climate, seismic), and using the most readily available resources including materials and skillsets. For example, central European based information on heavy weight construction in non-seismic zones with good acoustic performance is readily available. From an acoustic performance point of view this is relevant in a NZ context, but engineers also need to ensure that high mass buildings are designed to withstand seismic movements. Light-weight construction is sometimes preferred for seismic or economic reasons. With less mass to impede noise transfer, lighter weight construction needs extra attention in design and construction detailing to achieve good acoustic performance.

   At present, there is common reliance on a few proprietary NZ product manuals to understand how to meet NZ acoustic requirements. Although these are often appropriate, and are an important link in the design / compliance chain, there was a strong desire for much more access to independent information on general concepts and generic solutions (including a far greater range of "Acceptable Solutions" as part of compliance documentation). It was felt this would help with product comparison, competition and affordability and help practitioners understand the full range of options available, as well as when to seek specialist advice.

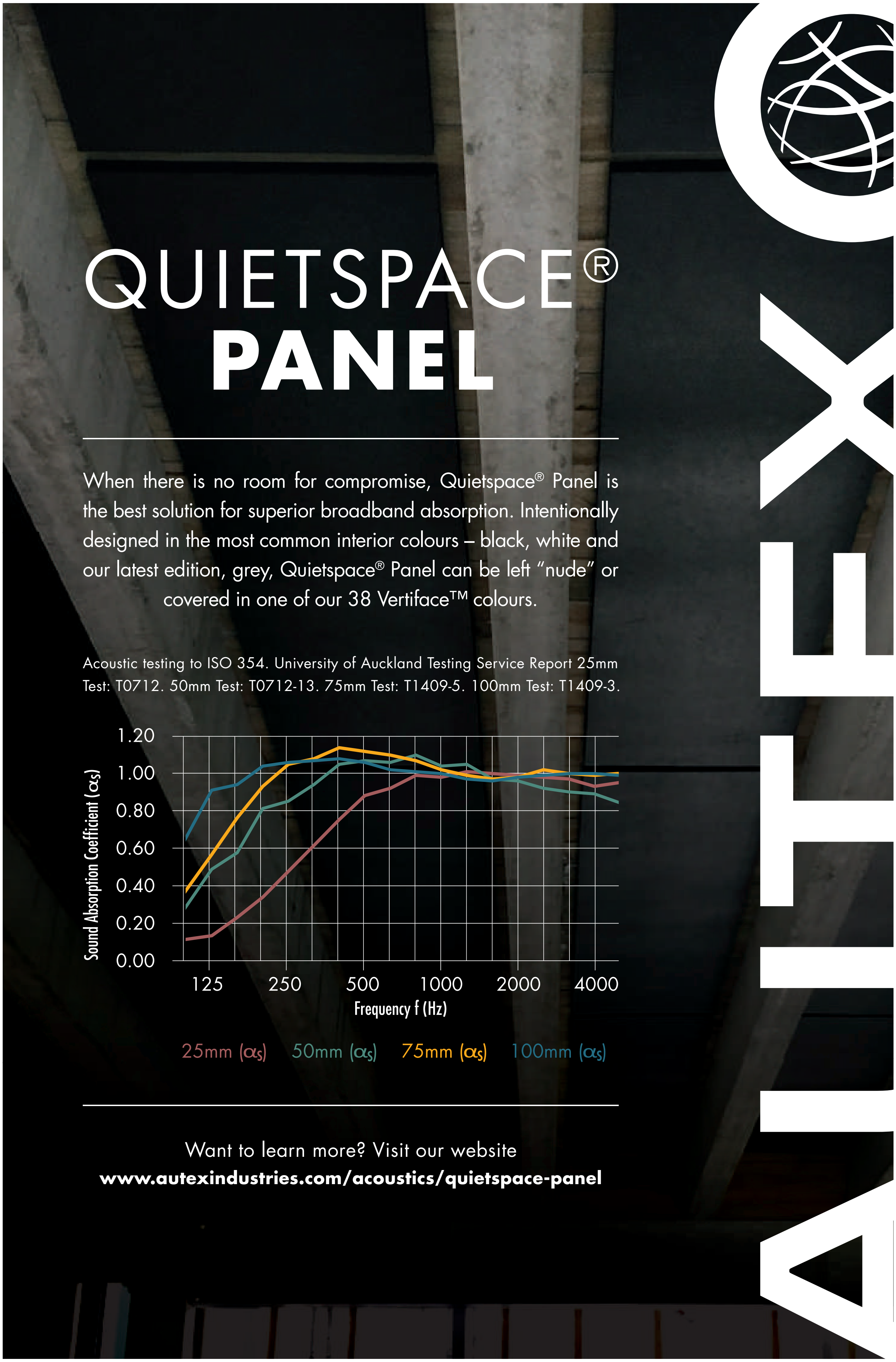
   More information was wanted across all areas, but especially inter-tenancy floors, walls and integrated building solutions (see next section). The Project report provides full details on specific technical information needs across all areas, information currently available and gaps in knowledge.

4. **Integration issues:** Currently, acoustic considerations are often not included early enough in the building design process. Given the impact of the whole building design on acoustic outcomes, the best and most cost-effective solutions require good integration of acoustics with structural and fire protection requirements, but also other areas of internal comfort (air quality, temperature and moisture control, natural lighting), sustainability (e.g. energy efficiency) and even aesthetic trends. Feedback noted a lack of integration between the various fields as an issue, with better awareness of the interplay between disciplines needed.

   There was a strong desire for more information on integrated systems and products that can work well together to meet multiple building code requirements. Research which helps develop cost-effective, practical building systems that meet multiple requirements was seen as one of the best ways to reduce costs while providing better quality.

5. **Understanding end-user needs:** The proportion of NZ end-users who live or have lived in MDH has only recently become significant, and the proportion will only increase in future. This means the feedback loop to drive market demand for improved sound insulation performance is only now coming fully in play, including to change developer focus, drive new building product development or inform regulatory requirements.

   In fact, very little NZ-specific, acoustic related, post-occupancy information is available that directly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1.00
0.80
0.60
0.40
0.20
0.00
125
250
500
1000
2000
4000
Frequency f (Hz)
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links subjective and objective acoustic performance outcomes. Although overseas experience is useful in the interim, understanding satisfaction rates and performance outcomes with local building techniques, constraints, regulations and end-user expectations is very important, as noted in the recent European COST Action TU0901 study on residential building acoustics [6].

The lack of feedback between end-users and industry participants (as well as between industry sectors) to better understand and improve building systems and regulations, was also noted as a wider industry issue.

6. Recommendations

The Project report gives recommendations for future action, centring on the following key areas.

1. Information dissemination

The first priority is that industry needs much more independent residential acoustic design information readily and freely available as quickly as possible. There is plenty of technical information available, but it needs to be packaged so the most relevant information is easily available to different sectors of industry, in an appropriate format to provide ongoing guidance and support.

Consultation showed that people want up to date, online information from a well-known independent body, providing the latest best practise guidelines and research updates. This should be combined with greater regulatory support through improved compliance documentation e.g. from MBIE (Ministry of Business, Innovation and Employment who are responsible for the NZ Building Code) and councils.

An online "*Quiet Housing Hub*" is suggested as the most effective means of delivering the information, potentially as part of a broader acoustic information hub. This could provide a central reference point for the most relevant information, arranged in a modular fashion with guidance material which can be expanded and updated more quickly and easily than regulatory documents.

Ideally this hub would expand from the general concepts, needed for each topic and industry sector, to include modules with best practise generic constructions (including junction details) that provide good acoustic performance. The UK's "*Robust Details*" system and handbook [7] is also discussed as an example framework. Robust Details was the most commonly referred to useful overseas solution during consultations. Feedback mechanisms, such as comments or forums, could also be incorporated so that the hub can become an integral part of ongoing research.

The hub would be a useful repository both in the absence of immediate regulatory change, and in support of any future changes. The NZBC Clause G6 update process has produced some useful NZ specific documents covering many of the areas highlighted during the Project's consultations. Making the information available for guidance would be extremely valuable, especially as people are wanting more information on generic solutions and achieving above the current code minimum. As the information on the hub would be for guidance only, practitioners would still need to follow compliance processes such as design signoff and/or on-site testing for approval, so there is still a desire for more formal "*Acceptable Solutions*" that assure compliance needs will be met.

Once the hub is created, it is recommended that a promotion and education phase be initiated, to help with raising awareness of the hub and increasing baseline knowledge levels. Once knowledge levels improve, there is potential to use some form of rating system (e.g. star rating) to help inform end-users of acoustic performance outcomes, to help provide transparency and incentivise better quality.

2. Research and development

In response to the industry survey and current state of play, recommendations are made for research areas thought to be most beneficial. In summary, the recommendations include:

- **Undertaking NZ post-occupancy surveys** that combine subjective and objective acoustic performance. Such surveys would provide feedback on the performance of constructions and regulations used in NZ, enabling verification of building design performance and input to regulation. This could be part of broader and ongoing MDH post-occupancy building performance research.
- **Enabling better building designs and solutions**. This includes developing acoustically better systems from existing construction designs and adapting new systems for use in New Zealand. In the case of both proven overseas solutions and local innovations, good information on performance, buildability, local compliance and cost-effectiveness are needed for widespread adoption. Methods and tools are also needed to enable incorporation of performance requirements from other disciplines (e.g. fire, structural), and to make information readily available.
- **Developing better acoustic prediction tools**. This entails adoption and further development of prediction methods which are showing good promise as acoustic prediction tools for sound insulation. Prediction is very important, especially for complex designs (including light weight construction with its multiple connections and components), to help designers understand likely performance.

...Continued on Page 34


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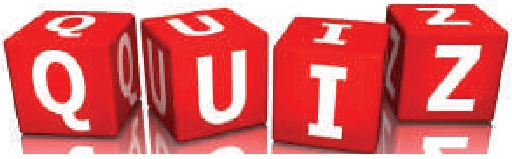
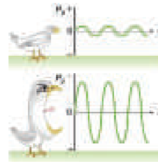
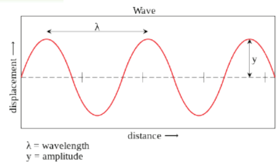


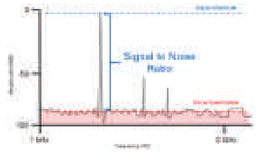
See how many questions you can answer correctly in 5 minutes...



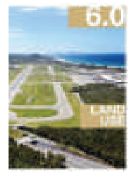
Q1 What is the increase in sound pressure level (in dB) if the intensity is doubled?

Q2 What is the wavelength of a sound of 20 kHz Frequency? (Assume speed of sound is 330m/s)?

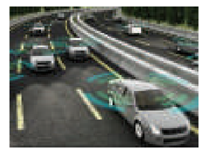




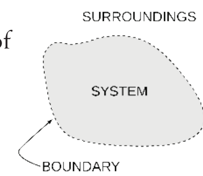
Q3 Briefly define the Signal-to-Noise Ratio (SNR) concept.



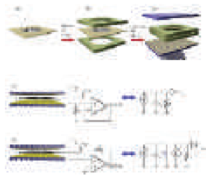
Q4 What is the full title of the New Zealand Acoustic Standard denoted: 'NZS 6805'?



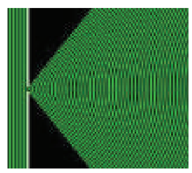
Q5 True or False; Vehicles on the road are specifically excluded from the excessive noise provisions of the Resource Management Act?



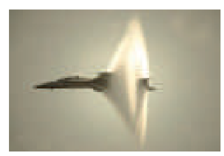
Q6 In regards to the fundamental laws of propagation in non-dissipative fluids and the basis of thermodynamics what are the two ways to describe fluid motion called?



Q7 Name two parts of an electrostatic microphone.



Q8 In a single sentence describe, what the term diffraction means.

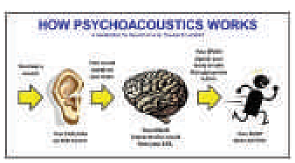


Q9 Complete this sentence - Sources that move faster than the speed of sound produce a___________?

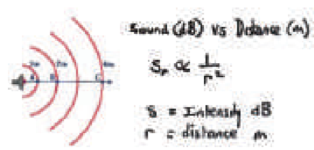
Q10 Helmholtz is a well-known German physicist who made significant contributions in several scientific field including acoustics, what is Helmholtz full name?

Q11 True or False; the majority of animals don't have ears?

Q12 What is the equipment shown in the photo?



Q13 What is psychoacoustics?



Q14 True of False; the intensity of sound decreases as the distance to the sound source increases?

Q15 Briefly describe to a lay person what octave bands are.

See page 37 for answers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Method to predict airborne flanking through concrete floors with nibs at the base of lightweight walls using ISO 12354-1

Gianfranco Quartaruolo and Tim Beresford

Norman Disney & Young, New Zealand

Email: g.quartaruolo@ndy.com

Abstract

Typically in the New Zealand residential market, concrete floor systems with lightweight walls are the preferred construction method. As floor slabs become progressively thinner, what consistently effects the achievement of the airborne acoustic design targets between adjacent residential units is the noise flanking transmission through the floor.

A solution to limiting flanking is identified in this paper for when it is not possible to have a slab of sufficient overall thickness, or when a floating floor or floating screed is not a cost effective option. The solution, utilising the introduction of a concrete nib along the wall line, reduces the floor to floor flanking noise transmission and promotes the achievement of better sound insulation ratings onsite.

The objective of the research is to determine whether the scientific prediction method contained within ISO 12354-1:2000 - "Building acoustics - Estimation of acoustic performance in buildings from the performance of elements – Part 1: Airborne sound insulation between rooms" can be adapted to accurately predict the flanking reduction achieved through the introduction of a concrete nib into a heavy-floor/lightweight-wall system. The standard is under review, but from the draft available, the prediction approach for this specific application has not changed and the proposed method in this paper is still valid.

Comparisons of predicted results with several field test results are made to verify the accuracy of the methodology. Incorporating a concrete nib into the wall-floor junction appears to effectively reduce the vibration transmission through the floor slab by introducing a secondary dissipation path for the sound energy running through the floor slab.

Additional testing should be done to validate the theoretical model, however, based on the analysed data to-date, it appears that ISO 12354-1:2000 gives good correlation between the predicted and field-measured weighted sound reduction index when a nib is introduced at the wall-floor junction.

Originally published in the Proceedings of Inter-noise 2017, Hong Kong.

1. Introduction

The New Zealand Building Code (NZBC) clause G6 "*Airborne and Impact Sound*" stipulates that "*Building elements which are common between occupancies, shall be constructed to prevent undue noise transmission from other occupancies or common spaces, to the habitable spaces of household units.*"

The NZBC calls for the Sound Transmission Class (STC) of walls, floors and ceilings between apartments to be a minimum standard of STC 55 when tested in the laboratory situation. The code then allows for a reduction in performance of 5 dB for the same construction when tested in the field situation, i.e. FSTC 50 in-situ. Both the laboratory rating and in-situ performance must be achieved in order to meet the NZBC requirements.

Historically, floor thicknesses have been sufficient to limit noise flanking to an acceptable level, but as floor slabs become progressively thinner (in part due to New Zealand seismic event design considerations), the proposed slabs compromise the achievement of the acoustic design targets.

A solution to limiting flanking is indentified in this paper for when is not possible to have a sufficient overall thickness of the floor slab, or when a floating floor or floating screed is not a cost effective option. This solution, utilising the introduction of a concrete up-stand or "*Nib*" along the wall line, reduces the floor to floor flanking noise transmission and promotes the achievement of better values on site.

It should be noted that the ASTM standard used in the NZBC does not propose an ISO equivalent prediction method for flanking transmission, and slight differences (maximum 2 dB) between the FSTC (Field Sound Transmission Class) parameter proposed by the ASTM and the R'_w (Apparent Sound Reduction Index) proposed by the ISO standard are expected. For the purposes of the remainder of this paper, R'_w will be used in place of FSTC to enable direct application of the ISO methodology.

2. Case studies

Three combinations of slab system and separating walls have been tested on different sites and the results have been compared to predictions using ISO 12354-1. In all cases, the floor-wall junction incorporated a concrete nib.

Norman Disney & Young proprietary software was used for the ISO prediction, with the software making use of the "simplified method" generally, but using the "detailed method" in the prediction of the flanking through the floor.

In all three analyzed cases, separating walls with high Rw ratings have been proposed.

A plasterboard ceiling on both sides of the wall was installed to reduce the flanking through the upper slab, and the wall/facade junction has been designed to not transmit a significant amount of energy from one unit to the other.

The following image schematically represents the cases of study. The primary transmission paths are through the separating wall and flanking through the bottom floor.

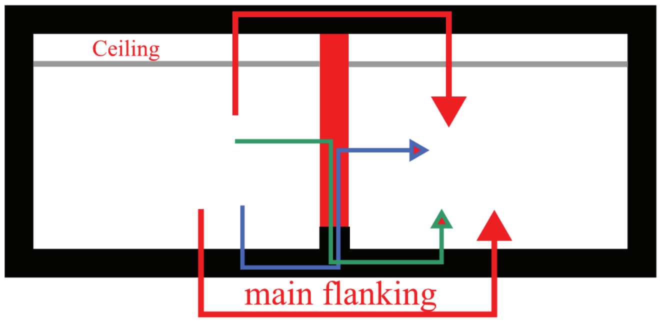

Figure 1: Schematic of flanking noise paths

The three case study combinations are described below.

2.1 Case 1 - Precast concrete T slab

In this case, the project brief was to maximise the wall sound insulation rating (R'_w essentially maximized), limited, of course, by construction practicalities. The following floors and walls were proposed.

2.1.1 Floor

- Precast concrete T slab (200mm overall depth) + 100mm concrete topping
- Minimum thickness of the concrete: 150mm
- Total weight: 410 kg/m²
- Laboratory R_w: 54 dB

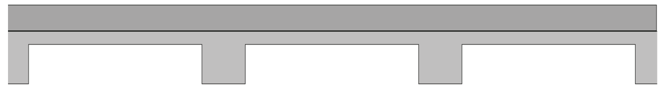

Figure 2: Diagram of Case 1 floor construction - Precast concrete T slab

2.1.2 Separating Wall

- Double steel frame (64mm + 64mm studs) wall, studs at 600mm centres, 20mm gap between frames
- 2 layers of 13mm plasterboard (≈13 kg/m² per layer) on each side
- 90mm layer of polyester insulation (≈10 kg/m³) in the cavity
- Total weight: 52 kg/m²
- Laboratory Rw: 63 dB

The precast concrete T slab was orientated with the beams perpendicular to the separating wall as shown in the following sketch.

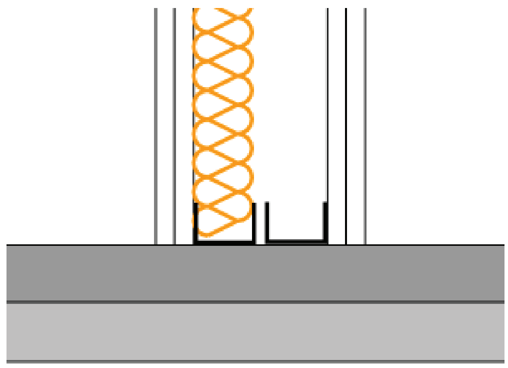

Figure 3: Vertical cross section orientation of the Case 1 floor

2.2 Case 2 - Corrugate steel deck slab

In this case, the project brief was to achieve the minimum NZBC rating (essentially R'_w = 50 dB) with the proposed wall and floor construction. The following floors and walls were proposed.

2.2.1 Floor

- Corrugated steel deck with 120mm thick concrete topping
- Minimum thickness of the concrete: 65mm
- Total weight: 230 kg/m²
- Laboratory R_w: 45 dB

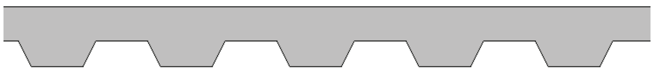

Figure 4: Diagram of Case 2 floor construction - Corrugate steel deck

2.1.2 Separating Wall

- Double steel frame (64mm + 64mm studs), studs at 600mm centres, 20 gap between frames
- 2 layers of 13mm plasterboard on one side and 1 layer of 13mm plasterboard on the other side (≈10.5 kg/m² each), fixed vertically at 600 centres in each row
- 75 mm layer of polyester insulation (≈10 kg/m³) in the cavity
- Total weight: 33 kg/m²
- Laboratory R_w: 58 dB

The corrugated steel deck slab was orientated with tray profile perpendicular to the separating wall as shown in the following sketch.

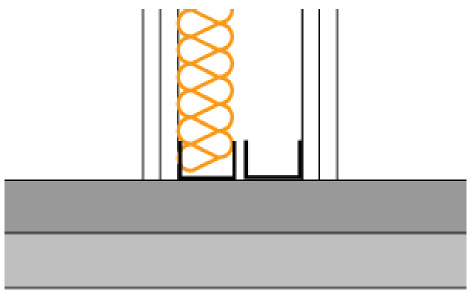

Figure 5: Vertical cross section orientation of Case 2 floor

2.3 Case 3 – Suspended concrete flooring system

In this case, the project brief was to achieve the minimum NZBC rating (essentially R'_w = 50 dB) with the proposed wall and floor construction. The following floors and walls were proposed.

2.3.1 Floor

- 400mm joist system floor with 90mm concrete topping
- Minimum thickness of the concrete: 90mm
- Total weight: 220 kg/m²
- Laboratory R_w: 48 dB

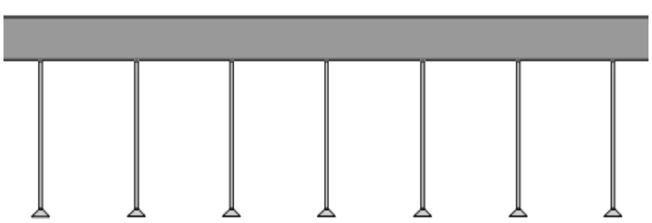

Figure 6: Diagram of Case 3 floor construction - Joist system floor

2.3.2 Separating Wall

- Double timber frame wall (90mm + 90mm studs), studs at 600mm centres, 20mm gap between frames
- 2 layers of 13mm plasterboard (≈10.5 kg/m² each layer) on both sides
- 90 mm layer of polyester insulation (≈10 kg/m³) in the cavity
- Total weight: 45 kg/m²
- Laboratory R_w: 61 dB

The suspended concrete flooring slab was orientated with the beams perpendicular to the separating wall as shown in the following sketch.

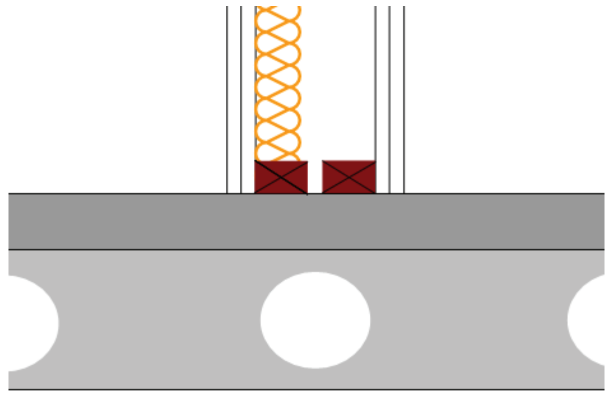

Figure 7: Vertical cross section orientation of Case 3 floor

3. Proposed solution - Concrete nib at wall base

In the absence of traditional flanking-reduction treatments to the bottom floor (floating floor or floating screed) - considered too expensive - the required airborne rating is not possible to achieve in-situ as the sound energy transmitted through the bottom slab, in the absence of sufficient thickness, produces a short-circuit in the wall performance.

The solution adopted to reduce the floor transmission onsite consists of the introduction of a 200mm x 200mm (WxH) concrete nib at the base of the separating wall, extended across the entire length of the wall. The separating wall was then constructed on, and around, the nib, as shown in the following sketch.

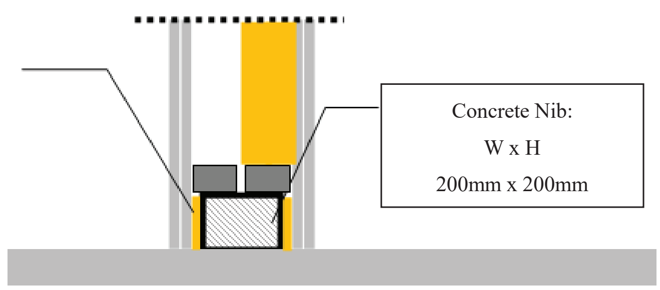

Figure 8: Nib configuration to limit flanking

The following photos show how the nib and wall were constructed onsite.

Figure 9: Photos onsite of the nib solution

3.1 Flanking transmission prediction between non-homogenous constructions ISO 12354-1

ISO 12354-1:2000 proposes a predictive method for calculating flanking transmission in section 4.4.1, in which the following mathematical formula is applied:

$$R_{Ff,w} = \frac{R_{F,w} + R_{f,w}}{2} + \Delta R_{Ff,w} + K_{Ff} + 10\lg \frac{S_s}{l_0 l_f} \text{ dB} \quad (1)$$

Where:

$R_{Ff,w}$ is the weighted sound reduction index of the F_f element, in decibels

$R_{F,w}$ is the weighted sound reduction index of the flanking element F in the source room, in decibels;

$R_{f,w}$ is the weighted sound reduction index of the flanking element f in the receiving room, in decibels;

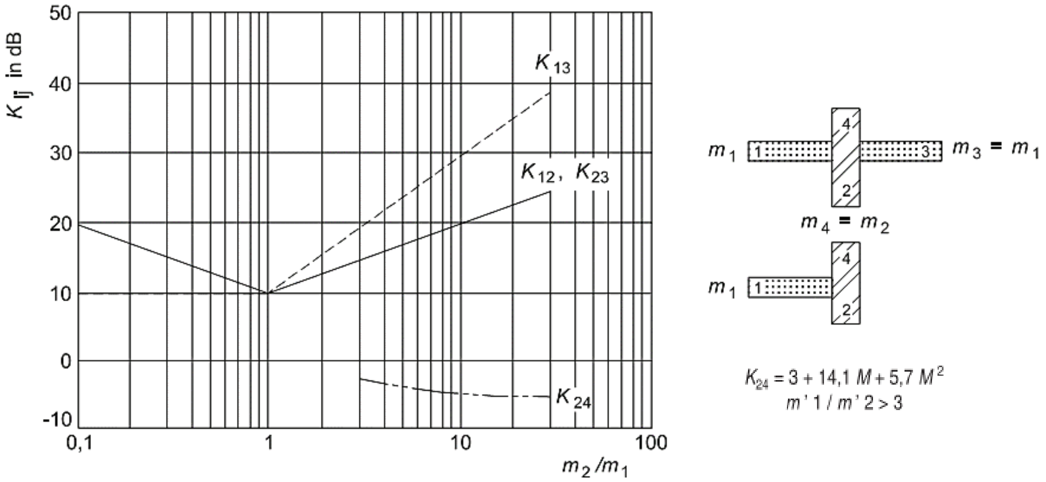

Figure 10: Junction of lightweight double leaf wall and homogeneous elements – ISO 12354-1:2000

$\Delta R_{Ff,w}$ is the total weighted sound reduction index improvement by additional lining on the source and/or receiving side of the flanking element, in decibels;

K_{Ff} is the vibration reduction index for transmission path *Ff*, in decibels;

S_s is the area of the separating element, in square metres;

l_f is the common coupling length of the junction between separating element and the flanking elements *F* and *f*, in metres;

l_o is the reference coupling length; l_o = 1 m.

The most effective parameter of the equation is the vibration reduction index K_{Ff}. Annex E of ISO 12354-1:2000 proposes several combinations for this junction.

The parameter K_{Ff} is related to the mass per unit area of the elements connected at the junction, m_1 and m_2 according to the following equation:

$$M = 10\lg \frac{m'_{\perp i}}{m'_i} \tag{2}$$

Where:

m'i is the mass per unit area of the element *i* in the transmission path *Ff*, in kilograms per square metre;

$m'_{\perp}i$ is the mass per unit area of the other, perpendicular, element making up the junction, in kilograms per square metre.

ISO 12354-1:2000 proposes different types of connections, but in this case of study, only the following junctions are considered:

1. Junction of lightweight double leaf wall and homogeneous elements
2. Rigid T-junction

The main junction between the dividing wall and the bottom floor slab is schematically represented by the ISO standard as the junction of a lightweight double leaf wall and a homogeneous element (equation E7). As illustrated earlier in Figure 10, this is the main noise flanking path.

In the case of junctions between heavy floors and lightweight walls, the "simplified" method proposed by ISO 12354-1:2000 has been shown, from testing comparisons, to underestimate the R_{Ff} flanking sound reduction index, therefore, our calculations were implemented with the "*detailed*" ISO approach. On this basis, the previous simplified formula (1) was replaced for this junction with formula 25a of the ISO 12354-1:2000:

$$R_{Ff} = \frac{R_{F,situ}}{2} + \Delta R_{F,situ} \frac{R_{f,situ}}{2} + \Delta R_{f,situ} + \overline{D_{v,Ff,situ}} + 10\lg \frac{S_s}{\sqrt{S_F S_f}} \quad \text{dB} \tag{3}$$

All the parameters are similar to those in formula (1), except for the in-situ transmission $\overline{D_{v,Ff,situ}}$ and the source and receiving room floor surface areas, S_i and S_j, respectively.

The in-situ transmission is calculated using formula 21 of the ISO 12354-1:2000:

$$\overline{D_{v,Ff,situ}} = K_{Ff} - 10\lg \frac{l_{Ff}}{\sqrt{a_{F,situ} a_{f,situ}}} \quad \text{dB}$$

$$\overline{D_{v,Ff,situ}} \geq 0 \ \text{dB} \tag{4}$$

Where $a_{F,situ}$ and $a_{f,situ}$ are functions of the structural reverberation time of the elements and K_{Ff} is the vibration reduction index.

3.2 Modelling variation of the wall-floor junction - Concrete nib at wall base

Incorporating a concrete nib into the wall-floor junction changes the vibration transmission behaviour through the floor slab by introducing a secondary dissipation path for the sound energy running through the floor.

This in turn alters the way in which we should apply the ISO 12354-1:2000 junction calculation from a lightweight

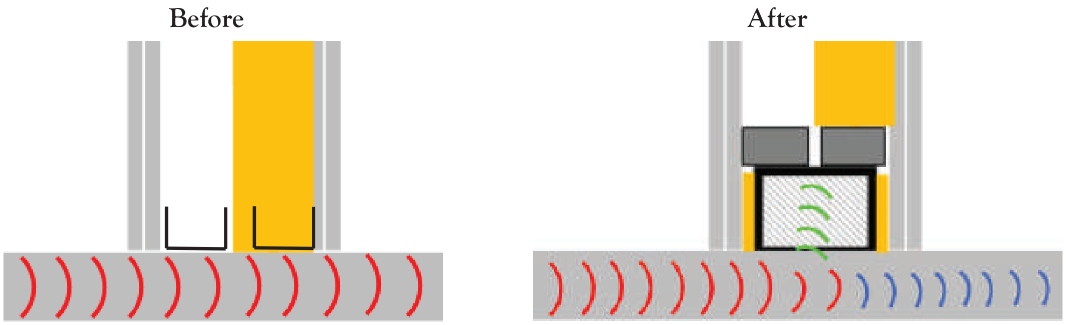

Figure 11: Vibrational energy dissipation at the wall-floor junction in the absence and presence of a concrete nib

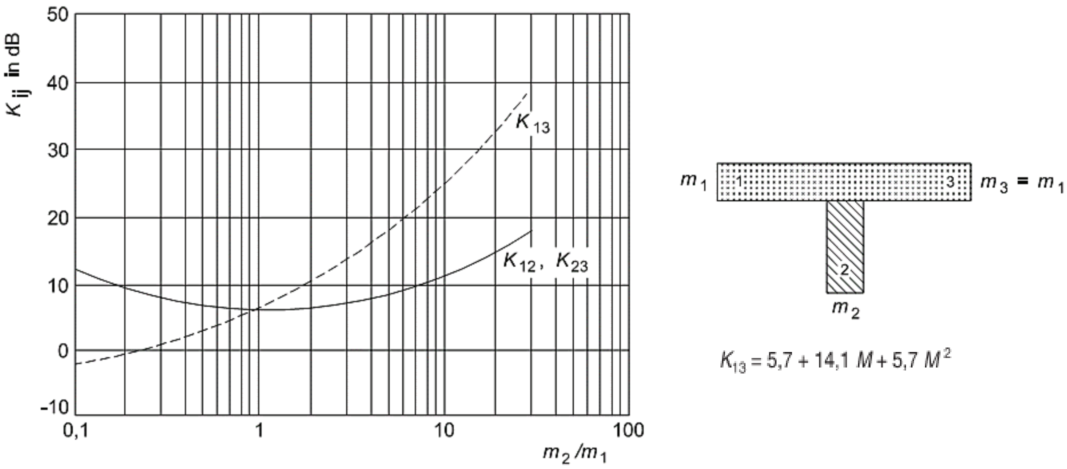

Figure 12: Rigid T-junction equation – ISO 12354-1:2000

double leaf wall and homogeneous elements connection, to a rigid junction. The bottom wall-floor junction is replaced with a rigid T junction as proposed in the equation E.4 of ISO 12354-1 (see figure 12).

The mass per square metre of the concrete nib is considered for the connection at the bottom wall-floor junction only, while at the other junctions (wall-ceiling, wall-sidewall_1 and wall-sidewall_2), the original mass of the plasterboard wall is considered.

In this case, the simplified model (formula (1)) was applied at the bottom wall-floor junction, because as demonstrated by the NRC publication, "*Guide to calculating airborne sound transmission in buildings*" [6], the simplified and detailed method give the almost identical results for rigid connections.

A mass per square metre of 400 has been assumed only at the bottom junction wall/floor where the nib is introduced. The other junctions maintain the original M (formula 2) value.

The figure 13 below illustrates the mass that is assumed for the separating wall at the four junctions.

3.3 Results

The proposed flanking prediction method described above has been employed and compared to onsite test data obtained for the three case studies. Table 1 shows the results, inclusive of the estimated performance had the concrete hob not been installed.

The prediction of the ISO 12354-1 appears to be accurate in a range of ± 2 dB and in most of the case the results differs by 1 point.

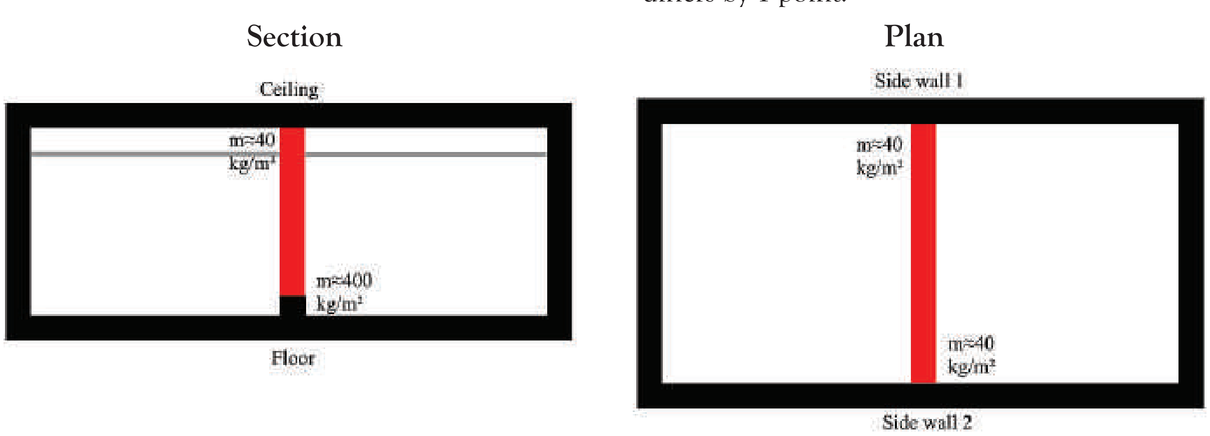

Figure 13: Mass per square metre assumed at each junction

Table 1: Comparison between predicted and Measured R'_w

Location	R_w wall (dB)	Predicted R'_w (dB) ISO 12354-1 Without Nib	Predicted R'_w (dB) ISO 12354-1 With Nib	R'_w (dB) Measured Onsite	Nominal R'_w Target
Test 1 Apt 15-Apt 16 (Case 1: R_w 54 dB floor)	63	55	58	57	Max Possible
Test 2 Apt 11-Apt 10 (Case 1: R_w 54 dB floor)	63	54	57	58	Max Possible
Test 3 Apt 13-Apt 14 (Case 1: R_w 54 dB floor)	63	55	58	57	Max Possible
Test 4 Apt 2-Apt 1 (Case 1: R_w 54 dB floor)	63	54	58	60	Max Possible
Test 5 Apt 1716-1717 (Case 2: R_w 45 dB floor)	58	48	53	54	50
Test 6 Apt 1202-1203 (Case 2: R_w 45 dB floor)	58	47	52	50	50
Test 7 Apt 1501-1502 (Case 3: R_w 45 dB floor)	58	46	51	52	50
Test 8 Apt 1602-1603 (Case 2: R_w 45 dB floor)	58	48	52	54	50
Test 9 Apt 214-215 (Case 3: R_w 48 dB floor)	61	50	56	57	50

Using this prediction method, it can be shown that when the thickness of the floor slab is insufficient, wall ratings below R'_w 50 dB can be expected onsite due to flanking via the floor.

A clear demonstration of this is that the increase obtained with the introducing of the nib is more perceptible when the mass/thickness of the floor is lower. In presence of a massive floor, the increment of performance given by the nib is 3 dB, in presence of lighter slabs the increment can achieve 7 dB.

4. Conclusions

Nine different combinations of floors and walls with a concrete nib at the base have been analyzed using a modified approach of ISO 12354-1 and the results have been compared with onsite testing of the same analyzed constructions. Although only a small set of experimental data was available to completely validate the theoretical model, it appears that the modified approach of the ISO Standard gives relatively accurate correlation between the predicted and field-measured weighted sound reduction index (R'_w) when a nib is introduced at the wall-floor junction.

The introduction of the rigid concrete nib at the base of the lightweight wall appears to change the vibration transmission behaviour through the floor slab by introducing a secondary dissipation path for the sound energy running through the floor. It is interesting to observe how, with some adaption, it is possible to use the ISO 12354-1 methodology to predict the nib effect. The validation of this method could be an interesting improvement of the ISO standard, introducing an additional design tool.

In New Zealand, the use of the nib at the base of the light weight walls is common practice when the floor system appears to have insufficient capability to reduce the flanking transmission, however there is not a developed scientific method to predict how effective the nib may be.

An extension of this experimental campaign is proposed in addition to the work contained in this paper, investigating other similar cases using the same methodology.

A review of the draft of the new ISO 12354 confirms that the prediction approach for this specific application has not changed and the proposed method in this paper will still be valid.

References

1. ISO 12354-1:2000 - Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation between room
2. CEN TC 126 - Building acoustics. Estimation of acoustic performance in buildings from the performance of element – Part 1:. Airborne sound insulation between rooms
3. Osama A.B. Hassan: Building Acoustics and Vibration, Theory and Practice
4. Associazione Nazionale per 'Isolamento Termico e Acustico (ANIT) – Vol. 3 Manuale di acustica edilizia
5. Apparent sound insulation in cold-formed steel-framed buildings - Hoeller, Christoph; Quirt, David; Zeitler, Berndt; Sabourin, Ivan
6. Guide to calculating airborne sound transmission in buildings Zeitler, Berndt; Quirt, David; Hoeller, Christoph; Mahn, Jeffrey; Schoenwald, Stefan; Sabourin, Ivan

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The Project report looks at each of these areas in further detail.

3. Regulations

The industry feedback indicated there is certainly support across all sectors to improve NZ's regulations related to building acoustics. The report urges that efforts actively continue in this direction. In the meantime, it is hoped that the introduction of an information hub would help people become more familiar with what can and cannot be easily achieved and avoid unnecessary mistakes, which should help drive a general improvement in quality. Hopefully, any future shift in regulations will then come more easily.

7. Conclusions

This Project has collated a large amount of information on the current state of play and the most relevant information resources, needs and gaps as they relate to noise control and acoustics in NZ medium-density housing. The extensive industry survey and other consultation includes qualitative and quantitative data covering the full range of perceptions in this topic from across NZ industry.

The suggested online Quiet Housing Hub format should be able to utilize this information to help provide an invaluable expandable resource to deliver technical information to industry, to support better noise control for medium-density housing and any future changes to acoustic regulations. Information from the research areas highlighted can also be better fed back to industry via the hub.

However, building acoustics cannot be considered alone - for quality, affordable, desirable medium-density housing, careful integration is needed with other areas of planning, design and construction.

References

1. BRANZ, Building Research Levy Prospectus 2016/2017, BRANZ, Editor. 2016.
2. World Health Organisation. Guidelines for community health. 1999; Available from: http://www.who.int/docstore/peh/noise/guidelines2.html.
3. World Health Organisation, Burden of disease from environmental noise: Quatification of healthy life years lost in Europe. 2011, World Health Organisation - Regional office for Europe.
4. World Health Organisation, Night Noise Guidelines for Europe. 2009, World Health Organisation - Europe.
5. Department of Building and Housing, Compliance Document for New Zealand Building Code - Clause G6 - Airborne and Impact Sound. 2006, vicbooks: Wellington. p. 20.
6. Rasmussen, B. and M. Machimbarrena (editors), COST Action TU0901: Building acoustics throughout Europe. Volume 1: Towards a common framework in building acoustics throughout Europe. 2014, COST - European Cooperation in Science and Technology.
7. Robust Details Ltd. The Robust Details Handbook [online]. Available from: www.robustdetails.com.

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Goods for Sale

In the second edition of the year (Vol.31 No.2) we are going to provide Members with the opportunity to list equipment or goods for sale. If you have anything you would like to sell please contact the Editors for further information.

Man electrocuted cutting power to noisy caravan

Stuff has reported that a Hamilton man was electrocuted attempting to disconnect power to a noisy caravan tried to cut off a power plug while the cord was still connected to a powerbox.

The 26-year-old man was said to be camping with friends at Northland's Whangaruru Beach Front Camp in December 2015, when he reportedly became upset with noise from a stereo in a nearby caravan, Northland police spokeswoman Sarah Kennett said. 'About 12.30am yesterday, the man left his campsite, telling friends he was going to deal with the issue'. Tragically the man was found dead by the occupant of the caravan at about 3am. It is understood that the man appeared to have pulled the power plug out of the caravan but left it connected on the powerbox side, Hikurangi Volunteer Fire Brigade deputy chief Trevor Gallagher said. 'The plug looked like it had been ripped out of the caravan itself'. Gallagher went on to say 'I think the moral of the story is that inconsiderate people can cause people to be angry enough to do things that they normally wouldn't do'.

International Noise Awareness Day 25 April 2018

Center for Hearing and Communication

Connect to Life®

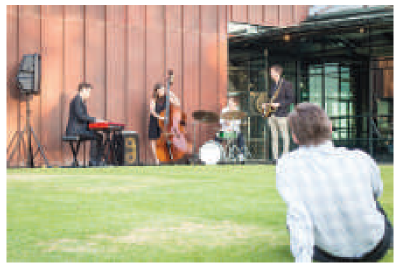
All over the world, people, organisations and governments will commemorate the 23rd Annual International Noise Awareness Day (INAD) on Wednesday, April 25, 2018. INAD is a global campaign, founded in 1996 by the Center of Hearing and Communication (CHC), aiming to raise awareness of noise on the welfare and health of people.

Report find faults in Kapiti Expressway

Stuff has reported that a panel of experts appointed by the New Zealand Transport Agency in August last year to review the noise impacts of the

$630 million expressway, which opened in February and runs from MacKays Crossing to Peka Peka on the Kipiti Coast found residents in at least six houses near the State Highway 1 expressway were possibly experiencing "unreasonable" traffic noise, caused by rumble strips and noisy bridge joints. Their report recommends, among other things, removing the rumble strips on the lefthand edge lines near the undisclosed properties, and fixing approach surfaces to bridges to make them smoother. The panel said, while noise from the expressway was generally reasonable, noise from the rumble strips and bridge joints should not have occurred. The issue could be addressed by installing mechanical ventilation or cooling in the affected properties, allowing residents to keep their windows shut.

Acoustics 2017 Conference - Perth



Acoustics 2017 hosted in Perth Australia drew to a close on November 22 and was reported to be a successful conference for the Australian

Answers

To the 5 minute Quiz (on page 24)

A1 The increase is 3 dB

A2 The wavelength is approx. 16.5mm (330/20 000 = 0.0165m or 16.5mm).

A3 Signal-to-Noise Ratio (SNR) is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal).

A4 NZS 6805:1992 'Airport Noise Management and Land Use Planning'.

A5 True; the Resource Management Act Section 326(1)(b) specifically notes that vehicles on the road are specifically excluded from the excessive noise provisions.

A6 The two ways to described fluid motion are the Lagrangian and Eulerian descriptions of fluid motion. The Lagrangian method is where one follows all fluid particles and describes the variations around each fluid particle along its trajectory. The Eulerian method is where the variations are described at all fixed stations as a function of time.

A7 The electrostatic microphone also known as the electrostatic condenser microphone has a diaphragm, perforated backplate, quasi-closed back cavity, battery, resistor, capillary aperture etc.

A8 Diffraction describes the phenomenon that waves are bent around obstacles.

A9 Sonic boom.

A10 Hermann Ludwig Ferdinand von Helmholtz or Hermann von Helmholtz.

A11 True the majority of known animals don't have ears or what humans may refer to as ear opening this includes, amphibians and invertebrates however many animals without ears can still detect sound via other sensory organs for example a turtle which has no ear opening and would be in human terms deemed deaf can perceive a limited frequency range so as to assist with detecting the presence of predators.

A12 The photo is of a hand-held sound intensity system, to be precise the Bruel and Kjaer Type 2270-S made up of a sound level meter and sound intensity probe.

A13 Psychoacoustics is the branch of psychology concerned with the perception of sound and its physiological effects.

A14 True; the further away from the source the lower the intensity.

A15 Octave bands are a group of standardized frequencies named by the centre frequency where the upper limit is always twice the lower limit of the range. Importantly on a sound level meter when sound is measured the level may be for example 110 dB but using the octave band filters [such as 1/1 of 1/3rd octave bands] we can break the measured sound into its component parts across the frequency range to see how much sound is in each octave band of the sound i.e. how much low, mid or high frequency sound is present.

2018

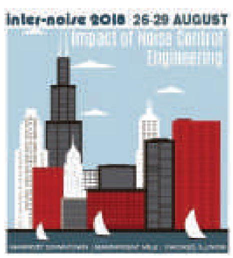
7-9 May 2018, Ibiza Spain. NOVEM (Noise and Vibration Emerging Methods)
novem2018.sciencesconf.org

7-11 May 2018, Minneapolis, USA. 175th Meeting of the Acoustical Society of America
www.acousticalsociety.org

27-31 May 2018, Heraklion, Crete, Greece. Euronoise 2018
www.euronoise2018.eu

8-12 July 2018, Hiroshima, Japan. The International Institute of Acoustics and Vibration ICSV25
www.icsv25.org

26-29 August 2018, Chicago, USA 47th International Congress and Exposition on Noise Control Engineering (Inter-noise 2018).
www.internoise2018.org

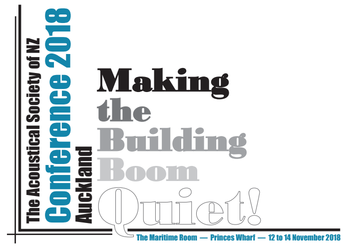


6-9 November 2018, Adelaide, Australia AAS Acoustics 2018 Hear to Listen.
www.acoustics2018.com

5-9 November 2018, Victoria, Canada 176th Meeting of the Acoustical Society of America.
www.acousticalsociety.org

11-15 November 2018, New Deli, India WESPAC 2018.
www.wespac2018.org.in

12-14 November 2018, Auckland, New Zealand, ASNZ 2018 Conference.



2019

13-17 May 2019, Louisville, Kentucky, USA. 177th Meeting of the Acoustical Society of America
www.acousticalsociety.org

16-19 June 2019, Madrid, Spain. 48th International Congress and Exposition on Noise Control Engineering (Inter-noise 2019)
www.internoise2019.org

09-13 September 2019, Aachen, Germany. 23rd International Congress on Acoustics (ICA 2019)
www.ica2019.org

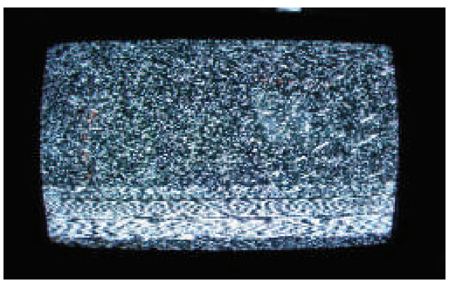
Acoustical Society. The conference rang over 3-days with approximately. 76 papers presented along with 5 workshops. The Australian Acoustical Society's 2018 Conference 'Hear to Listen' will be held in Adelaide South Australia from 6 to 9th November 2018.

ASNZ 2018 Conference Announcement 12-14th November 2018 Auckland

The Acoustical Society of New Zealand

The ASNZ committee recently meet to discuss the up and coming Acoustical Society New Zealand Conference to be held later this year. The date for the conference will be 12-14th November 2018. The venue is The Maritime Room, at the Viaduct Harbour, Auckland City. Further information will be announced as soon as it is available.

White noise may improve learning



A report by Engineering 360 notes that according to researchers, white noise — background noises at the same volume, but different frequencies, for instance, the sound of a passing jetliner or the ocean — can enhance learning performance.

Typically, the ideal environment for learning is often envisioned as one that is noiseless and distraction-free. However, researchers from the University of Queensland are suggesting that some noise is necessary to boost learning ability. To demonstrate this, scientists conducted experiments where participants were taught new words with some participants learning the new words against a backdrop of white noise and other participants learning the new words in complete silence.

Researchers reported that those participants learning new words against a white noise backdrop could better recall those words than the participants who learned the words in a completely silent environment.

However, while it seems that white noise can help improve participant focus, researchers caution that continued research is necessary to determine how white noise can improve cognitive performance. Anthony Angwin, one of the authors of the study, said, "*Once we develop a better understanding of the effects of white noise on healthy adults, we would like to apply this knowledge to do further studies with people with learning or language difficulties to see if white noise improves their learning performance.*"

Directory of New Zealand Acoustics Advertisers

Publication Dates and Deadlines

New Zealand Acoustics aims or least three issues per year, in April, August and December.

The deadline for material for inclusion in the journal is the 1st of each publication month, although long articles should ideally be received at least 4 weeks prior to this.

Advertising

Enquiries regarding advertising are welcome. For a list of current prices and any further information please contact: advertising@acoustics.org.nz

Society Membership

Associate Membership of the Acoustical Society of New Zealand is open to anybody interested in acoustics. Members receive benefits including;

- Direct notification of upcoming local events
- Regular mailing of Noise News International
- Reduced charges for local and national Society events
- Priority space allocation for trade stands at Society events
- Discounted rates on selected acoustic products

To join the Society, visit www.acoustics.org.nz or contact the Secretary at secretary@acoustics.org.nz