NEW ZEALAND ACOUSTICS

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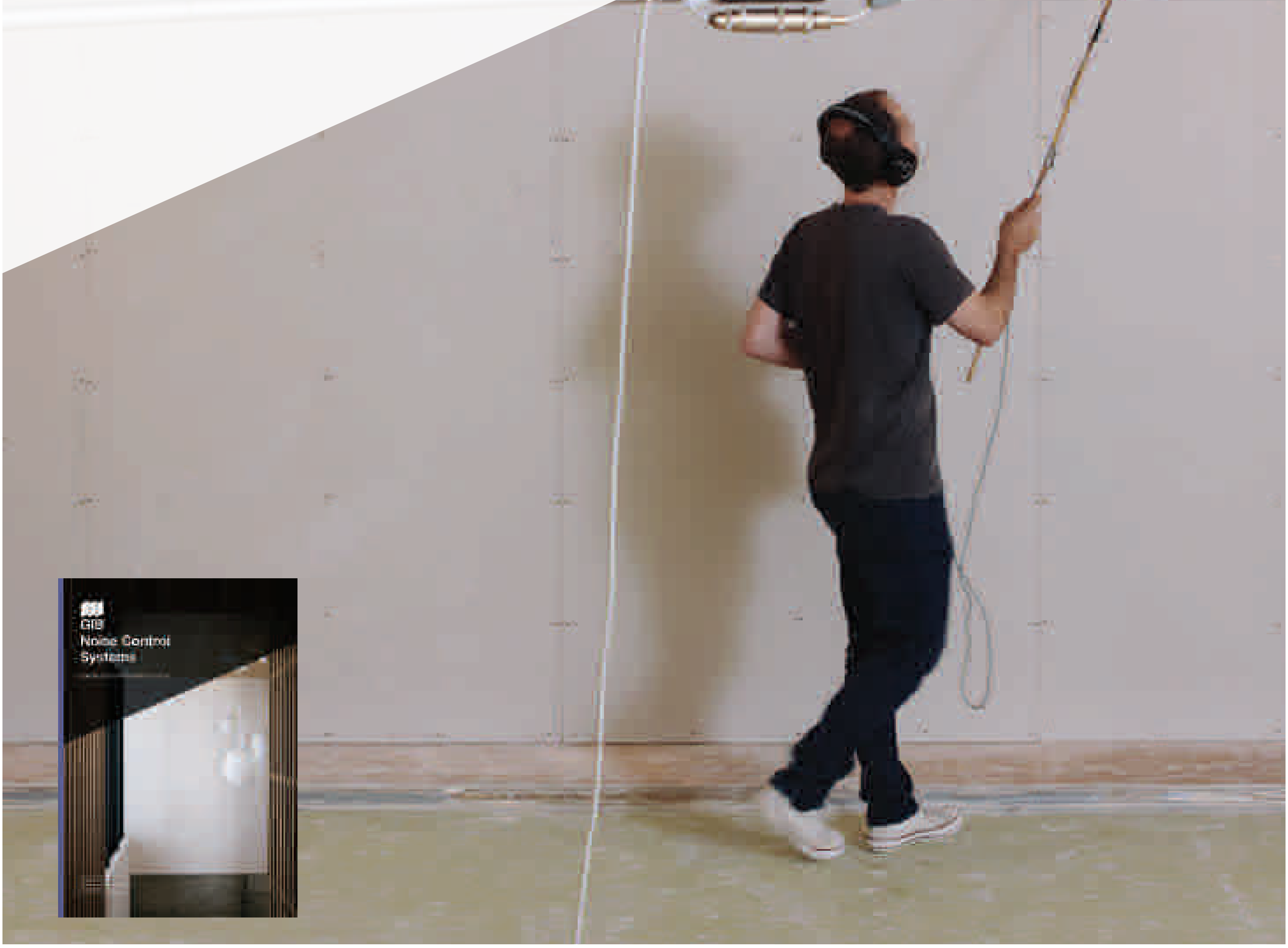

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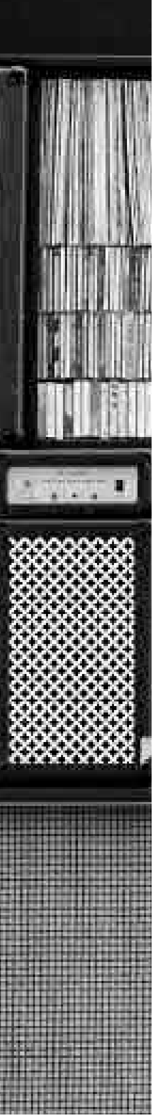

Welcome to the third and final edition of New Zealand Acoustics for 2020.

What an extraordinary year it continues to be. The Committee has been working extremely hard over the past few months to organise the 2021 ASNZ conference **'The Sound of a Changing World'**, which will be held on the 15th and 16th February 2021 at Five Knots in Auckland. Please visit the ASNZ webpage at www.acoustics.org.nz/conferences/asnz-conference-2021 to find out more. We hope to see you all there where we can share experiences, view the latest developments in acoustics and strengthen our networks and relationships. We wish you all a safe and healthy summer break, and please keep safe.

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NEWS

Bader, Hamilton – *Kelly Hodel*

Noise complaint leads to assault

Police were notified of a serious assault in the residential suburbs of Bader, Hamilton. A security guard was serving a noise abatement notice when police were requested for assistance. He was taken immediately to Waikato Hospital for treatment. "The investigation is still ongoing and our CIB team is following some lines of enquiry to identify those responsible." Waikato Senior Sergeant Phil Ruddell said. "The victim has been spoken to by police and will be visited again in due course in hospital." Ruddell explained the victim is still in a serious condition.

More information *– https://www.stuff.co.nz/waikato-times/news/300077818/hamilton-security-guard-remains-in-serious-condition-after-noise-complaint-assault*

Study reveals – world noise drops by 50%

Seismic wave measurement is mostly used for detecting earthquakes and volcanic activity but during the global lockdowns, seismographs were able to pick up vibrations from people around the globe (including New Zealand). It was found that the world has been half as loud since the lockdowns began.

Scientists have called it the "anthropause" due it being the longest and most prominent reduction in noise created by people to date. Dr Kasper van Wijk from the Department of Physics at University of Auckland and lead study author has told Morning Report that most urban spaces in the world reduced their noise levels by 50 percent.

Lockdown was like "an extreme case of [the] Christmas holidays" when people leave the city. "This is even quieter and a much longer period...."We saw some earthquakes, little earthquakes ... Auckland doesn't get many earthquakes. We even saw funny things - I haven't run this next to the Fuller's timetable yet - but on Motutapu Island I think I can see the few ferries that still were going out to Waiheke Island, that's the amount of detail you can see."

More information *– https://www.rnz.co.nz/news/national/421926/human-noise-dropped-by-50-percent-during-lockdown-study*

Empty roads in Ponsonby, Auckland – *Ollie Wall*

Homes near Christchurch stadium deemed too noisy by council

> "There are no controls on how much noise can be generated by the arena under the existing CCRP. We also potentially have inadequate noise insulation requirements for new buildings in the area."
> – David Griffiths

Christchurch city council has admitted that sound-proofing rules for homes near the new Christchurch stadium could expose residents to excess noise.

The council wants to use rebuild powers to limit noise from the planned $473 million roofed stadium, due to open in late 2024. It also wants to boost sound protection in new homes nearby.

The existing central city recovery plan (CCRP), also known as the blueprint, places no limits on stadium noise due to the site's anchor project designation.

Surrounding areas fall into a low-noise zone and the council has also conceded that requirements for soundproofing of nearby homes are limited.

Hundreds of new homes have already been constructed near the stadium site. This includes the Crown's east frame housing. Private developer Williams Corporation has also built new homes nearby.

Residents moving into new central city homes have lodged complaints with the council about noise from bars and music venues, prompting calls to fairly balance inner-city living and nightlife. Some businesses have been told to turn down the volume on their music.

The council's head of planning and strategic policy, David Griffiths, said before starting construction of the stadium that they wanted to look at its effects on immediate neighbours, including traffic, parking and noise.

"There are no controls on how much noise can be generated by the arena under the existing CCRP," he said. "We also potentially have inadequate noise insulation requirements for new buildings in the area." Existing acoustic insulation rules require some sound deadening on new homes built within 75 metres of the stadium site. Griffiths said the council recognised "this needs to be addressed if we want to maximise the benefits of having this venue in our city centre".

***More information** – https://www.stuff.co.nz/the-press/news/122367323/homes-near-christchurch-stadium-site-could-be-too-noisy-council-says*

***Artist impression of proposed roof –** Stuff*

NBA virtual crowd noise amidst COVID-19 lockdowns

No sport lives and dies by the intensity of its crowd reactions as much as basketball. With triple-digit game scores as close as a single point with tenths of a second left on the clock, crowd reactions can literally influence the outcome of games. That fact confronted the folks figuring out how to re-create the sounds and swells of those crowds when the NBA began its COVID-shortened and crowd-less season in late July, within a protective bubble inside the Wide World of Sports venues (WWoS) at Disney World.

"A 360-degree soundscape where the sound would come from all directions, and it would sound different for home, and visitors, and for each shot."

It was a tall order, and it produced a startlingly realistic sonic environment that authentically re-creates what NBA players experience on the courts, doing so with a technology infrastructure unlike any ever seen.

Sound is focused on each of the three WWoS courts, each with distinct system designs. The PA system in The Arena, the main national-telecast court and site of Conference Finals and NBA Finals, is unique in that it puts the sound only on the field of play. It comprises 60 L-Acoustics K2 loudspeakers configured as 10 hangs of six boxes each, buttressed by a dozen L-Acoustics KS28 subs. These speaker clusters place the sound on the court instead of the seats (which are "occupied" by 300+ actual fans populating 17-ft. LED videoboards lining the sides of the court via Microsoft Teams' Together mode; the audio, along with venue announcers and a DJ, is also part of the ultimate mix). It's all mixed through a DiGiCo SD7 console – heavily loaded at 147 inputs – by the front-of-house A1.

Although some of the most basic examples of acoustic resonators are found in musical instruments or even automobile exhaust pipes, they're also found in a variety of electronics. They are used as sensors, filters, and transducers because of their compatibility with a wide range of materials, frequencies, and fabrication processes.

Myers adds that, once the audio mixers had passed through the first week of the season, they were comfortable in what is certainly a unique audio environment in sports broadcasting.

"We're trying to replicate the intensity and the anticipation that the players feel during a game in a full arena," he says. "That's not easy. But we're succeeding."

***More information** – https://www.sportsvideo.org/2020/08/13/nba-returns-court-sound-is-complex-and-authentic/*

Gold Coast Helitours

Gold Coast helicopter business issued show-cause notice after noise complaints

A long-running Gold Coast helicopter joy flight business is facing closure after noise complaints prompted the city council to issue a show-cause notice.

Gold Coast Helitours, has operated on the Broadwater at Main Beach for 30 years. Management claims to have been blindsided when notified via the media that they have until September 22 to demonstrate they are not operating illegally. "We're not a new business," general manager Ray Brown said. "We've had the support of council all along."

The business, which has halved its workforce to 10 people since the pandemic began, operates scenic flights, charters and aerial surveying.

Mr Brown said the operation also worked closely with the local film industry.

Councillor Brooke Patterson, whose division includes Southport which is impacted by helicopter noise, said after investigation, it was council's view that "the use of the premises for air services is not a lawful use".

"Council has issued a show-cause notice as to why an enforcement notice should not be issued pursuant to Section 168 of the Planning Act 2016."

Mr Brown said he had not yet sighted the show-cause notice and would work to comply with the council's requirements. Division 10 councillor Darren Taylor said council was responding to complaints from residents who lived near the Broadwater at Main Beach and Southport.

"At the moment there are two options; either they stop, or submit an application and they will have to go through that process," he said.

"It effectively gives them until September 22 to either stop flying or stop trading ... or they can submit an application to actually provide their services.

"By doing that, it will be an impact-assessable application which the residents would have a say in the outcome."

More information *– https://www.abc.net.au/news/2020-08-13/gold-coast-helicopter-tour-noise-complaint-show-cause/12553898*

Noise from The Lights causes nearby resident to relocate

Designed to entertain, from new bars to live music, The Lights has become a headache for nearby neighbors.

"It's very loud when you have to work in the morning and have to listen to that until midnight to 1 o'clock in the morning," Paige Johnston of West Fargo said. "It's hard to get up."

Johnston says the noise is too much.

It's more than an inconvenience, it's forcing her out of her home.

"I'm moving because of it," Johnston said. "Just getting up in the morning, it's hard to do when you are listening to that all night."

She says the concerts should end earlier, especially during the week, wondering about the city's noise ordinance.

According to city ordinance 15-14, it's against the law for any person to "make loud, unnecessary, or unusual noise or any noise which either annoys, disturbs, injures or endangers the comfort, repose, health, peace or safety of others within the limits of the city of West Fargo."

And the trouble goes beyond the noise.

"The traffic, people walking through your yard, everything that goes along with the concerts," Johnston said. "It gets to be an awful lot."

Another neighbor who did not want to go on camera tells us Johnston is not alone. It keeps her kids up at night, so she will be moving from the neighborhood as well.

The City of West Fargo has received multiple formal complaints about the noise coming from The Lights. They are working on compiling those documents for Valley News Live.

West Fargo city leaders say they are working with EPIC Events and West Fargo Events to address the issue.

More information *– https://www.valleynewslive.com/2020/08/13/noise-from-the-lights-causes-nearby-resident-to-move/*

Photo: *www.thelightswf.com*

A conversation with Dr Matt Pine –

Principal Underwater Acoustics, Auckland

Matt is a rare species in the world of Acoustics in New Zealand. Matt is an Underwater Noise Specialist. He received a Marine Bioacoustics Scholarship from the University of Auckland, and devoted seven years of full-time study (plus two postdoctoral fellowships in marine bioacoustics in China and Canada) to acquiring his highly specialised knowledge and skills, which are unmatched in the New Zealand acoustics consultancy sector. Matt's PhD thesis concerned noise pollution on marine life; something that is generally not thought of when discussing acoustics in general. Matt is involved in bioacoustics research at the Department of Biology at the University of Victoria (in British Columbia, Canada) and with the Institute of Marine Science (University of Auckland) and has published several papers about the effects of Underwater Anthropogenic Noise on Marine Life, including the Effects of Marine Turbines. Matt's body of work is diverse and includes publications in the Journal of Marine and Freshwater Research, Planning Quarterly, Marine Pollution Bulletin, Ocean & Coastal Management, Journal of Applied Ecology and our very own New Zealand Acoustics Journal.

Can you tell us what the study of underwater acoustics is all about?

Underwater acoustics is a really diverse field that is truly cross-disciplinary. Many people working in the field are oceanographers, marine biologists, engineers, policy advisors etc. This is because it covers so many areas – from the propagation of sound through to water, mapping ocean floors, tracking noisy sources (like boats or whales), to how animals make sound and communicate, and their interaction to noise pollution.

The field of underwater acoustics covers many areas. What is your area of expertise? Tell us what it is you do, and more importantly why you do it?

My main area of expertise is marine bioacoustics – so how animals interact with their acoustic environment, what sounds they make, and how noise pollution impacts marine animals. I was first introduced to marine bioacoustics during the final year of my marine biology degree at the University of Auckland. The class was on current issues in marine science and we were discussing how fish use sound to navigate the oceans and the role of sound as an orientation cue in larvae. The idea of something as small as a tiny fish larva could locate the safety of a reef by following natural sounds was completely captivating. From there, I did a lot of reading, changed my thesis proposal to the effects of anthropogenic noise on marine life and began my postgraduate study at the Leigh Marine Laboratory. Since then, my passion for ocean noise research has grown into an obsession that's taken me around the world – I do it because I love it!

Underwater acoustics is probably best known for studies in our oceans and our seas — do you or your colleagues work in other bodies of water such as lakes or rivers? Where is the majority of your work undertaken and why?

Absolutely – a lot of work is being done on freshwater soundscapes. One of the more interesting studies that I was lucky to work on at Styles Group was with Waikato Regional Council where we developed a computer algorithm to detect fish passage through flood pumps (native eels being killed by these pumps is a major issue, and by using acoustics to monitor changes in pump noise or turbine blades we could quantify eel mortality by these pumps). We published that study last year and are continuing to further develop the system through 2020. Since marine mammals are my main focus I spend most of my time in marine environments, although I have worked with the Yangtze finless porpoise and measuring vessel noise in the Yangtze River. Where marine mammals and fish are found is where we go!

How well established is the underwater acoustics community in New Zealand compared to say, the wider international community?

Actually quite well established but it's a very small community compared to other counties and pretty limited to our universities. There are a number of exciting projects underway at research institutes around the country.

Sources of anthropogenic underwater noise such as shipping have increased significantly over the past fifty years. Internationally the study has been well recognized by many experts as a concern and threat for marine mammals ecosystems. In your opinion where does New Zealand sit in regards to understanding the impacts on our marine ecosystems and underwater pollution and how do we sit compared to our international counterparts in mitigating marine pollution?

New Zealand's take on underwater noise pollution is in its infancy still – especially with regard to vessel noise. That being said, we have advanced a lot in just the past 5 or 6 years with underwater noise being introduced in the Auckland Unitary Plan and several port companies around NZ establishing really good monitoring programs that are more similar to what we see overseas - which is great to see! Consultants, planners and regulators in NZ also have a growing sense of awareness regarding the issue of underwater noise pollution, especially for marine mammals.

There are a multitude of equipment and tools used in underwater acoustics, tell us about some of the tools and equipment you use everyday and what they are used for in your work?

We use a range of different bits of kit depending on the project – the main being, of course, the hydrophone and recorders (either cabled hydrophones (from Cetacean Research Technology, or HTI for example) or autonomous recorders (like SoundTraps, Songmeters and AMARS)). But some of the other bits of cool tech that we use a lot for our deep water deployments are acoustic releases and a range of different mooring designs depending on the location of the deployment. For shallow water deployments, we also rely a bit on GPS-integrated sonar systems (like side-scan or downscan sonar) to locate our seabed mounted platforms since we have no surface floats to mark their position.

International regulatory requirements are increasing for underwater noise, as marine noise pollution is now classified as a specific type of pollution (such as, the EU Marine Strategy Framework Directive (MSFD), which requires member states of the EU to achieve Good Environmental Status for European seas). What regulatory requirements or standards apply specifically in New Zealand to marine pollution and underwater noise?

There are some regulatory requirements in NZ with regard to underwater noise because of the effects on marine life. Depending on where certain activities occur, regulatory requirements may fall under the Exclusive Economic Zone and Continental Shelf Act 2012 and regulations, the Resource Management Act 1991, the Marine Mammal Protection Act 1978, the New Zealand Coastal Policy Statement and of course the Auckland Unitary Plan. All these come together to form the overall statutory context in New Zealand, while specific standards for the actual assessment of noise effects, itself, generally come from overseas.

Tell us about some underwater acoustic projects you have been involved with in New Zealand?

Some of the larger projects in NZ that I've been lucky enough to be a part of, with Styles Group, are the monitoring of marine mammals, using passive acoustics, around large-scale developments for Lyttelton Port Company, Northport, Refining New Zealand and others. Newer projects these days are also focused on acoustic tracking and automated detections of a variety of marine mammal species to assess their interactions with vessels. These are the cooler projects where I get to be involved with the experimental design, field work, writing code for the data processing and finally the overall biology of the problem. Then there are the usual underwater noise effects assessments for marine mammals and fish for a range of anthropogenic noise sources.

Tell us about some of the research projects you are working on at present?

I'm working on a range of research projects at the moment, both in NZ and abroad, focusing on many different species of marine mammals and fish which I'm really fortunate to be involved with. My three biggest research projects at the moment that have funding, are based in the Canadian Arctic, Hong Kong and our own Hauraki Gulf. Each project is really different of course, but they're all about trying to better understand how marine mammals and fish respond to underwater anthropogenic noise – so when put together, they form a more cohesive body of work (which is nice!).

What future professional goals do you wish to attain?

Getting an underwater acoustics paper published in Nature would be pretty cool!

What are the most satisfying things about your work and why?

Great question! The most satisfying thing in my work is being able to apply what we learn in an academic setting to private consulting. Most of my colleagues who are primarily academics undertake the research but don't often have the opportunity to be directly involved in the decision-making process for managing underwater noise pollution. That's the great thing with consulting – that you get to work directly with either the regulators or applicants to work on a management solution that fits with best practice – and being both affiliated with an academic institution (University of Victoria) and private consulting (Styles Group) means I get the best of both worlds!

When you're not working what do you do for leisure?

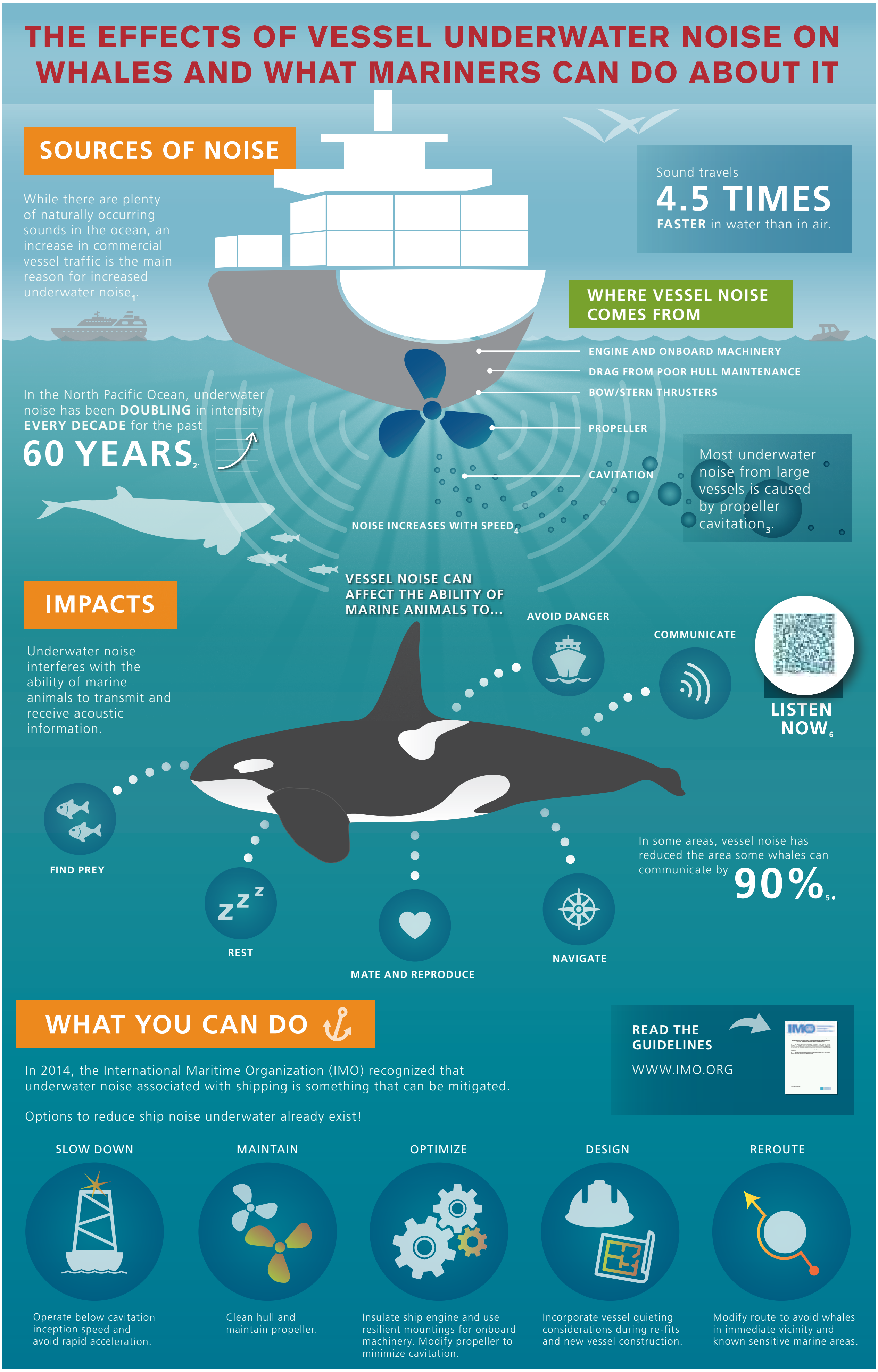
SCUBA diving, boating or surfing mainly, though the diving is a lot more often than the surfing these days. As a PADI Divemaster, jumping on board trips is always a win.

For those readers who want to find out more about ocean noise and underwater acoustics — what are some useful resources or sites they can visit for further information?

There's a really good website for just that – called Discovery of Sound in the Sea (www.DOSITS.org). There's a whole wealth of information there, from the basics of underwater acoustics to a whole audio gallery of various sounds from different species. The creators are also often seen at underwater bioacoustics conferences, where they introduce us researchers to their updates and call for new information to upload. It's particularly good for regulators, with free webinars.

Finally, a wise man once told me fish can hear. Is this true?

It is! Hearing mechanisms in vertebrates first appeared in fish, and they have two independent systems for detecting the various aspects of sound. The first, more important one for sound detection is the inner ear, and second is the lateral line (sensitive to the slight vibrations and water flow). But some fish also have anatomical components that help with sound detection – like a swim bladder. The swim bladder is an air sac that some fish have to control their buoyancy. The air inside the swim bladder can become 'excited' when a sound pressure wave passes through and travels down these small bones that connect the swim bladder to the fish's inner ear – called Weberian ossicles. Swim bladders help fish to have wider hearing ranges, so those without swim bladders (like sharks) appear less sensitive to sound and have narrower hearing ranges (since sound has to reach the inner ear directly, instead of being able to also arrive to the inner ear through a swim bladder).



Infographic – *Port of Vancouver*

FEATURES

Floor airborne and impact sound insulation performance of cross laminated timber vs. timber joist and concrete systems

Timothy Beresford[1] and Jeffery Chen[1]

[1]Acoustic Engineering, Norman Disney & Young, Auckland, New Zealand

Original peer-reviewed paper

Abstract

Cross laminated timber (CLT) is a modern building material which is gaining increasing application in Australian and New Zealand building developments. It is used as a structural wall and floor element, and has certain advantages over traditional building methods utilising concrete floors, particularly relating to the speed with which CLT structures can be constructed on-site. One disadvantage of CLT is that the base timber floor panel has less mass per square meter than concrete. Therefore, CLT typically requires additional layers of material (ceilings and raised floors) to achieve airborne and impact sound insulation performance similar to that of concrete floors and, indeed, to meet Building Code requirements. This paper explores a range of on-site test results obtained from two similar CLT apartment buildings. Standard airborne and impact sound insulation results ($D_{nT,w}$, FSTC, $L_{nT,w}$ and FIIC) are presented, as well as heavy impact results obtained using a "Japanese ball drop" method ($L_{iA,Fmax}$) to assess the low-frequency performance of the CLT floors. Various flooring upgrades were tested with the aim of improving the sound insulation performance of the floors. Test results from other apartment buildings with a mixture of concrete floors and timber joist floors are also presented and compared to the CLT floor results.

Introduction

Cross Laminated Timber (CLT) is a modern building material produced by glue-laminating planks of timber together and layering these in perpendicular directions to form a highly rigid, multi-layered, panel (akin to large-scale plywood). The CLT panels can be easily machined in the factory with a high degree of accuracy to form structural wall, floor, facade and roof elements. Prefabrication of such elements is one significant advantage of CLT over more traditional construction methods utilising concrete structural elements, which leads to reduced construction times on-site.

Compared to concrete, however, CLT has relatively low surface mass (kg/m^2). This is a key material property which dictates the sound insulation performance of a dividing element (wall, floor, etc.). The thickness of CLT in apartments is typically 100-200mm, with a surface mass of between 40 and 100kg/m^2; compared to that of a concrete apartment floor's surface mass, which is normally between 240 and 480kg/m^2. The CLT, however, is significantly heavier than the layer of plywood or particle board typically found as the structural flooring membrane on other "lightweight" apartment timber joist floors.

The primary aim of this paper was to assess the relative airborne and impact sound insulation performance of CLT versus concrete or timber joist floors, and to determine the type of flooring upgrades which would be required to obtain Australian and New Zealand Building Code compliant results for each floor system. A further aim was to determine whether the lightweight (CLT and timber joist) floors can achieve similar low frequency impact insulation performance to that of concrete floor systems.

Tested apartment floor types

This study focussed on the comparison of in-situ acoustic performance of floors separating apartments in four apartment buildings that contained varying floor constructions. Two of the buildings were largely identical and constructed with CLT as the primary structure (internal walls, floors, roof and facade). The third and fourth buildings contained both concrete floors and timber joist floors.

In all tested floor samples, the separating floor area and receiving room volume were relatively large, i.e., greater than 23m^2 and 61m^3, respectively, and therefore deemed suitable to assess the low-frequency performance of the floors with reasonable accuracy.

Concrete vs. lightweight apartment floors

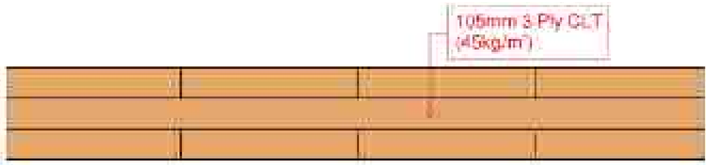
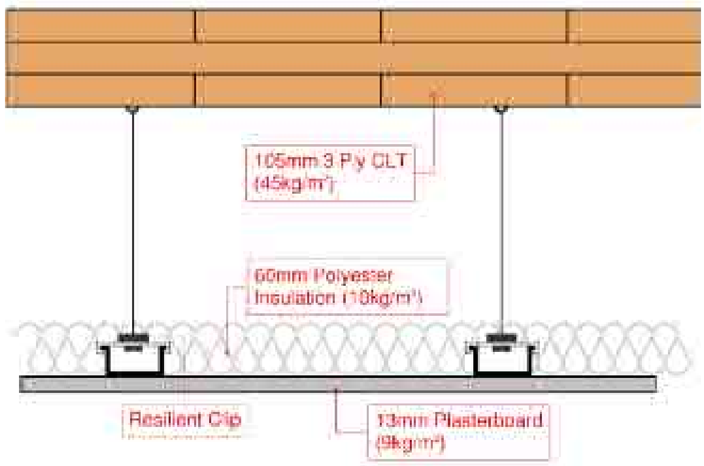
In the context of this study, the concrete floor system tested was taken to represent the benchmark of acoustic performance in apartment buildings, since this is historically the most common floor structure used in Australian and New Zealand apartments. Ideally, CLT or timber joist floors would be designed and constructed such that their performance was no worse than that of concrete, however, achieving good low-frequency performance from relatively lightweight floor systems often proves costly or impractical.

Floor construction details

The diagrams below outline the key elements which make up each of the tested floor constructions.

Flanking of the CLT floors via the structural CLT walls was not considered to be a limiting factor in these tests since all CLT walls were lined with separate plasterboard layers.

Table 1 – *Construction diagrams for the eight tested floors.*

Test ID	Construction Details
1 105mm CLT (no ceiling)	
2 105mm CLT + suspended PB ceiling on resilient clips	

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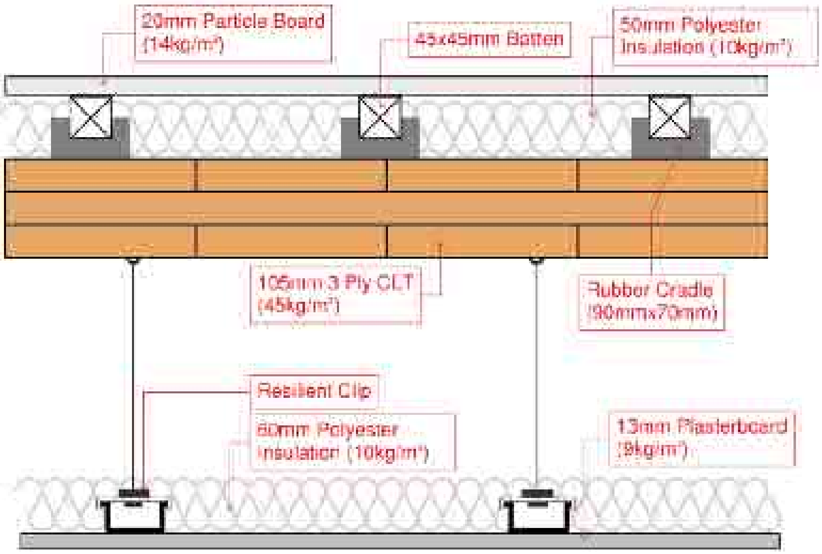
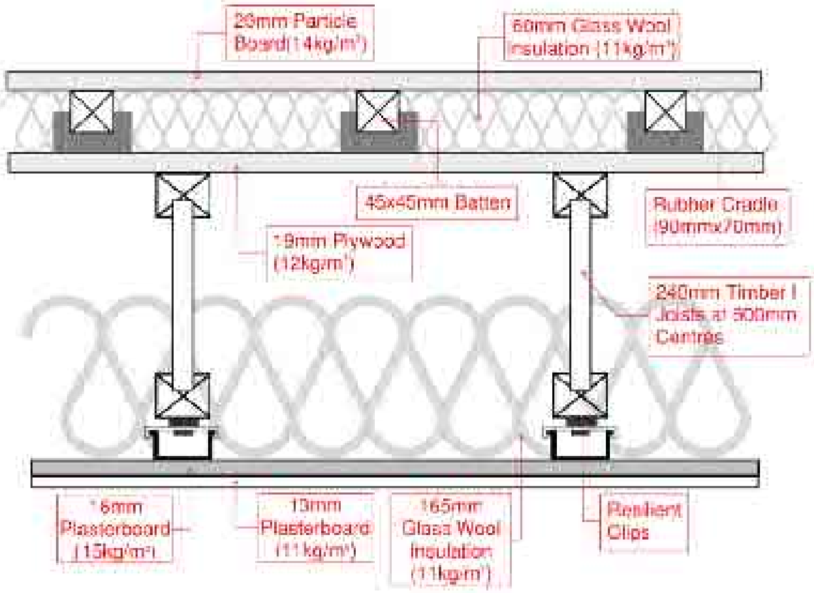
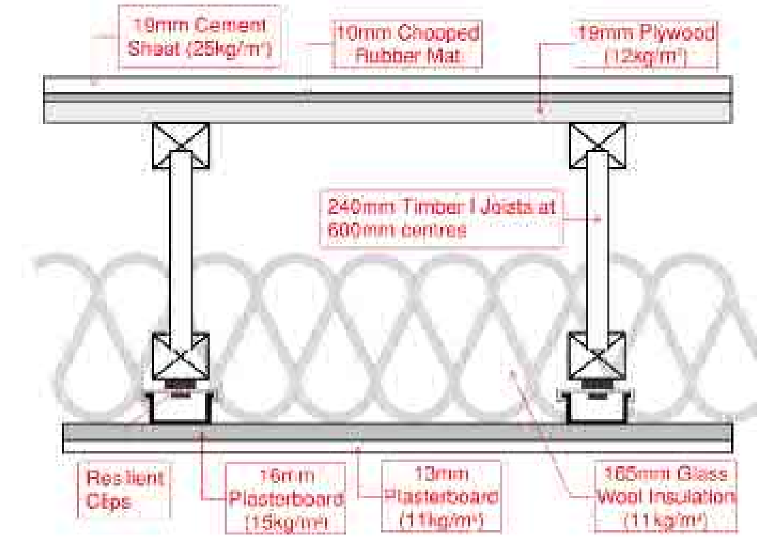
20mm particle board raised floor + 105mm CLT + suspended PB ceiling on resilient clips</td><td>
</td></tr>
<tr><td>4
20mm particle board raised floor + 19mm plywood + timber I joists + 2xPB ceiling on resilient clips</td><td>
</td></tr>
<tr><td>5
19mm cement sheet + 10mm chopped rubber mat + 19mm plywood + timber I joists + 2xPB ceiling on resilient clips</td><td>
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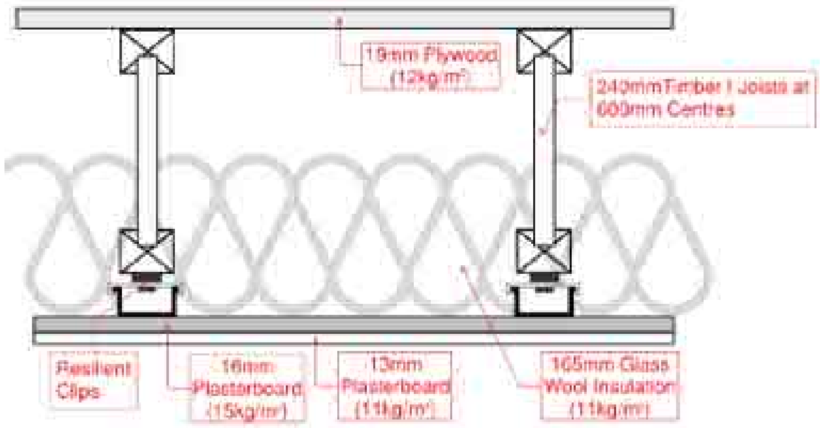
19mm plywood + timber I joists + 2xPB ceiling on resilient clips</td><td>
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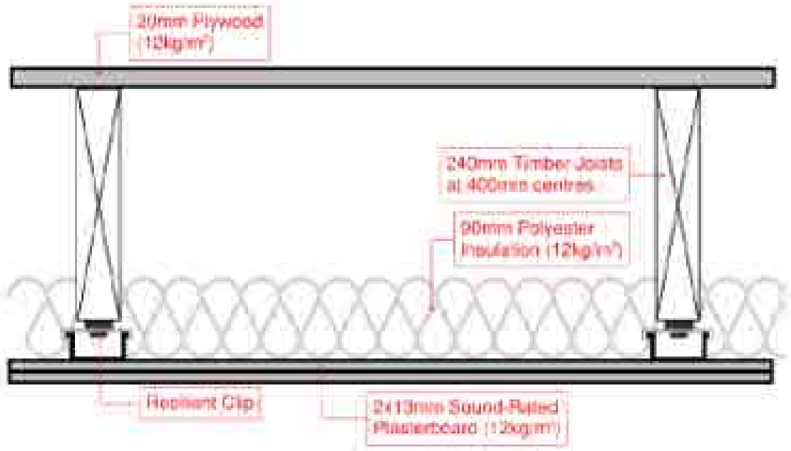
20mm plywood + timber joists + 2xPB ceiling on resilient clips</td><td>
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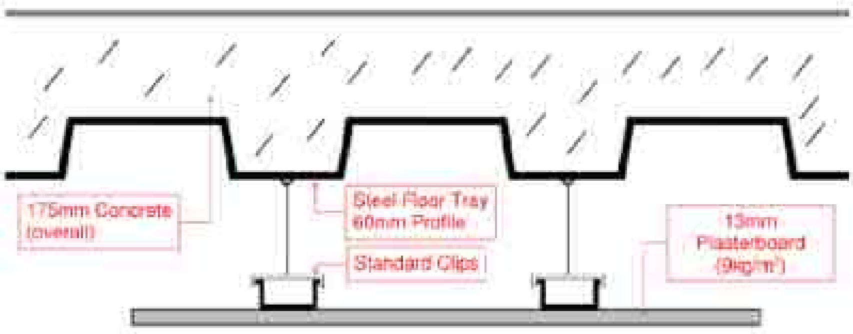
175mm concrete on 60mm profiled tray + suspended PB ceiling</td><td>
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Norman Disney & Young (Jeffery Chen, 2018)

Assessment criteria and methodology

The various floors were each assessed against the airborne and impact sound insulation performance metrics found in the Building Code of Australia (BCA) and the New Zealand Building Code (NZBC). Additionally, assessing the low-frequency performance of these floors was of particular interest. Because the standard tapping machine impact tests described in the ISO and ASTM standards (refered to in the BCA and NZBC) are unsuitable for assessing very low-frequency floor impact performance, the "Japanese ball drop" heavy impact source method was used to give a simple, yet standardised, assessment procedure. This type of floor impact test is intended to be representative of heavy and soft impacts, such as jumping and the running around of children (JIS A 1418-2: 2000).

The assessment methods used were as follows:

- **$D_{nT,w}$ + C_{tr}**: Weighted standardised level difference with spectrum adaptation term determined according to ISO 717.1-1996 (BCA Part F5 2016 requirement)
- **FSTC**: Field Sound Transmission Class determined according to ASTM E 336 - 90 and ASTM E 413 - 87 (NZBC G6 1992 requirement)
- **$L_{nT,w}$**: Weighted standardised impact sound pressure level determined according to ISO 717.2-2004 (BCA Part F5 2016 requirement)
- **FIIC**: Field Impact Insulation Class determined according to ISO 140/VII-1978 and ASTM E 989 - 89 (NZBC G6 1992 requirement)
- **$L_{iA,Fmax}$**: Maximum A-weighted floor impact sound level (octave bands 31.5Hz to 500Hz) determined according to JIS A 1418-2: 2000 using the rubber ball drop method and JIS A 1419-2: 2000 Annex 2

The minimum Building Code on-site performance requirements for apartment floors are as follows:

- BCA airborne: Not less than $D_{nT,w}$ + C_{tr} 45dB
- BCA impact: Not greater than $L_{nT,w}$ 62dB
- NZBC airborne: Not less than FSTC 50
- NZBC impact: Not less than FIIC 50
- No $L_{iA,Fmax}$ criteria under either Building Code

Results

The graphs and tables below summarise the measured results. For conciseness in ***Figure 2*** below, the apparent sound reduction index, R'_w, has been plotted in place of the BCA required $D_{nT,w}$. Similarly, in ***Figure 3*** below, the normalised impact sound pressure level, $L'_{n,w}$, has been plotted in place of the BCA required $L_{nT,w}$. In both cases the graphed results still show the general trends in sound insulation performance relative to the reference contours. Note that the airborne sound insulation for floor Tests 6 and 7 was not measured.

Figure 1 – *Tapping machine (left) and standardised rubber ball (right) used during floor impact testing. Norman Disney & Young (Tim Beresford, 2018)*

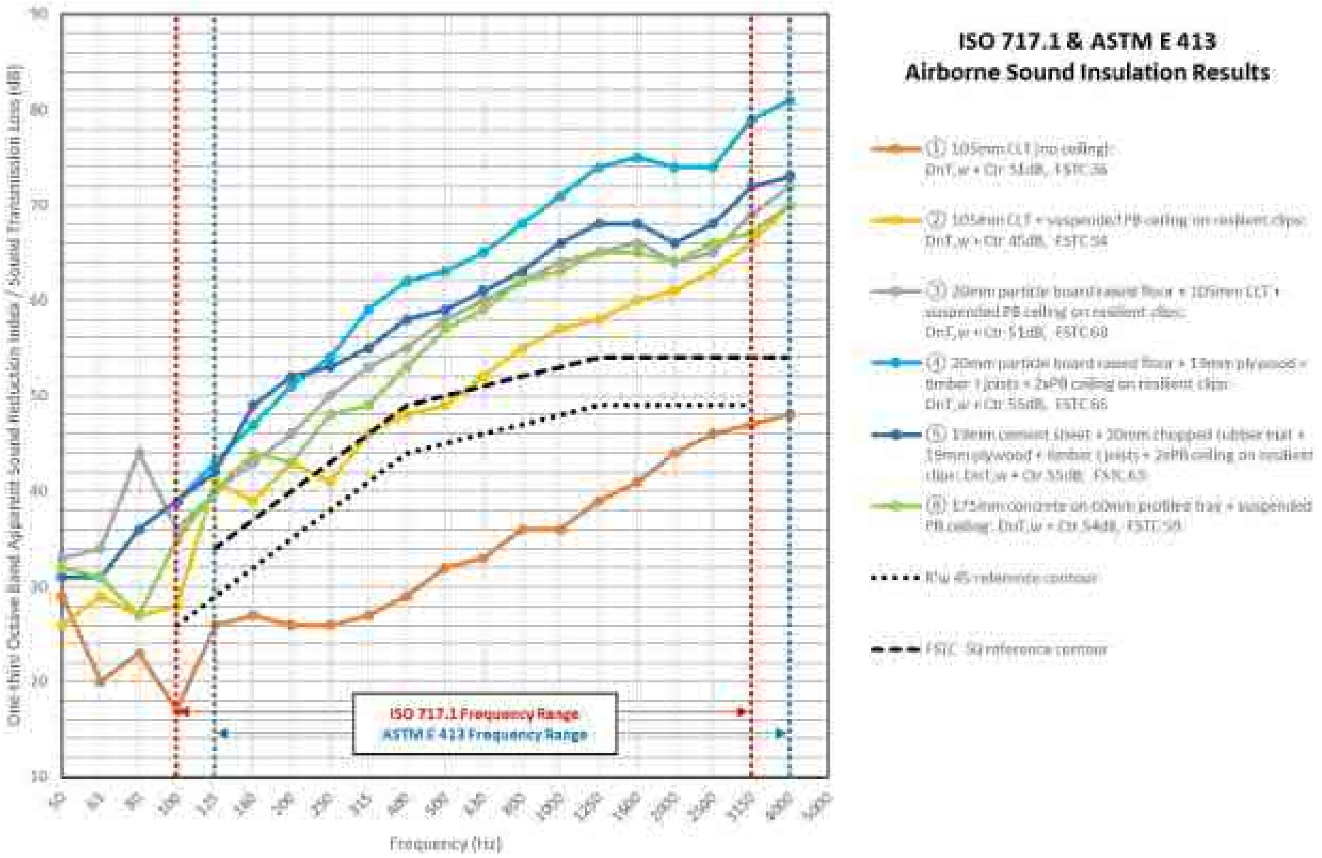

Figure 2 *– Measured airborne sound insulation results for various floor constructions.*
Norman Disney & Young (Tim Beresford & Jeffery Chen, 2018)

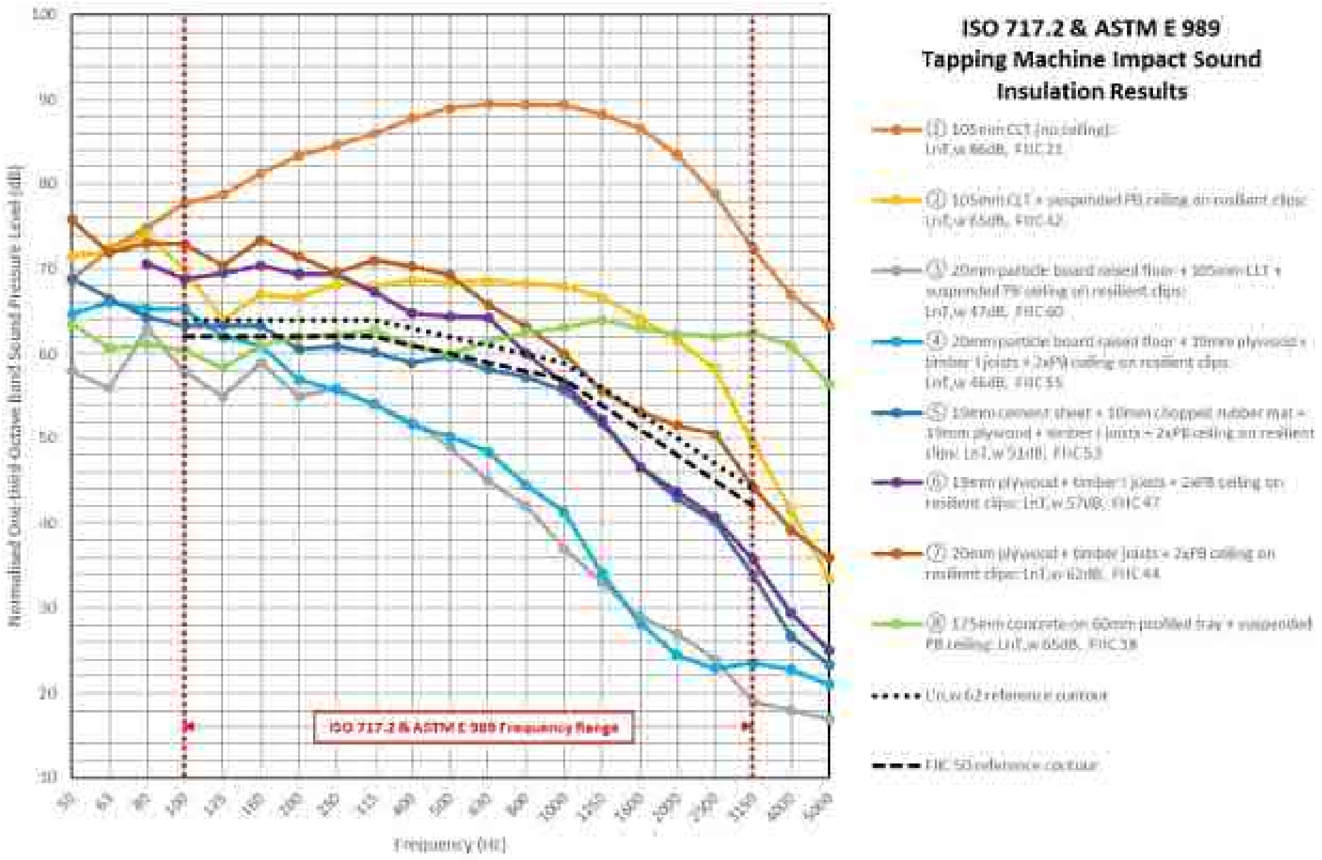

Figure 3 *– Measured tapping machine impact sound insulation results for various floor constructions.*
Norman Disney & Young (Tim Beresford & Jeffery Chen, 2018)

***Figure 4** – Measured heavy impact sound insulation results for various floor constructions.*
Norman Disney & Young (Tim Beresford & Jeffery Chen, 2018)

***Table 2** – Summary of measured results*

Test ID	Description	$D_{nT,w} + C_{tr}$	FSTC	$L_{nT,w}$	FIIC	$L_{iA,Fmax}$
1	105mm CLT (no ceiling)	31	36	86	21	71
2	105mm CLT + suspended PB ceiling on resilient clips	**45**	**54**	65	42	63
3	20mm particle board raised floor + 105mm CLT + suspended PB ceiling on resilient clips	**51**	**60**	**47**	**60**	58
4	20mm particle board raised floor + 19mm plywood + timber I joists + 2xPB ceiling on resilient clips	**55**	**65**	**46**	**55**	59
5	19mm cement sheet + 10mm chopped rubber mat + 19mm plywood + timber I joists + 2xPB ceiling on resilient clips	**55**	**63**	**51**	**53**	59
6	19mm plywood + timber I joists + 2xPB ceiling on resilient clips	-	-	**57**	47	61
7	20mm plywood + timber joists + 2xPB ceiling on resilient clips	-	-	**62**	44	66
8	175mm concrete on 60mm profiled tray + suspended PB ceiling	**54**	**59**	65	38	53

For clarity, in the $D_{nT,w} + C_{tr}$, FSTC and FIIC tests above, a higher value represents better sound insulation. Conversely, in the $L_{nT,w}$ and $L_{iA,Fmax}$ tests, a lower value represents better sound insulation. The results are colour coded from worst (red) to best (green) sound insulation. Values in bold are compliant with the relevant Building Codes.

Discussion

Airborne sound insulation results ($D_{nT,w} + C_{tr}$ and FSTC)

Not surprisingly, the bare CLT with no ceiling (Test 1) provided the poorest airborne sound insulation performance due to it being a single, relatively lightweight panel ***Figure 2***. Adding an additional panel to this, i.e. the ceiling (Test 2), improved the performance to the point where Building Code compliance was just achieved. Adding a third panel, i.e. the raised or resiliently supported floors (Tests 3, 4 and 5), further improved the airborne insulation to a level which could be considered very good. The concrete floor with ceiling (Test 8) performed similarly to the three-panel floors (Tests 3, 4 and 5) simply due to the large mass of concrete.

Although not assessed, it is estimated that bare plywood-on-timber-joist floors (Tests 6 and 7) would achieve airborne sound insulation compliance for both the BCA and NZBC.

Tapping machine impact sound insulation results ($L_{nT,w}$ and FIIC)

Again, the bare CLT with no ceiling (Test 1) did not provide good impact insulation ***Figure 3***. Adding a ceiling beneath the CLT floor (Test 2) improved its performance, making it comparable with the concrete floor with ceiling (Test 8). However, the spectrum shape of these two results is quite different, as can be seen in ***Figure 3***. The concrete floor exhibits a characteristic flat spectrum, and the single-number ratings ($L_{nT,w}$ and FIIC) are limited by the floor's poor high-frequency performance. As is common practice, resilient floor finishes or underlays are required to improve the high-frequency performance of the concrete floor's impact insulation. The CLT floor with ceiling (Test 2), however, exhibited its main deficiencies in the mid-frequencies, with comparatively good high-frequency performance. This is due to the timber providing a degree of cushioning (absorption) of the tapping machine hammer impacts. Neither Test 2 nor Test 8 were compliant with Building Code requirements, so further upgrades would be required if used as the floor between apartments.

The remaining CLT and timber joist floors (Tests 3, 4, 5, 6 and 7) were all compliant with BCA impact requirements, although, interestingly, only those floors with upgraded top surfaces (Tests 3, 4 and 5) were compliant with NZBC impact requirements. The floors with bare plywood as the topping (Tests 6 and 7) fell reasonably short of NZBC compliance, highlighting the more onerous requirements under the NZBC for floor impact insulation compared to the BCA. It is the authors' opinion that the timber joist floors in Tests 6 and 7 would be deemed subjectively unacceptable by a large proportion of apartment dwellers who might live beneath such an intertenancy floor.

Overall, the best performing floor in this group of tests was the CLT floor, upgraded with a suspended plasterboard ceiling, and a raised particle board floor on top (Test 3).

Heavy impact sound insulation results ($L_{iA,Fmax}$)

As expected, the concrete floor with ceiling (Test 8) performed the best under the heavy impact test; in fact, significantly better (at least $L_{iA,Fmax}$ 5dB better) than all of the CLT and timber joist floor constructions. This indicates that there is really no substitute for mass in a flooring system for protecting against low-frequency footfall thumps.

Of the lightweight floors, the upgraded CLT with suspended ceiling and raised floor on top (Test 3) performed slightly better than the other timber joist floors with upgrades above and below the base floor (Tests 4 and 5).

Acoustic advantages of CLT floors

As can deduced from the discussion above, CLT flooring, like almost all other floor systems, requires upgrades from the base floor to achieve a reasonable level of impact sound insulation, and ultimately Building Code compliance. These upgrades will most likely involve the introduction of a ceiling below and resiliently mounted floor finish on top of the CLT panel.

Acoustically, the main advantage of using CLT as the base floor, however, is that fewer upgrades are required to achieve compliance. This can largely be attributed to the higher surface mass of the CLT base floor panel ($45kg/m^2$) compared to the plywood ($12kg/m^2$) used in the other non-concrete floor systems. Comparing the three fully compliant lightweight floor systems (Tests 3, 4 and 5), the CLT floor (Test 3) utilised a ceiling of only a single layer of standard 13mm plasterboard ($9kg/m^2$), compared to the timber joist floors which required two layers of heavier plasterboard ($26kg/m^2$ total) to achieve similar impact insulation results.

The thickness of CLT in the tested samples (3-ply 105mm) is also likely to be the thinnest CLT found in apartment floors. If thicker CLT panels were used (perhaps for structural reasons), the greater surface mass would further improve the base floor performance, meaning that less ceiling or floating floor upgrades would be required.

Conclusions

All of the base floor systems (whether CLT, timber joist or concrete) required both ceiling and floor topping upgrades to achieve Building Code compliance, except for the bare plywood-on-timber-joist floors (Test 6 and 7) which achieved BCA impact, but not NZBC impact compliance. The BCA-only compliance of floor Tests 6 and 7 is a function of the somewhat lower impact insulation standard required for compliance in Australian apartment buildings.

Heavy impact assessments on each floor configuration showed that the concrete floor performed significantly better than all of the lightweight floor configurations. The CLT base floor, upgraded with a ceiling and floating floor on top (Test 3), performed marginally better than the upgraded timber joist floors (Tests 4 and 5). The ceiling of the upgraded CLT floor configuration was less than half the surface mass of the timber joist ceiling.

In conclusion, the upgraded CLT floor configurations assessed in this study performed comparably to other timber joist floors that had similar or slightly greater upgrades. The 105mm thick CLT floor in this study, however, was relatively thin compared to that likely to be found on many other CLT projects. Thicker CLT floors would require fewer upgrades to meet Building Code compliance, making CLT as a base flooring material, potentially more attractive than standard timber joist floors from a sound insulation perspective.

Further research

Of particular interest to the authors is how the low-frequency performance of lightweight floors should be assessed and whether such floors are subjectively acceptable to apartment dwellers. The inadequacy of the tapping machine test at assessing low-frequency performance is somewhat alarming, and a repeatable and standardised method of low-frequency assessment needs to be adopted within the Australian and New Zealand acoustic industry, with some haste, as the number of lightweight-floored apartments rapidly increases.

The authors recommend that more heavy impact ($L_{iA,Fmax}$ rubber ball drop) sound insulation data is gathered from within Australian and New Zealand apartments and correlated with occupants' subjective impressions of the floors, to assist in defining appropriate low-frequency impact criteria.

Regarding the low-frequency performance of CLT, it is also of interest to conduct further research into whether a thicker, and therefore stiffer, CLT floor panel would significantly improve the low-frequency impact insulation performance of this floor type towards that of a concrete floor.

References

[1] ASTM E 336 - 90: Standard Test Method for Measurement of Airborne Sound Insulation in Buildings. 1990. West Conshohocken: ASTM International.

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[6] ISO 717.2-2004: Acoustics - Rating of sound insulation in buildings and of building elements - Part 2: Impact sound insulation. 2004. Geneva: International Organization for Standardization.

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Comparative Impact Performances of Lightweight Gym Floors

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Abstract

Gyms are a common source of complaints for adjacent tenancies due to vibration and impact related noise issues. In many cases it is impractical to install a concrete floating slab and therefore lightweight floor options are increasingly being considered for retrofitting. This paper presents test data results for noise and vibration levels of low and high density rubber installed directly onto a suspended slab, rubber mounts under plywood and damped spring mounts under plywood. A comparative test was also performed between plywood and compressed fibre cement on damped spring mounts. A 10kg kettlebell was dropped ten times from 620mm height for each system. A Svantek 958 Analyser was used to record noise and vibration levels for each impact. High density rubber achieved the lowest improvement of 9.1 dB while damped spring mounts under plywood achieved the highest reduction of 30.8 dB. Damped spring mounts also achieved the highest attenuation for vibration levels. Low and high density rubbers installed directly on the slab amplified vibration levels. The secondary study indicated that compressed fibre cement provided significantly improved results compared to an equivalent plywood system.

Introduction

Structurally isolated floors reduce noise and vibration transfer from various types of harmonic excitations and impacts. While heavyweight constructions are preferable for performance, lightweight isolated floors can be retrofitted, are cost effective and are much more easily removed for changes in tenancy. For this reason, they are commonly employed in gyms located in apartments, commercial buildings and hospitals. However, a lack of clarity exists around comparative performance in selection of lightweight floor build-ups due to the vast range of options for isolation layers.

It is commonly accepted that free weights, pin weight machines, treadmills and aerobic exercises are the typical sources of complaints from people occupying spaces adjacent to gyms due to annoyance from vibration and associated structure-borne noise. Treadmill and aerobic activities input low frequency excitation of less than 3.2Hz on the floor (Bachmann & Amman, 1987). The effects of these activities are largely dependent on the underlying structural concrete slab's modes of vibration. Computational analysis is required to express the effects of treadmill and aerobic activities which will not be covered in this paper. Pin weight machine isolation has been achieved in many cases by installing spring mounts directly underneath weight stacks, providing effective cushioning support and negating the need for an acoustic floor. As such, the performance of the lightweight floor types in this paper is measured by a single impact typical of free weight drops only.

This paper presents the acoustic and vibration testing method and results carried out on four commonly used floor types. A further study follows with a differing test method on the effect of using compressed fibre cement (CFC) compared to plywood as a separated floor layer. The aim of this paper is to provide a comparison of acoustic and vibrational performance between different lightweight gym floor systems. It should be noted that all materials except for low density rubber are Embelton products.

Lightweight gym floors

Test A Floor Systems

The floor systems were characterised by two types; rubber mat systems laid onto the slab and isolated floating floor systems. The four test floor systems differing in cost, materials used and finished height are as follows, with floor systems presented in order of expected performance (lowest to highest).

High density rubber tile top surface finish

- 15mm high density rubber top surface (approximately 800 kg/m^3) 1.2 x 1.0 metre tiles installed directly onto 150mm concrete slab.
- 150mm ceiling cavity with 10mm plasterboard rigidly fixed.

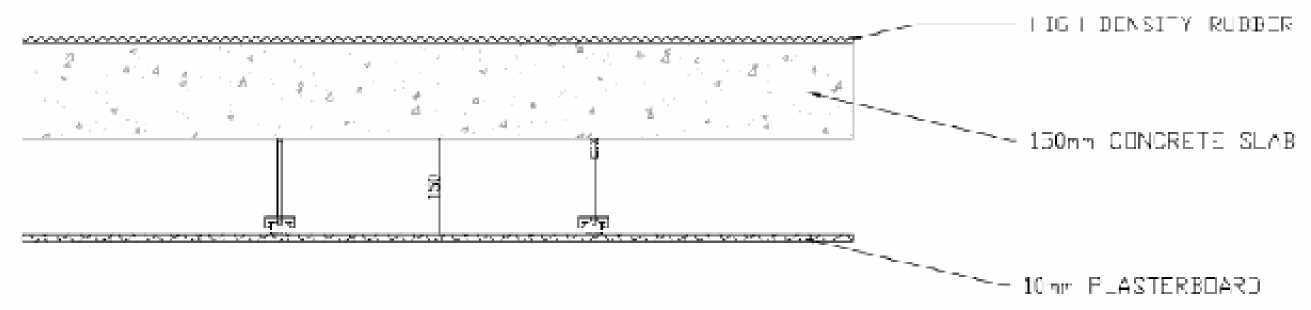


Figure 1 – High density rubber floor build-up

Low density rubber underlay tile with top surface finish

- 25mm, 50mm, 75mm and 100mm low density rubber underlay tiles (approximately 600 kg/m³) 1.0 x 1.0 metre tiles installed directly onto 150mm concrete slab.
- 15mm high density rubber top surface finish (as in ***Figure 1***).
- 150mm ceiling cavity with 10mm plasterboard rigidly fixed.

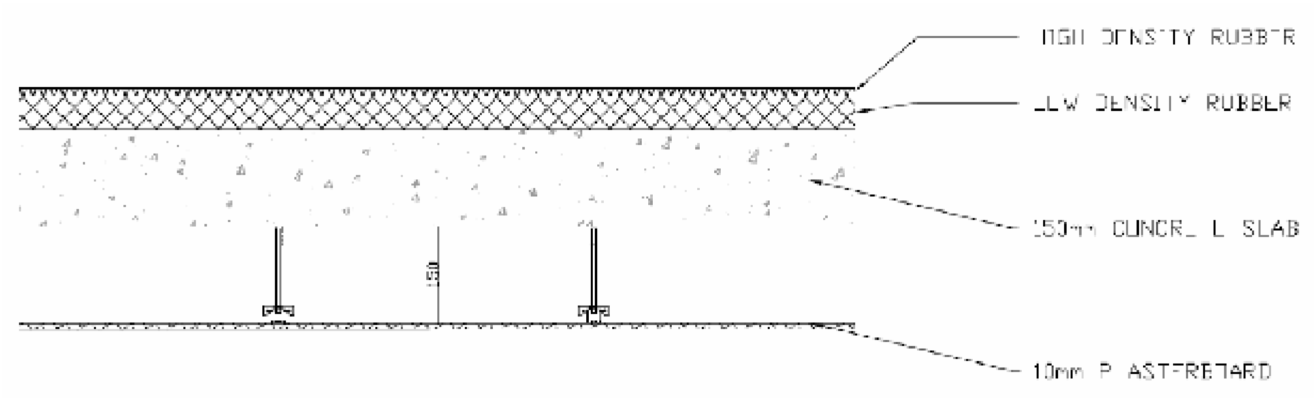


Figure 2 – Low density rubber with top surface rubber build-up

Rubber mounts under plywood with top surface finish

- Embelton NRD3 rubber mounts installed onto 150mm concrete slab at 600 x 600mm spacing.
- 2 layers of adhered 2400 x 2400 x 14mm plywood installed over rubber mounts.
- 15mm high density rubber top surface finish (as in ***Figure 1***).
- Cavity filled with 50mm 32 kg/m³ polyester insulation.
- 115mm overall free height.
- 150mm ceiling cavity with 10mm plasterboard rigidly fixed.

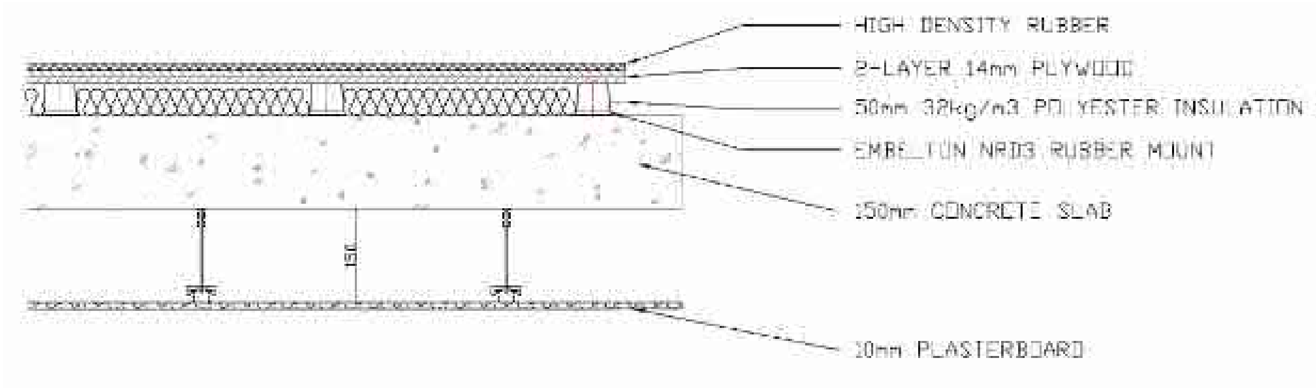


Figure 3 – *Rubber mounts with 2-layer 14mm plywood and top surface rubber build-up*

Damped spring mounts under plywood with top surface finish

- Embelton 25mm deflection damped spring installed onto 150mm concrete slab at 600 x 600mm spacing.
- 2 layers of adhered 2400 x 2400 x 14mm plywood installed over damped spring mounts.
- 15mm high density rubber top surface finish (as in ***Figure 1***).
- Cavity filled with 50mm 32 kg/m^3 polyester insulation.
- 137mm overall free height.
- 150mm ceiling cavity with 10mm plasterboard rigidly fixed.

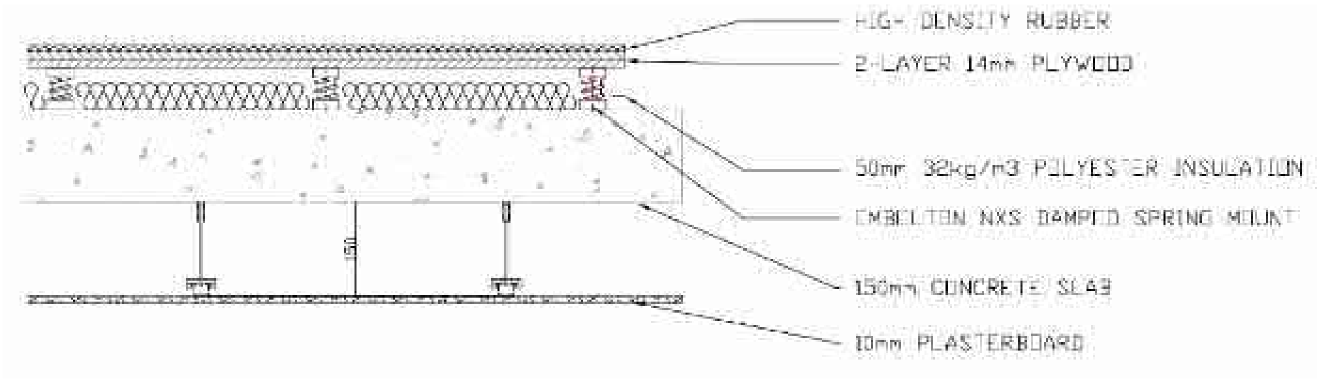


Figure 4 – *Damped springs with 2-layers, 14mm plywood and top surface rubber build-up*

Test B Floor Systems

A further study comparing the performance of plywood to CFC used the following systems:

Damped spring mounts under plywood with top surface finish

- Embelton 25mm deflection damped spring mounts installed onto 150mm concrete slab at 600 x 600mm spacing.
- Steel support channels installed over the top of damped spring mounts.
- 2 layers of 1200 x 1200 x 18mm plywood clamped to channels.
- 15mm high density rubber top surface finish (as in ***Figure 1***).
- Cavity filled with 50mm 32 kg/m^3 polyester insulation.
- 147mm overall free height.
- No ceiling installed.

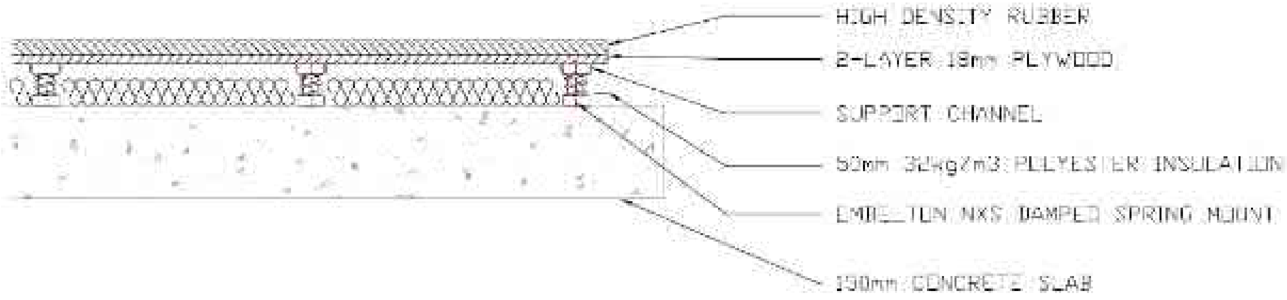


Figure 5 – *Damped springs with 2-layers, 18mm plywood and top surface rubber build-up*

Damped spring mounts under compressed fibre cement with top surface finish

- Embelton 25mm deflection damped spring installed onto 150mm concrete slab at 600 x 600mm spacing.
- Steel support channels installed over the top of damped spring mounts.
- 2 layers of 1200 x 1200 x 18mm CFC clamped to channels.
- 15mm high density rubber top surface finish (as in ***Figure 1***).
- Cavity filled with 50mm 32 kg/m^3 polyester insulation.
- 147mm overall free height.
- No ceiling installed.

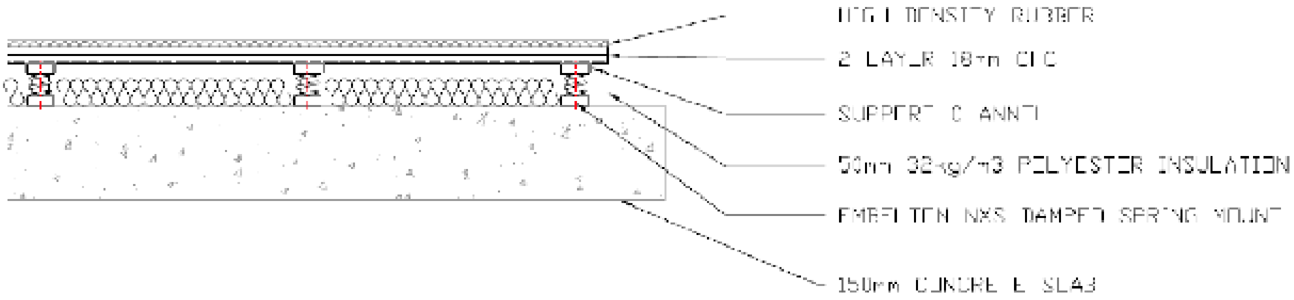


Figure 6 – *Damped springs with 2-layer 18mm CFC with top surface rubber build-up*

The floor area of floor systems ***Figure 5*** and ***Figure 6*** used were smaller than those of ***Figure 3*** and ***Figure 4*** and will therefore only be compared separately from Test A.

Equipment

Test Facility

Testing was conducted at Embelton's onsite facility comprising of an isolated concrete slab and receiving room of approximately 80m^3 volume. Floor samples were built onto the 10.8 m^2, 150mm thick 32MPa 20 Hz concrete slab. The slab is isolated by a rubber layer from the surrounding concrete structure to minimise the influence of wall flanking transmissions.

10kg Kettlebell

In the absence of International or Australian standards for heavy rigid impact testing, a 10kg kettlebell dropped from 620mm height would be used. It was expected that a kettlebell would deliver more repeatable localised impact as opposed to a dumbbell. Due to occupational health and safety concerns with repeated weightdrops, heavier test weights were not used.

Svantek 958 Analyser

A calibrated Svantek 958 Analyser was used with a microphone attachment for acoustic testing in 1/3rd octave bands. For vibration tests, a uniaxial accelerometer attachment was fixed to the top side of the concrete slabwith the analyser acting as the transducer. Measurements were taken in 1/3rd octave bands and weighted as presented in results.

Methodology

Test A

A ceiling system comprising of 10mm plasterboard with 150mm air cavity was installed underneath the isolated concrete slab in the receiving room. A 10kg kettlebell was dropped 10 times for each test floor at the centre of the isolated floor system. Results were averaged to minimise measurement errors and variability. L_{max} was measured from the centre of the receiving room over 2 seconds between 20 Hz to 20 kHz using the Svantek 958 Analyser's trigger function following weight drop. RMS acceleration levels on the concrete slab were measured over a 2 second interval for 10 additional weight drops following acoustic testing on each test floor.

Test B

No ceiling was installed for the further testing of CFC and plywood on damped spring mounts. This was expected to influence acoustic results substantially in comparison to Test A. L_{max} was measured between 0.8 Hz and 20 kHz using the Svantek 958 Analyser's start delay function and 60 second interval period over 10 cycles. A single 10kg kettlebell drop was registered for each cycle. The L_{max} dB(A) values were used to compare the performance between Test B floor setups. The RMS acceleration levels were recorded over a 10 second interval for 10 additional weight drops.

Results

Acoustic Test A Results

All floor types provided significant improvement to the bare concrete slab at high frequencies (***Figure 7***). Damped springs provided the greatest acoustic performance with a 30.8 dB reduction (***Table 1***) while 15mm high density rubber provided the least improvement with 9 dB reduction. A noticeable peak was observed for all Test A floor types at 63 Hz. Damped springs consistently outperformed all other systems at frequencies lower than 63 Hz.

Floor System	L_{max} dB(A)
Damped Springs	63.2
75mm Low Density Rubber	64.2
100mm Low Density Rubber	65.2
Rubber Mounts	66.7
50mm Low Density Rubber	70.4
25mm Low Density Rubber	72.5
15mm High Density Rubber	84.9
Bare Concrete Slab	94.0

Table 1 – *Single L_{max} dB(A) values for Test A floor types*

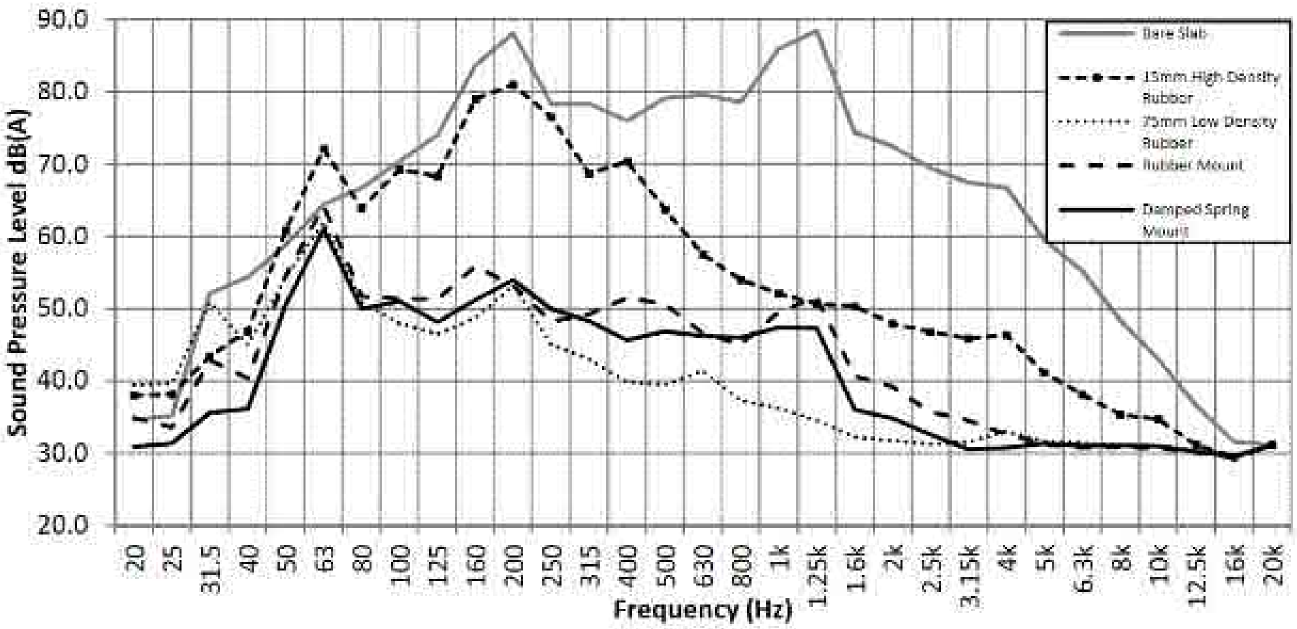


Figure 7 – *1/3rd Octave Lmax for Test A floor systems*

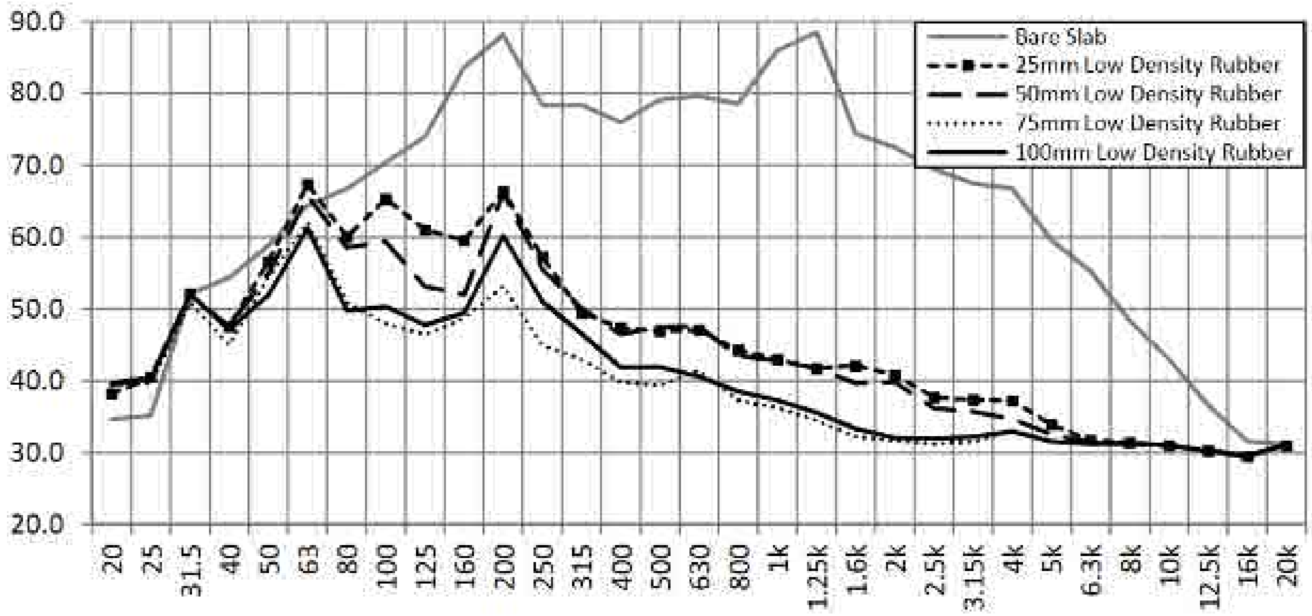


Figure 8 – *1/3rd Octave Lmax for Test A low density rubber systems*

Vibration Test A Results

The rubber mounts and damped springs recorded improved vibration levels from the weight drops over the bare slab between 1-80 Hz (***Table 2***). The rubber mat systems amplified the vibration of the concrete slab. Damped springs provided the greatest attenuation with a 60.5% reduction. The 25mm low density rubber was the worst performing, marking a 27.4% increase compared to bare concrete slab. A noticeable peak was present for all test floors at 20 Hz, which indicates the slab fundamental frequency.

Floor System	Weighted RMS (mm/s^2)
Damped Springs	22.3
Rubber Mounts	30.6
Bare Concrete Slab	56.5
15mm High Density Rubber	67.4
75mm Low Density Rubber	67.5
100mm Low Density Rubber	67.6
50mm Low Density Rubber	71.5
25mm Low Density Rubber	72.0

Table 2 – *BS 6472:2008 Weighted single value RMS acceleration for Test A floor types*

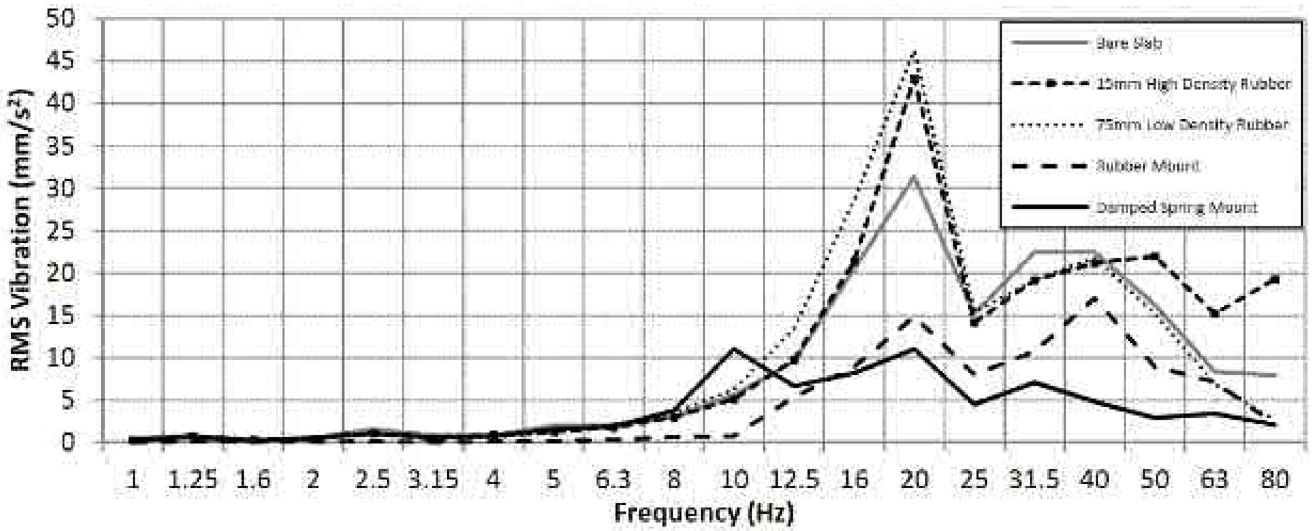


Figure 9 – *1/3rd Octave weighted RMS values for Test A floor systems*

Acoustic Test B Results

A 6.5 dB improvement in performance was observed with the CFC systems over the plywood system (***Table 3***). The CFC reached a maximum of 60.4 dB(A) at 50 Hz in comparison to plywood's 70.3 dB(A) at 250 Hz. From 80 Hz onwards, it is clear that the CFC on damped spring mounts provides superior noise reduction with respect to the plywood.

Floor System	L_{max} dB(A)
Plywood on Damped Springs	71.3
Compressed Fibre Cement on Damped Springs	64.8

Table 3 – *Single A-weighted L_{max} values for Test B floor types*

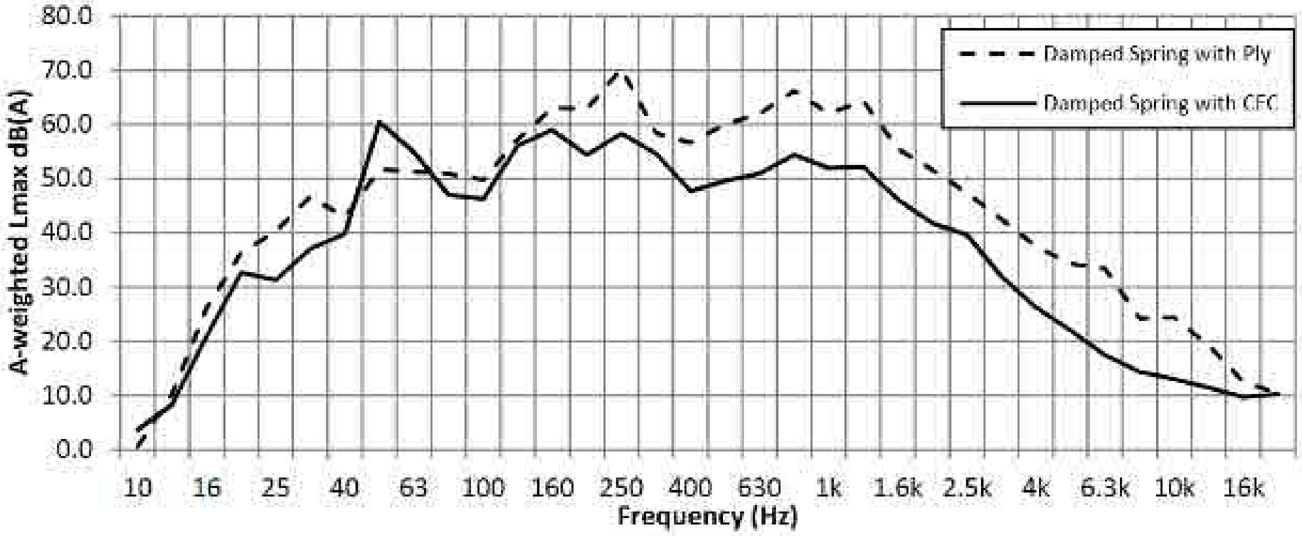


Figure 10 – *1/3rd Octave L_{max} for Test B floor systems*

Vibration Test B Results

The CFC also outperformed the plywood in vibration testing. The single value weighted RMS acceleration for the plywood was 20.4mm/s² compared to 13.9mm/s² of the CFC, a reduction of 32%.

Floor System	Weighted RMS (mm/s²)
Plywood on Damped Springs	20.4
Compressed Fibre Cement on Damped Springs	13.9

Table 4 – *BS 6472:2008 Weighted single value RMS acceleration for Test B floor types*

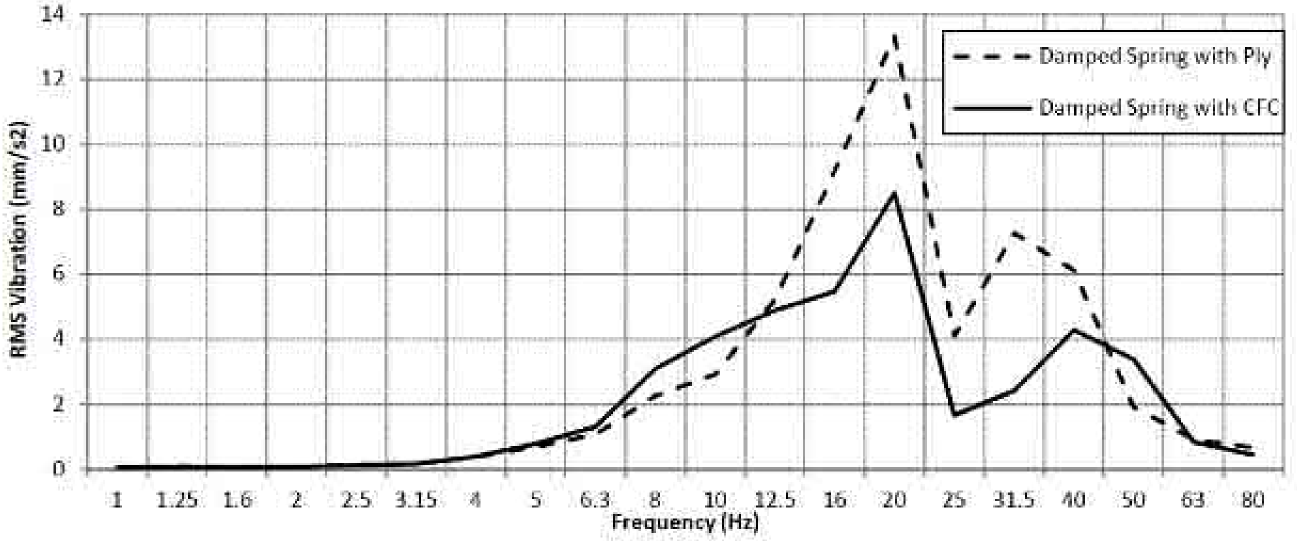


Figure 11 – *1/3rd Octave weighted RMS values for Test B floor systems*

Analysis

Test A Discussion

The surface area of plywood was approximately 4 times larger than the rubber mat systems. This was not expected to have affected the results due to plywood's rigidity requiring a large area to account for realistic load spreading from impact, and the flexibility of rubber mats constraining the spread of the impact to a smaller area.

The rubber mat systems provided minimal acoustic improvements at low frequencies. The 15mm high density rubber resulted in reductions of up to 25 dB at frequencies greater than 1.25 kHz. The 75mm low density rubber underlay performed best of all low density rubber thicknesses with significant attenuation for frequencies higher than 80 Hz. Reductions greater than 50 dB were measured above 1.25 kHz. Vibration levels between 1-80 Hz in the concrete slab were amplified by 19.5% when using rubber matting.

Rubber mounts provided improved acoustic isolation at lower frequencies than rubber matting, although its overall single A-weighted value was higher than 75mm low density rubber system by 2.5 dB. It was expected that the use of rubber mounts would outperform the low density rubber due to discrete transmission points, and an overall lower stiffness per square metre. However, the low density rubber provided superior attenuation at frequencies higher than 80 Hz. This may be due to the lack of any semi-rigid component with high resonant frequencies within the system such as plywood. Within the source room the low density rubber system deadened the noise from impact considerably more than the plywood systems. However, the rubber mounts reduced the vibration levels measured for the 20 Hz concrete slab by a substantial 45.8%.

The damped spring system achieved the highest attenuation in both acoustic and vibration testing with 30.8 dB noise reduction from the bare slab and 60.5% lower weighted RMS acceleration. The acoustic attenuation was consistently high for the damped springs across all frequency bands.

The amplification in vibration at low frequencies compared to bare concrete results is likely due to lower resonant frequencies of the rubber being excited. Distinct pairs of data were observed between the low density rubber samples (***Figure 8***). The 25mm and 50mm systems produced similar results in acoustic and vibration testing, while the 75mm and 100mm systems also behaved similarly. It was expected that there would be an incremental improvement with increasing thickness. The reasons for two distinct pairs of data are not entirely clear, although it is suggested that the 25mm and 50mm systems may have formed an essentially rigid connection to the concrete slab due to being overly compressed by the impact. With the 75mm and 100mm systems, a greater load spreading across the floor area due to the additional thickness may have prevented this.

Further testing can be conducted to investigate the performance of damped springs with plywood and low density rubber underlay and a high density rubber top surface. This system would be expected to improve comfort, reduce vibration levels otherwise present for low density rubber, while maintaining the airborne acoustic benefits.

Test B Discussion

The CFC on damped springs resulted in lower L_{max} noise levels and vibration levels than the plywood. This was expected due to the higher density of CFC. The extra weight added onto the damped springs increased static deflection, thereby lowering the natural frequency. Further, the CFC's greater inertia results in a lower amplitude of displacement following impact. Airborne noise performance also benefits from additional mass at frequencies well above resonance as the effectiveness of a wall or floor in blocking sound is largely mass dependent.

From (***Figure 11)*** it can be seen that the vibration was measured higher for the CFC at 50 Hz which is directly related to the point where the A-weighted L_{max} was greater for CFC than plywood. A resonant frequency of CFC may have been a contributing factor.

Conclusions

Comparative performance of some common lightweight gym flooring options has been presented in terms of structure borne noise levels measured in an adjacent space and vibration of the underlying isolated 20 Hz concrete slab following a discrete impact. Not discussed throughout this paper are some of the practical and subjective considerations such as cost, ease of installation and comfort.

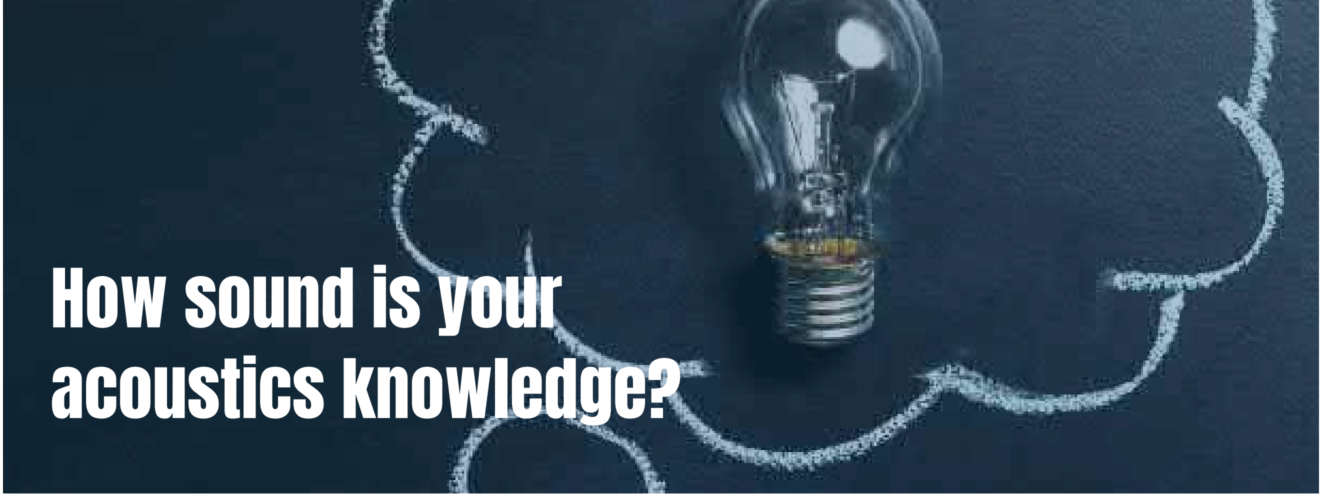
The damped spring system in Test A was the best performing system in terms of both slab vibration and structure borne noise measured in the receiving room, with 60.5% and 30.8 dB reductions respectively. Although 75mm low density rubber performed comparably to damped springs in the acoustic testing with only 1 dB difference, it amplified weighted vibration levels compared to the bare concrete slab. The use of rubber mounts instead of damped springs generated higher noise levels than both 75mm low density rubber and damped springs but showed significant improvement over the low density rubber in weighted vibration results. By itself, the high density rubber tile resulted in the least noise reduction from the bare slab test. Further testing of low density rubber on top of the plywood damped spring system would likely yield a higher benchmark in performance. However, test results proved that to gain vibration improvement between 1-80 Hz a separated floor such as plywood or CFC on rubber or damped spring mounts would be required as a minimum as no combination of rubber matting by itself provided attenuation.

Test B results demonstrated that the use of CFC as a structural flooring material provides a measurable improvement to plywood in both vibration and noise isolation when used with a 20 Hz concrete slab. Also due to its mass, the CFC could be considered an option when the natural frequency of the floating floor isolators are required to be engineered to a specific range.

References

[1] Bachmann H, & Ammann W 1987 'Vibrations in Structures Induced by Man and Machines', ***International Association for Bridge and Structural Engineering (IABSE)***; Structural Engineering Document 3e, ch. 2

[2] British Standards. Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting. BS6472-1:2008. Appendix B BS 642 weightings.



How sound is your acoustics knowledge?

1 Which of these statements is correct?

a. It is generally easier to provide sound insulation for high frequency sound.

b. It is generally easier to provide sound insulation for low frequency sound.

c. Sound insulation materials have the same effect on high frequency as they do on low frequency sound.

d. Sound insulation is only required for low frequency sound.

2 To the human ear a 10 dB increase in sound 'feels' like an increase in loudness of how many times?

a. 1 b. 2

c. 4 d. 10

3 Which of the following should be carried out for good detailing practice of junctions?

a. There should be continuous solid contact across separating walls and floors.

b. Joints in lining boards should be staggered.

c. Wall lining boards should be fitted in contact with the floor slab to minimise gaps.

d. Avoid contact between wall and floor finishes.

4 Acoustic insulation testing is generally carried out at ...?

a. One single frequency.

b. A range of frequencies from 100 Hz to 3150 Hz.

c. Two specific frequencies of 100 Hz and 3150 Hz.

d. A range of frequencies from 300 Hz to 1000 Hz.

5 What is the name of speed greater than that of sound?

a. Much b. Mach

c. Max d. Macht

6 What is another name for the voicebox?

a. Coccyx b. Pharynx

c. Lynx d. Larynx

7 **True or False?**

The equal loudness curve goes from the lowest audible sound to the level of the threshold of pain?

8 **True or False?**

In order for a sound to occur, the air at rest must vibrate between an at rest state, to a pressure state and then back to an at rest state, over and over?

(answers on pg.41)

In the environment court

NEIL CONSTRUCTION LIMITED – ***Applicant***

AUCKLAND COUNCIL – ***First Respondent***

MINISTER OF DEFENCE – ***Second Respondent***

L O LEE, S C LIN & S C CHEN – ***s 274 Parties***

[2019] NZEnvC 154, p28, [89] paras, 16 September 2019

www.rma.co.nz

Summary of facts

Neil Construction Ltd (Neil) sought several declarations from the Court relating to aircraft noise generated within the area affected by Designation 4310, known as Whenuapai Airbase;

a. That aircraft noise generated within the area affected by Designation 4310 held by the Ministry of Defence in the AUP, being the area known at Whenuapai Airbase and RNZAF Base Auckland and its surrounds, must comply with the conditions of Designation 4310;

b. That an exceedance of aircraft noise limits of condition 1 of Designation 4310 with the area was a breach of the designation and potentially a breach of s 9 RMA;

c. That the use of NZS6805:1992 and FAA Integrated Noise Model for measurement of noise generated by the requiring authority was mandatory.

Both the Auckland Council and the Ministry of Defence oppose the making of these or any other declarations.

The Court noted that the main issue related to engine testing noise and whether and to what extent such noise was controlled by the conditions of the Designation 4310. The Court detailed the history of noise provisions for the region and noted that the extent of control under Designation 4310 on activities, including noise from activities, at Whenuapai Airbase was substantially less than the extent of controls at other airports and airfields in the Auckland Region under the AUP.

In September 2017 the Council notified Plan Change 5 (PC5) to the AUP which proposed to rezone some 360 ha of land to the south of Whenuapai Airbase to mixed business and residential zones. PC5 proposed particular controls relating to aircraft engine testing by placing noise boundaries on certain land in the Whenuapai 3 Precinct outside the Airbase and restricting noise sensitive activities within the noise boundaries. NEIL owned land within that proposed precinct which it intended to develop for residential purposes and lodged a submission which sought the deletion of noise boundaries from the land it owned. The Court noted that submissions on PC5 were currently being heard by council appointed commissioners and the current application was part of providing a legal opinion requested by the commissioners as to the status of engine testing noise within the "Aircraft Noise" condition 1 of the Designation.

At the end of the hearing there was acceptance that aircraft engine testing was within the purpose of Designation 4310 and that the Auckland-wide rules would apply to activities not within the purpose of the designation. As such the primary issue remained as to whether aircraft engine testing was an activity that fell within the mentions of "aircraft operations" in condition 1 of Designation 4310.

The Court found that there was no evidence that would support the proposition that an ordinary, reasonably knowledgeable neighbour would perceive a material difference in engine noise depending on whether the aircraft was moving as part of flight operations or was static for engine testing. In the Court's view, in the absence any specificity in condition 1 of Designation 4310, the relevant effect controlled by that condition was the overall exposure to noise of land outside the Airbase and Noise Control Area. A consequence of that interpretation appeared to be that the Minister may not have the same ability to operate aircraft at Whenuapai Airbase as other requiring authorities at other airports where noise was dealt with differently by setting different limits for flight operations and engine testing. The Court noted that condition 1 of the Designation was not worded as comprehensively or effectively as it could be and as such the Court suggested that the Minister might wish to review the Designation.

It was the Court's view that an amended form of possible declaration would address the issues but noted that the conclusions reached were not in themselves determinative of Neil's application for declarations. The Court highlighted NZDF's view that making a declaration restricting engine testing noise could have the consequential effect of terminating flight operations at the Airbase and as such the RNZAF would not be able to pursue their purpose under s 5 Defence Act 1990. The Court concluded that it should exercise its discretion and make a declaration however it remain concerned that a consequence of making one could disrupt the purpose of the designation. As such the Court proposed to suspend its decision pending the outcome of any appeal, and if no appeal was forth coming the suspension would be for a limited time.

Court held

Court declared condition 1 to Designation 4310 - Whenuapai Airbase by the Minister of Defence in the AUP applied to all noise generated from aircraft operations on the Airbase including noise from engine testing.

The declaration was suspended for 20 working days from the date of issue, if an appeal is filed within that period, the suspension will continue pending the outcome of the appeal.

Leave reserved for any party to apply for further directions.

No order as to costs.

RICHARD JAMES DAVIS – ***Applicant***

GISBORNE DISTRICT COUNCIL – ***Respondent***

GISBORNE PISTOL CLUB INCORPORATED – ***Consent Holder***

DAVID DUNBAR, BRUNO HAAG, ROB KARAITIANA – ***s 274 Parties***

[2020] NZEnvC 74, p77, [273] paras, 9 June 2020 | www.rma.co.nz

Summary of facts

The appeal related to a review of the conditions of a 2001 land use consent PD 201041 which authorised the operation of the Gisborne Pistol Club Incorporated at 150 Gaddums Hill Road, Kaiti. The review was in accordance with s 128 RMA to deal with adverse effects on adjacent residents, who's dwellings were constructed sometime after the club began operation. The relief sought by the Appellant was to set aside the decision made on review or that appropriate conditions were set that "both constrained noise generated from the Club to a reasonable level as experienced by adjacent and surrounding residential land owners and occupiers, and better constrain the hours of operation within which such noise could be generated".

The review substituted a revised set of conditions that, among others, limited the days and hours of operation, and made specific provision for training times for the NZ Police. The Club was also required to provide a report to the Council detailing the best practicable option for sound insulation and for reducing the noise created from metal targets, but no noise limits were imposed.

The Court noted that the issues were complex legally, technically, environmentally, socially and practically, and the resolution would have major implications for the Club, the owners and occupiers of land in the locality of the site and the NZ Police, who used the Club facilities for training purposes. The Court was tasked with determining what effects noise from the Gun Club was having on the environment and what conditions would most properly address those effects and as such the Court considered many aspects of the case in detail. The Court also had to consider what the 2001 Consent authorised and in determining the appropriate conditions, the extent to which the Club "having been there first" should influence those conditions, if at all.

The Court detailed the evidence and background to the appeal, before assessing the site, the activity and the environ and land use in the locality of the site. Relevant Plan provisions were then discussed and the review process detailed before moving to the community concerns relating to the noise and the expert opinions on noise and effects and what activities were authorised by the 2001 consent.

The Court noted that the land in the vicinity of the site was zoned Rural Residential and a reasonable assumption was that both the Council and the Club could have anticipated that reverse sensitivity would be an issue at some time in the future. The site was zoned Neighbourhood Reserve and the Court was satisfied that the current activities were contrary to the several objectives and policies of the Plan. The Court noted there was a high level of consistency between what the experts predicted the noise effects

of the Club's activities would be and the effects being experienced by the residents. From the noise experts' evidence it was clear to the Court that the Consent's noise condition was inappropriate and did not prevent unreasonable noise from occurring and that L AFmax was a more pragmatic measure for shooting noise. The Court was satisfied that the use sought by the Police very significantly exceeded what was authorised by the 2001 consent. Consequently, it could not be authorised through the current review but would require a variation to the existing consent or a new consent.

Overall the Court considered that based on the 2001 consent application the maximum number of days authorised in any year was 116 less any public holidays on authorised shooting days. The Court was also satisfied that no competitions were authorised by the consent and that 2 of the 4 rangers were not consented. The Court was also not satisfied that the use of shotguns, the use of rifles other than by the Police or the use of the loudest firearms were authorised by the consent.

The Court went on to evaluate the evidence by addressing the underlying matters on which the Court relied, s 16 RMA, reverse sensitivity, noise effects, relevant plan provisions and other relevant matters. Subsequently the Court evaluated the change required to the conditions and the viability of the activity following any changes.

The Court noted that nothing in the RMA suggested that pre-existing noise should be subject to any lesser degree of control or mitigation than more recent noise. Even if the residents came to an area where there was no expectation of residential development occurring in the locality of a noisy activity at the time consent was granted, the obligations of s 16 would apply and noise would have to be controlled at reasonable levels. The Court was satisfied that the effects of the noise were unreasonable by any measurement yardstick and by a substantial amount, and had the potential and was causing adverse health effects. The effects had continued unabated for almost 10 years and had likely increased as shooting practices and firearms had changed over time. The Court considered that as a minimum a very significant immediate interim reduction from current noise levels to 65 dB LAFmax must occur for health and amenity reasons. Within two years, the levels must reduce further to the 55 dB LAFMax. The use of the Glock pistols at the Club were also prohibited for more than three hours each day of shooting and then only for a two-year interim period due to their very high noise. The Court invited the Police to submit to the Court on whether noise suppressors could be fitted to the pistols or whether quieter alternatives could be used for training purposes.

The Court considered that the Club had not complied with the requirement of Condition 1 of the Consent to undertake its activities "in general accordance with the details submitted with the application", nor sort any variation relating to the additional or extension of the authorised activities which could increase the adverse effects. The Court considered that as a minimum a very significant immediate interim reduction in noise levels must occur for health and amenity reasons with the starting point being that the existing noise levels were too high, too intense and went on for too long to be reasonable. As such the Court focused on conditions relating to the hours of operation, noise levels and location within the site. The Court noted that while the Club had made it clear it did not want to be restricted or to modify its current activities to any significant extent, that was not an option open to it. The Court strongly suggested that the Club recognise the adverse effects it was having on its neighbours and started working constructively with them to minimise those effects to the greatest extent achievable.

Overall, the Court was satisfied that the conditions were necessary and appropriate to address the adverse effects of the Club's activities. An interim period of two years was included in the conditions to provide sufficient time for the Club to seek a variation to its existing consent to allow other activities or to seek new consents for more activities at the site or an alternative site.

Summary of conditions

a. No shooting on Monday, Thursdays, Friday or Sunday, all Public Holidays and period between, and including, from midnight 23 December to midnight on 2 January

b. Shooting at the site may only occur on Tuesdays from 0900 to 1700 hours, Saturday's from 0900 to 1600 hours and on every second Wednesday from 0900 to 1700 hours for the period Midnight on 30 June 2022 and on every fourth Wednesday after that date.

c. The Police may undertake shooting up to 2100 hours on a maximum of two permitted weekdays in any calendar year.

d. A noise limit of 65 dB LAFmax shall apply to all activities on site for the period to midnight on 30 June 2022, save for the use by Police of Glock pistols, which may be used for no more than three hours a day on any days a year of Police use. Thereafter, a noise limit of 55 dB LAFmax shall apply to all activities at the site.

Court held

a. Appeal allowed.

b. Resource consent PD 201041 amended by substitution of conditions in Appendix 1 (draft Conditions).

c. Draft Conditions apply from 11.59pm Monday 28 July 2020 subject to D.

d. Parties may suggest alternative days and times to those set out for Club activity in Draft Conditions 4, 5 and 7 by way of joint memorandum no later than 5pm Monday 14 July 2020 provided there is no increase in total days or hours of operation. Club to seek views of NZ Police.

e. Having considered the parties memorandum Court will then issue its final decision.

f. Costs reserved.

Further update

No memorandum was received from the parties and as such the Court confirmed in decision [2020] NZEnvC 116 the conditions outlined in the Interim Decision [2020] NZEnvC 74. Costs remained reserved.

Upcoming Events

Postponed until a later date | Faro, Portugal [ICA Sponsorship]
Current trends on ocean sound and impacts on marine biodiversity
www.spacustica.pt/acustica2020/index.html

Postponed until a later date | Faro, Portugal
Iberian Acoustics Congress, Acústica 2020
www.spacustica.pt/acustica2020/index.html

23 - 26 August | Seoul, Korea [E-Congress]
49th International Congress and Exposition on Noise Control Engineering (INTER-NOISE 2020)
internoise2020.org/

Postponed until a later date | Verona, Italy
The Acoustics of Ancient Theatres
acustica-aia.it/en/event/verona2020/

Postponed until a later date | Vienna, Austria
4th Vienna Talk
viennatalk2020.mdw.ac.at/

Postponed to September 2021 | Ciche, Poland [ASA/ICA Sponsorship]
67th Open Seminar on Acoustics
www.ptakrakow.pl/osa2020/

19 - 21 October | Paris, France [ICA Endorsement]
Quiet Drones. A Symposium on Noise from UASs/UAVs
www.quietdrones.org

30 November - 4 December | Grenoble, France
International Conference on Voice Physiology and Biomechanics (ICVPB 2020)
icvpb2020.sciencesconf.org/

1 - 2 December | Tehran, Iran
10th International Conference on Acoustics and Vibration (ISAV2020)
2020.isav.ir/

7 - 11 December | Lyon, France
Forum Acusticum 2020
fa2020.universite-lyon.fr

8 - 12 December | Acoustics Virtually Everywhere
179th Meeting of the Acoustical Society of America
www.acousticalsociety.org/asa-meetings/

26 - 28 January | Auckland, New Zealand
Noise and Vibration Emerging Methods (NOVEM 2021)
www.novem2021.ac.nz

3 - 5 May | Oslo, Norway [ICA Sponsorship]
Baltic-Nordic Acoustics Meeting BNAM2020
www.bnam2020.org/

23 - 26 May | Florianopolis, Brazil
12° Congresso Iberoamericano de Acústica (FIA 2020)
fia2020.com.br/

26 - 28 May | Matera, Italy
47th AIA National Conference
acustica-aia.it/en/event/matera2020/

7 - 11 June | Seattle, Washington
180th Meeting of the Acoustical Society of America
acousticalsociety.org/asa-meetings/

14 - 17 June | Karolinska Institutet, Stockholm, Sweden
13th ICBEN Congress on Noise as a Public Health Problem
www.icben2020.se

21 - 23 June | Madeira, Portugal
EURONOISE 2021
www.spacustica.pt/euronoise2021/

All event dates are current as at time of print.

Quiz Answers

1. a.
2. b.
3. b. & d.
4. b.
5. b.
6. d.
7. True
8. True

Tested on all aspects- get that due diligence box ticked

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