New Zealand Acoustics

Volume 30, 2017 / # 2

A review of AS/NZS 2107:2016 Acoustics – Recommended design sound levels & reverberation times for building interiors

Effect of plenum absorption on ceiling attenuation

Can a connecting door between two apartments be compliant with Clause G6?

Light, transparency and sound absorption

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Features

Regulars

Cover Image: From an article entitled "Many Pleas for Quiet, but City Still Thunders". A photo in 1929 of acoustical engineers in New York, new measurement of sound to assess the noise levels in Times Square.

Source: Times Wide World Photo

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Contributions to the Journal are encouraged, and may be sent directly to the Editor's by email (journal@acoustics.org.nz) or by post c/o, the Acoustical Society of New Zealand Incorporated, PO Box 1181, Auckland.

From the President and the Editor's

President's Column

Dear ASNZ Members, Associates and Fellows,

Wow, what a winter it has been so far! Noise monitoring jobs are backing up while we wait for decent weather and lunchtime cricket has moved indoors to the office!

Just recently I spent some time with my 9 year old son in the snow last weekend part way up Mt Ruapehu. The scrub was covered in about 18 inches of pretty fresh powder and there was no one else in sight and probably less than 10 people within several kilometres of us, the sun was shining and the wind perfectly calm. I sat down with my son and asked him to stop breathing. When his confusion cleared and he realised why I asked, the stunning silence descended on us… It was so *incredibly* quiet… In fact, I'd say it was the quietest outdoor environment I have ever been in, without exception. With the powder absorbing all (or nearly all for you purists) of the ground reflections, it felt like being in an anechoic chamber, but in the great wide open. I don't think I could hear any sounds outside of my own body. Winter can be a wonderland, and there are some great natural acoustical wonders out there to discover and to show those around us who may not notice themselves. Sometimes you just have to stop and listen. Hopefully the young fella remembers it for a few years.

Back to business - thanks to all those that participated in the formation of the working group on National Planning Standards – I am sure that the collective experience of the group will be of great value to the Ministry and hopefully we can help them improve things.

I hope you have all updated your CPD (Continuing Professional Development)! It's easier than you think – www.acoustics.org.nz. Get it done!

Take care out there, stay dry and warm and I'll catch you again in the spring.

Jon

Editor's Column

Welcome to the second edition of New Zealand Acoustics for 2017 (Vol 30, #2). While I prepare this the outside temperature has just dropped to 4 degrees, heavy hail is dancing on the skylight above and gale force winds rush past my window. The forecast is for torrential rain….so all in all it's a normal Wellington Winters day! The good news is now the shortest day of the year has passed we can look forward to Daylights Savings and Summer. So hang on both are just around the corner, well Daylight Savings is but who can tell what Summer may bring? Let's all hope Tawhirimatea (the Maori God of weather) brings some settled, dryer and warmer weather!

We have a full edition which has something to offer all our members. We present our usual news, reviews, profiles and events including the RMANet and a Member Profile. We are in a fresh cycle of advertising so we would encourage our members to take the time to look through and review the updated advertising. We would also encourage our readers to consider supporting those advertisers in the journal that generously support us.

In regards to technical papers, this issue has a strong building acoustics focus with a diversity of papers. We have a review paper on AS/NZS 2107:2016 (Recommended design sound levels and reverberation times for building interiors); a research paper on the effect of plenum absorption on ceiling attenuation; a paper on Clause G6 of the Building Code regarding compliance with a connecting door between two apartments and finally one on transparent surfaces with sound absorption properties.

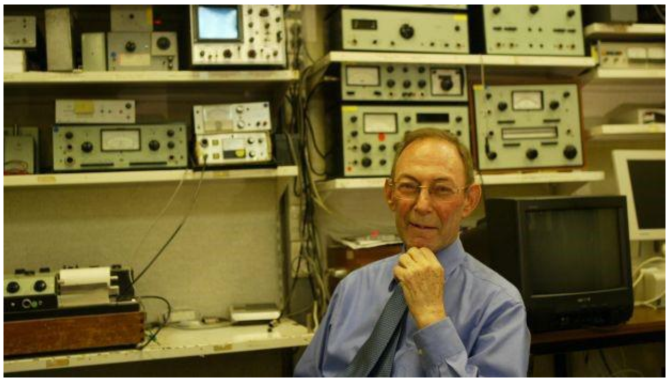
As Editors we are constantly looking for New Zealand based content thus we would encourage anyone who is thinking of preparing a paper, technical note or has any other content such as an opinion piece, that they get in contact to discuss this with us, this includes researchers, students or any 'non-experts' in the fields.

Finally if there is anything you would like to see in the Journal or have any feedback please get in touch as we are always keen to hear from our members. Enjoy the rest of Winter.

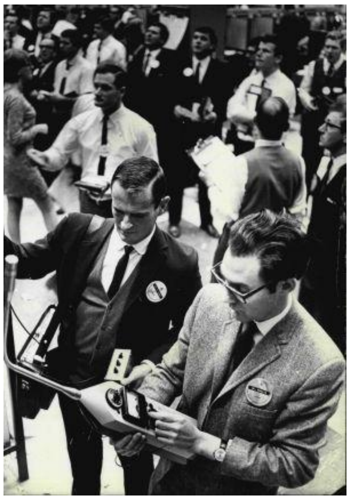

Lindsay & Wyatt journal@acoustics.org

Remembering Louis Challis Acoustic Pioneer

Louis Challis had a reputation as one of Australia's leading acoustical engineers. He provided outstanding acoustical designs and advice for some of Australia's most important and prestigious buildings among these was his involvement in the architectural acoustic design and supervision of Parliament House in Canberra. Other landmark public buildings and infrastructure projects include the Parliament Houses of New South Wales, Queensland and Papua New Guinea; the Olympics 2000 project at Homebush Bay, and Sydney Harbour Tunnel.



In the 1970s, Challis designed and developed an audio-tactile push-button signalling system, so pedestrians who are sight- and/or hearing-impaired can easily determine whether the signal is displaying "Walk" or "Don't Walk" simply by touching the button. Although the New South Wales Department of Main Roads offered Challis the right to patent his invention, he declined to do so on the basis that he believed the innovation should be made as widely available as possible at the lowest possible cost. This system he designed is used not only in all Australian cities but also around the world.



In regards to his professional career Challis spent a year in Israel and then completed a Bachelor of Electrical Engineering at the University of Sydney, later followed by a Master of Architectural Science from the same university. His first job on graduation was in underwater acoustics for the Royal Australian Navy. After working there and OTC, now part of Telstra, he started Louis A. Challis & Associates in 1966. His wife, Anna, left her career as a geophysicist in 1973 to work with Challis in his practice. Over the next 40 years, they worked together building a successful practice. Challis served in the Royal Australian Air Force Reserve as a specialist adviser in acoustics, where he attained the rank of Wing Commander. He also acted as specialist adviser on forensic assessment of tapes for ASIO, the New South Wales Independent Commission Against Corruption and the New South Wales Crime Commission.

Challis generously donated his time serving on committees to develop acoustical standards, many of which are still in use today. He also wrote hundreds of reviews of hi-fi equipment for the leading electronic magazines, Electronics Today International and Electronics Australia – his approach was unusual in that it combined objective laboratory testing with subjective experience. As a testament to Challis' pioneering work, service and contributions, he received numerous awards. His first was in 1976, recognising his work on New South Wales Parliament House. He was elected as a Distinguished.

Corresponding Member of the Institute of Noise Control Engineering of the United States in 1993. He was made an Honorary Fellow of Engineers Australia in 1998. He was selected by the Australian Academy of Technological Sciences and Engineering to be a Fellow in 2000. He was honoured with the Centenary Medal in 2001; Membership of the Order of Australia in 2005, and a Doctor of Engineering (Honoris Causa) from the University of Sydney in 2015. Over the course of his career, he received an unprecedented 12 Engineering Excellence Awards from Engineers Australia and Consult Australia.

Photos: Top left - Louis Challis seen in 2005 in the acoustics laboratory he had built at his Sydney home. Photo by Brendan Esposito. Bottom left - Michael Mason (left) and Louis Challis perform acoustics testing at the stock exchange in 1968. Photo by Ray Sharpe.

Article adapted from article prepared by Darren Challis for the Sydney Morning Herald.

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, we would like to hear from you! All comments and feedback is treated as confidential by the Editors.

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A review of AS/NZS 2107:2016 Acoustics – Recommended design sound levels & reverberation times for building interiors

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Original peer-reviewed paper

1. Introduction

Contemporary acoustic standards are essential to ensure standardization across government, private, and public sectors. In the case of *AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors*, this standard reflects the progress in acoustic science and technology and in building design since its predecessor, AS/NZS 2107:2000 was published some 16 years ago.

This paper provides comments and observations on the changes to the most recent version of the standard from the viewpoint of the authors, with oversight from our peer reviewer, who was on the Standards Australia Committee which drafted the 2016 standard. The aim of this paper is to provide the reader with a concise review of AS/NZS 2107:2016, focusing primarily on the key changes and updates between the 2000 and 2016 versions of the standard.

2. The purpose of updating AS/NZS 2107

The purpose of AS/NZS 2107:2016 is to provide guidance on recommended design sound levels and reverberation times for building interiors, including measurement for compliance assessment purposes. The objectives of the latest revision to AS/NZS 2107 were to update and expand guidance on design sound levels and recommended reverberation times. The basis for the required update was that the standard needed 'modernising', so as to include spaces relevant to the modern architecture and remove spaces that were no longer relevant. Minor but important changes to the text, layout and format have also been made.

3. Overview of national and international standards

Standards are documents setting out specifications, procedures and guidelines to ensure products, services and systems are reliable and consistent. There are generally three kinds of standards: international, regional, and national. In general, international standards are developed by the International Organization for Standardization (ISO) and its sister organisation, International Electrotechnical Commission (IEC). Individual countries can choose to adopt international standards directly for use as their countries national standard and through national standards organisations they have an opportunity to contribute the development of ISO/IEC standards.

Regional standards are generally prepared by a specific geographical region, such as the European Union, which develops European 'EN' standards. Similarly, in this part of the world, there are Joint Australian/New Zealand standards, with the designation AS/NZS that are regional standards for Australasia. AS/NZS 2107 is one of many Joint Australian/New Zealand standards.

The third type of standard is developed by a national standards body, which in the case of New Zealand is 'Standards New Zealand'. Standards developed under the brand of 'Standards New Zealand' are generally developed specifically for New Zealand conditions.

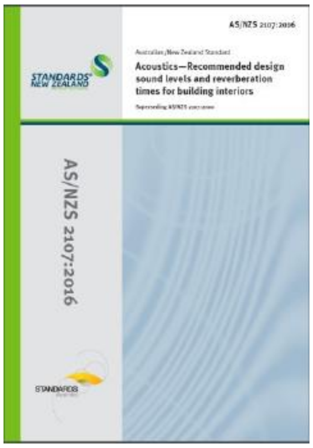
Standards are generally voluntary, but can become mandatory when cited in Acts, regulations, or other legislative instruments. Standards may also be referenced in regulations as one means of compliance or as an acceptable solution under those regulations, without being mandatory. Compliance with specific standards is often a requirement in specifications for buildings, plant and equipment.

4. New Zealand national standards organizations and management

The first national standards organisation was created in New Zealand in 1932 and was known as the 'Standards Association of New Zealand' (SANZ). Currently in New Zealand under the *Standards and Accreditation Act 2015*, the 'Ministry of Business, Innovation and Employment' (MBIE) has the primary responsibility to administer the *Standards and*

Accreditation Act and thus provide and manage standards. Standards are developed by MBIE through 'Standards New Zealand' (Paerewa Aotearoa), a business unit within MBIE. Standards New Zealand forms part of the Consumer Protection and Standards Branch in Market Services within MBIE.

5. A brief history of AS/NZS 2107



The '2107' standard originated some 40 years ago as Australian Standard AS 107-1977. The standard was updated 10 years later in 1987 as AS 2107-1987. In 2000 the standard was jointly revised and adopted by the standards organisations in both Australia and New Zealand as AS/NZ 2107:2000. The most recent 2016 edition is an update of AS/NZS 2017:2000 and was prepared by the Joint '*Technical Committee AV-004, Acoustics, and Architectural Acoustics*'. Twelve organisations are represented on this committee, including the Acoustical Society of New Zealand, the Acoustical Society of Australia, six Universities from Australia and New Zealand and government and industry bodies.

Under the current practices of the standards organisations the revision of a standard must specifically identify the scope for the revision and requires justification of the need for a range of stakeholders. Once that documentary evidence of the need has been collated the standards organisation prioritises the requests and decides if and when the revision process can be commenced by the relevant committee. The standard revision project involved the technical committee completing a revision and an updated draft of the standard in 2014. This was then issued for public comment as draft standard 'DR AS/NZS 2107:2014' in October of 2014. The public comment draft received almost 500 comments, a record for acoustics standards and demonstrating the extensive use and interest in this standard. After the close of the public submission period, and collation of the comments, a two-day meeting was held in March 2015 for the 'AV-004 Technical Committee' to go through the submissions, discuss and amend the draft standard as necessary. A number of comments related to extension of the scope of the standard to include aspects related to audio systems but that was outside the scope of the original versions and hence could not be introduced in the revision. The final updated version with the designation 'AS/NZS 2107:2016 Acoustics – Recommended Design Sound Level and Reverberation Time for Building Interiors', was approved on behalf of the Council of Standards Australia on 25th August 2016 and on behalf of the Council of Standards New Zealand on 6th September 2016. It was officially published in late 2016 (24th October 2016).

6. Scope and application of AS/NZS 2107:2016

AS/NZS 2107:2016 recommends design criteria conditions within building interiors to ensure "healthy, comfortable and productive environments for the occupants and end users". The purpose of the standard is to provide guidance on acceptable acoustic environments within unoccupied spaces ready for occupancy. It specifies methods of measurement of 'background sound levels' and reverberation times, for unoccupied spaces. The use of the term 'background sound level' in this standard is different to the definition in the environmental noise standard NZS 6801:2008, where it is defined as $L_{A90(t)}$. In AS/NZS 2107, 'background sound level' is defined as the $L_{Aeq,t}$ value with the space unoccupied, but ready for occupancy. In general environmental sound measurement terminology, this would be considered to be the 'ambient sound level'.

AS/NZS 2107:2016 is intended for use by acousticians and professional designers of acoustic environments within new and existing buildings. The design sound levels in the standard are intended for stead-state and quasi-stead-state sounds (sounds whose average characteristic substantially represent the steady-state sound) and not transient or variable noises outside buildings such as, but not limited to, aircraft, railway, road or construction noise.

Two key designations in AS/NZS 2107:2016 are the 'design sound level' and 'design reverberation time'. Table 1 in the standard provides a detailed list of values of these two quantities for nine distinct areas of occupancy within buildings, which range from educational buildings through to studios and for the spaces within those general areas. The standard makes it clear, where acoustic performance is critical, a specialist acoustic design is required (for example, spaces for students with learning difficulties) and that this design is beyond the scope of the standard. As with any technical standard, the end user should be suitably qualified, experienced and educated in (building) acoustics to ensure they understand the applications and limitations of the standard.

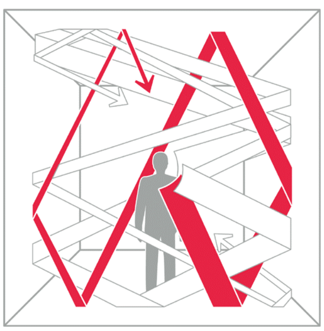
As well as specifying the recommended design values of background sound level and reverberation time, the standard provides detail on methods of measurement and reporting. It also contains four detailed informative appendices. Appendix A provides a guide for further information on reverberation times of selected spaces, such as music, speech, sports and lectures rooms. Appendix B provides information on building services evaluation, while Appendix C provides maximum recommended octave-band sound pressure levels for studios, drama theatres and cinemas. And lastly, Appendix D provides information for spectral imbalance and tonal components within spaces.

7. Changes between AS/NZS 2107:2000 and AS/NZS 2107:2016

7.1 Activity and occupancy

Table 1 of AS/NZS 2017:2016 set out each design sound level and design reverberation times in relation to a specific type of occupancy. The standard now includes the introduction of new spaces such as 'open plan office spaces' or 'post/pre-op recovery rooms' and has deleted specific types of historic occupancy and activities that no longer apply in modern buildings, such as an architect's 'draughting office'. The purpose of these changes was to reflect spaces used in modern architecture and delete those spaces that no longer exist in modern building practises.

7.2 Design sound levels



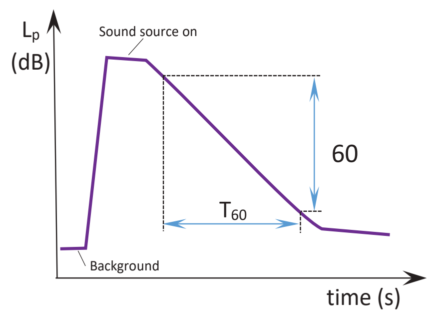
AS/NZS 2107:2016 defines the 'design sound level' as the 'background sound level' that is acceptable for most people for the space under consideration and uses the LAeq,t descriptor. As in the previous version of the standard, there is a section providing basic guidance on how to measure the background sound level.

The first noted change in AS/NZS 2107:2016 is that the detailed list of 'design sound levels', previously defined as 'satisfactory' or 'maximum', have been deleted and replaced with a range for the design sound level, thus providing an upper and lower range.

The historic standard AS/NZS 2017:2000, stated that a 'maximum design sound level' was the level of noise above which most people occupying a space start to become dissatisfied and a 'satisfactory design sound level' was defined as the level of noise that had been found to be 'acceptable' to most people for the environment not to be intrusive. Defining the sound levels in terms of a 'satisfactory' and 'maximum' level could be interpreted to suggest to the users of the standard that sound levels below 'satisfactory' were desirable, which in fact the opposite may be the case. Levels below those which were listed as 'satisfactory', could potentially lead to inadequate acoustic masking, resulting in loss of acoustic isolation and speech privacy. AS/NZS 2017:2016 specifically provides commentary on such implications, such as a sound level below the recommended range can have an unhelpful effect on acoustic masking and speech privacy. It is further understood that the use of 'satisfactory' and 'maximum' levels in AS/NZS 2107:2000 caused potential problems with meeting compliance for specifications, when one or the other may have become the mandatory compliance level. Thus, introducing the concept of a range in the 2016 standard, gives some flexibility and assistance to end users as one should be aware that there is no single or 'perfect' design noise level for a particular space.

A second update of note in AS/NZS 2017:2016 is that in some cases, the 'design sound levels' provides only a recommended maximum value. For example, the 2016 standard states a design sound level of "< 65 dB" for "uncovered car park areas". The reasoning for this approach was simply that for a space of this type there is no real justification for setting a lower level since speech privacy is not an issue.

7.3 Design reverberation times



AS/NZS 2017:2016 sets out 'design reverberation times' in terms of reverberation time (*T*) defined as the time required for the reverberantly decaying sound pressure level in the enclosure space to decrease by 60 decibels. The only guidance in the standard on the measurement of reverberation time is that "it shall comply with the relevant part of ISO 3382". This ISO standard titled 'Acoustics — Measurement of room acoustic parameters', has three parts: Part 1 (2009) is for performance spaces; Part 2 (2008) for ordinary rooms; and Part 3 (2012) for open plan offices. Only parts 1 and 2 include information on measuring reverberation time. In terms of notation, one of the notes in ISO 3382 Part 2 indicates that if the reverberation time (*T*) is evaluated based on a smaller dynamic range than 60 dB and extrapolated to a decay time of 60 dB, it should be labelled accordingly. For example, if it is derived from the time at which the decay curve first reaches 5 dB and 35 dB below the initial level, it is labelled T_{30}[1].

In the AS/NZS 2017:2016 standard there are more extensive recommendations regarding reverberation times. For many spaces a similar approach to that for the design sound levels is taken, by providing a range, such as

1 Using this notation means that: $T \equiv T_{60} \cong T_{30}$, which is confusing at first glance since mathematically, $T_{60} \approx 2x\ T_{30}$.

'0.3 to 0.6 seconds'. For other spaces only an upper level is given'. For a number of spaces, the comment is either that "reverberation time should be minimised for noise control" or reference is given to Appendix A reverberation time curves. This figure is based on German DIN 18041 standard ('Acoustic quality in rooms - Specifications and instructions for the room acoustic design') and the 'Mean Reverberation Times' curve has itself been updated as part of the AS/NZS 2107:2016 review.

7.4 Additional changes of note

There have been some practical changes to AS/NZS 2107:2016 which although relatively minor, are noticeable, and make the use and application of the standard easier. One such example is Table 1 where horizontal lines have been introduced, making it easier to read across rows. Another simple but affective change is the use of colour in 'Mean Reverberation Times' graph in Appendix A. Such changes are simple but make the standard clearer and easier to follow and apply.

8. Publications and reference documents

There are a host of technical documents on acoustics related websites which refer to AS/NZS 2107. As the latest standard is fairly new, the majority of these technical documents refer to AS/NZS 2107:2000 and have not yet been updated to refer to the 2016 version, including those of government agencies. It will take some time for these documents to be updated to reflect the changes in AS/NZS 2107:2016.

9. Conclusion

AS/NZS 2107:2016 is an important Joint Australian/New Zealand standard for the acoustic performance of internal building spaces. Changes made in 2016 revision improve its scope of application by including modern types of occupancy, and design values aligned with current international standards.

It is important that the work of the AS/NZS 2107:2016 standard committee and the standards organisations are acknowledged to ensure that this essential standard is updated and revised on a regular basis.

Qualifications and Copyright

This paper review is intended as a guide only; it is not intended to be surrogate for any expert advice from a professional acoustic consultant. The reader and users should further understand that the information within this review does not attempt to cover all areas and applications of the standards and therefore there are a host of omissions. While all care has been taken in the preparation of this work and the information

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The Acoustical Society of New Zealand

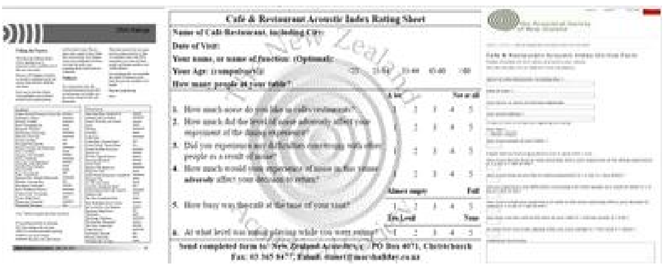
www.acoustics.org.nz

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?

Cafe and Restaurant Acoustic Index (C.R.A.I.)

The Cafe and Restaurant Acoustic Index, C.R.A.I., is now completely online with all results and online forms able to be viewed and download from the acoustics.org.nz website under the C.R.A.I tab.



AAAC Name Change

There has been a subtle name change to the AAAC, now being known as Association of Australasian Acoustical Consultants. This change is to be inclusive of New Zealand consultancy firms. At the time of preparing this article the AAAC Member Firms listed in New Zealand Included Malcolm Hunt Associates and Norman Disney & Young. The AAAC is seeking further NZ based consultancy firms. The AAAC is a not for profile body represent professionals who are involved in providing comprehensive nose and vibrations services. Please visit www.aaac.org.au for further information.

National Branch Meetings

As reported in NZ Acoustics (Vol. 30, #1, 2017) by the President Jon Styles, a host of branch meetings have taken place with the first South Island Acoustical Society of New Zealand branch meeting event held for some time at the end of March hosted at Dux Central.

The event was well received with the majority of the South Island members in attendance. The South Island branch of the ASNZ would like to thank all that attended and look forward to seeing you at our next event soon. The Auckland Branch meeting had Dr Matt Pine present work on underwater acoustics. The Auckland meeting also had a good turn out with around two dozen people.

Hugh Vivian Taylor Award Announced

Congratulations to Marshall Day Acoustics and there team who was announced as winner for 2016 of the Hugh Vivian Taylor Award (HVT) for the development of IRIS which is measurement system for capturing and analysing room impulse responses in 3D. The HVT award is presented by the Australian Association of Acoustical Consultants and recognises efforts in providing innovation, promoting consulting and advancing the field of acoustics.

NCS Acoustics

Last year NCS Acoustics Limited as part of a website upgrade produced several updated brochures. Three more brochures have been now been released. The new brochures all available to download off the NCS website: www.ncsacoustics.co.nz. The updated brochures include updated brochure AFA150 regarding compartment units and two new brochures covering Cross Talk Attenuators and Mufflers applications.

Pyrotek® launches new web site

Pyrotek® has have recently launched their new and improved www.pyroteknc.com website. Pyrotek's new site covers the acoustic and thermal solutions. This new, user-friendly website provides a quick and intuitive access to performance-improving technical solutions, intelligent products and simple designs for high-tech manufacturing. The addition of the search feature offers a fast and convenient way to browse with ease.

INSUL V9 Released

The newest version of INSUL a specialist program for predicting sound insulation and impact sounds has been released. The new release presents a major over haul of the user interface to provide a new foundation for the next 10 years development of the software. The most obvious new feature to INSUL users will be the 3D illustration of the partition to be calculated. For a more detailed review and information on the new Version 9 release visit: www.insul.co.nz

Acoustics for Autism to hit 10 year milestone

Since its formation as a one day music festival to raise money for families affected by autism, the annual event known as Acoustics for Autism has blossomed into an enduring act of compassion. With its 10th annual running this year, Acoustics for Autism will enter a double-digit era of exposure and success for a fund-raiser that was originally planned as just a one-time show. A follow-up to Project iAm's original benefit CD is expected to be released at this year's event.

Worksafe Exposure Monitoring Seminars

Worksafe have wrapped up their Exposure Monitoring Seminars which were held at five locations around New Zealand over May and June. The purpose of the workshop was to clarify acoustic consultants' legal duties under the Health and Safety at Work Act (2015) and its Regulations in regard to noise exposure as well as discussing competency expectations for noise monitoring and technical reporting.

No Appetite for Noise?

The Washington Post is reporting that some restaurant reviewers in the United States are now scoring establishments on their noise level. New Zealand already has its well known 'Cafe & Restaurant Acoustic Index' check it out at www.acoustics.org.nz, BON APPETIT!

#OneEarOut - Tune into Life Campaign

The *#OneEarOut* campaign was launched to bring awareness regarding people being injured and killed from distraction while using headphones,

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Effect of plenum absorption on ceiling attenuation

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Abstract

The influence of acoustic absorption laid directly on top of ceiling tiles installed in a two-way suspended grid system was examined to determine the effect that absorption played in ceiling attenuation. Glass fibre acoustic absorption material ranging in thickness from 15 mm to 100 mm was laid, in turn, directly over four different ceiling tile products. An increase in the transmission loss through the plenum sound path was seen when the acoustic absorption was laid over the ceiling tiles. The largest increase seen was with the thickest absorption, with the smallest increase seen with the 15 mm thick glass fibre acoustic absorption. The largest overall gain from a tile with no acoustic absorption behind, accounting for thickness was with the 25 mm thick glass fibre acoustic absorption. It was seen that a relatively poor performing ceiling tile can perform relatively well if a thick absorption product is laid directly on top of the tile in the plenum.

Original peer-reviewed paper

1. Introduction

The current typical design for office spaces in New Zealand is to create a single large open plan space. The tenant fit-out involves breaking the space up into smaller meeting rooms, private offices, reception areas, and so-forth (Hamme 1961, Haliwell & Quirt 1991). For ease of installation as well as long term flexibility, these separating fit-out walls are normally only constructed after the suspended ceiling is installed, and therefore are only constructed up to ceiling height. In addition to this, new seismic requirements in New Zealand may require a deflection plane at or around ceiling height, and therefore it may not be practical to construct full height acoustic walls. Because of these limitations, sound transmission between spaces is generally limited to that through the plenum sound path (sound travelling through ceiling tiles in one room, across the separating wall in the ceiling plenum space, and back through the ceiling tiles in an adjacent room), which may be less than a typical single stud wall system.

Hamme (1961) designed and constructed the first facility to determine the sound attenuation between rooms, which led to the development of the first International Standard to determine the ceiling attenuation of a ceiling product (AMA 1-II-1967). Using this facility, Hamme (1961) started to look at the effect of 'corrective' modifications to ceiling tiles to increase the ceiling attenuation of a ceiling tile specimen, by looking at installing fibrous insulation to the rear of the ceiling tile. An increase between 5 and 9 dB was seen below 1,000 Hz, with an increase of 31 dB at 4,000 Hz over the ceiling tile without any 'corrective' treatment. Royar and Schmelzer (2006) undertook measurements of absorption on side walls and on the roof of a 1:10 scale facility. There measurements were limited to frequencies above 500 Hz, however little difference was seen with and without acoustic absorption installed on the roof of their facility. Very little additional research has been published on this, with most completed by private ceiling tile manufacturers, so the results are not accessible. This research builds on that by Hamme, determining the effect of absorption in the plenum with four different ceiling tiles and four different thicknesses of acoustic absorption.

A Ceiling Flanking Noise (CFN) facility was designed and constructed at the University of Canterbury to establish the ceiling attenuation provided by a range of ceiling tile products, all installed in a 1200 mm x 600 mm two-way suspended ceiling grid. This ceiling flanking facility was designed, constructed, and commissioned to ASTM E1414-11a (ASTM International, 2011), the North American laboratory design and methodology standard for CFN facilities. After measuring the attenuation provided by four ceiling tile products using this facility, acoustic absorption with thicknesses of 15 mm, 25 mm, 40 mm, and 100 mm was laid, in turn, directly over the suspended ceiling system to determine the effect of the addition of absorption to the ceiling plenum cavity on the ceiling attenuation.

2. Test facility and product description

A CFN facility comprises of two separate rooms that are separated by a part height wall, with a suspended ceiling grid installed flush over the top of the separating wall, and sealed to ensure the predominant noise path is through the plenum sound path. A CFN facility is a small laboratory space, simulating two small private offices or

Figure 1: Overview of the CFN facility at the University of Canterbury

meeting rooms adjacent to each other with a common ceiling plenum above the common wall. To simulate a larger plenum, typical to that found in commercial or educational building, fibrous absorption is required to be installed on all four walls in the plenum, with minimum thickness and absorption coefficient requirements. The test facility at the University of Canterbury is described by Barclay et al. (2014), with further investigation conducted by van Hout et al (2016) to fully comply with ASTM E1414-11a. Figure 1 shows the two rooms of the CFN facility at the University of Canterbury.

To ensure that the dominant noise path is through the plenum, all other sound paths were measured in-situ. The separating wall was constructed of the following:

- 1 layer of 13 mm GIB Noiseline + 1 layer of 18 m Medium Density Fibreboard + 4 kg/m^2 mass loaded barrier + 2 x 50 mm timber studs separated by 10 mm, with 90 mm R1.8 Pink Batts glass wool insulation + 1 layer of 18 mm plywood + GIB ST-001 resilient clips with Rondo battens with 50 mm Autex AAB 35-50 fibrous insulation to the cavity + 2 layers of 13 mm GIB Noiseline.

The external walls were constructed of the following:

- 1 layer of 18 mm plywood + 90 mm timber frame with R1.8, 90 mm Pink Batts glass wool insulation + 1 layer of 18 mm plywood.

Finally, each floor was constructed of the following:

- 1 layer of 21 mm particleboard + 1 layer of 10 mm Standard GIB plasterboard + 1 layer of 18 mm plywood.

To determine the acoustic separation provided by each element, the plenum sound path was blocked. This was achieved by installing three 10 mm plasterboard ceiling tiles in the two-way grid, along with a 4 kg/m^2 and a 6 kg/m^2 mass loaded barrier hung from the roof, and two 420 mm wide baffle stack (compressed 40%) installed above the separating wall in the plenum, each side of the mass loaded barrier. Absorption was installed over all ceiling tiles in the plenum. The in-situ transmission loss from one room to the other with the above is shown in Figure 2 below, with an overall Sound Transmission Loss (STC) and Weighted Reduction Index (R_w) rating of 61.

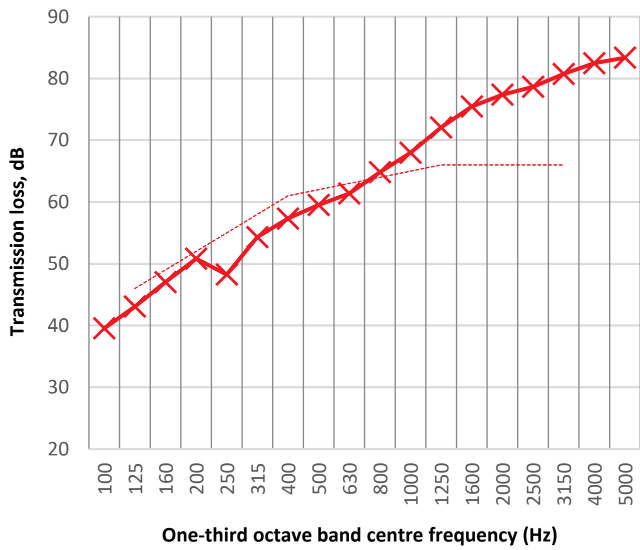

Figure 2: In-situ testing of all flanking sound paths for the CFN facility

2.1 Ceiling tile products

The ceiling attenuation provided by four ceiling tile products with and without acoustic absorption on the rear was determined. Three of the ceiling tile products are made of mineral fibre with the fourth a composite tile consisting of 25 mm fibrous absorption facing with a 10 mm plasterboard backing adhered to the plenum side of the tile. One mineral fibre ceiling tile was constructed of two different densities of mineral fibre, a denser backing (presumably to increase the transmission loss) and a more porous front (for absorption purposes). The random incidence sound absorption coefficients and resultant NRC value for the front face and back face of each ceiling tile specimen was determined using the method outlined in ISO 354:2003 mounted in Type-A[1] , by placing the products in turn in the Reverberation Room at the University of Canterbury. The key parameters of each ceiling tile product were measured or provided by each of the manufacturers, and are given in Table 1.

1 Each product was laid directly against the floor of the Reverberation Room, so there was no air gap between the floor and rear of the ceiling tile. Perimeter steels were installed around the edge of each product to mitigate the edge effect.

Table 1: Material properties of the ceiling tiles

Ceiling tile product	Material	Thickness (mm)	Surface density (kg/m^2)	Front face NRC	Back face NRC
Tile A	Mineral fibre	12	3.3	0.50	0.45
Tile B	Mineral fibre	19	4.7	0.70	0.45
Tile C	Mineral fibre	42	10.8	0.90	0.20
Tile D	25 mm glass fibre; 10 mm plasterboard	35	10.2	0.75	0.05

The sound absorption afforded by the back face of the ceiling tile was explored in order to determine the absorption provided in the plenum space by the ceiling tile products themselves. The results of the sound absorption measurements are given in Figure 3.

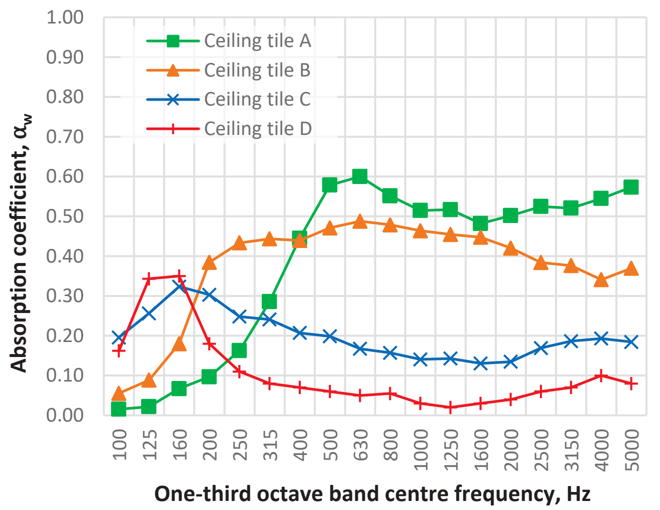

Figure 3: Absorption provided by the back face of the four ceiling tile products

Above 200 Hz, ceiling tile D provided little absorption, however below 160 Hz, this product had the highest measured absorption of the ceiling tile products. As this was a plasterboard layer effectively suspended above the floor (by the glass fibre front face), it is expected the face is acting similar to a resonant absorber. Ceiling tiles A and B provide absorption coefficient curves typical for mineral fibre material, albeit lower than that of the front face, as the back face is usually treated to provide more resistance to bumps and bangs. The front face is also slightly perforated (under the facing material) such that it provides better absorption. The denser mineral fibre backing of ceiling tile C limits the rear face absorption which is expected to be the reason that the absorption coefficient is low for this product.

2.2 Plenum absorption products

Four different thicknesses ranging from 15 mm to 100 mm of glass fibre acoustic absorption were added to the rear surface of the suspended ceiling system. The volumetric density (100 kg/m^3) of the acoustic absorption was kept constant, such that only the surface density changed with differing thickness. Key parameters of the acoustic absorption product are provided in Table 2.

Table 2: Material properties of the plenum absorption

Thickness	Material	Surface Density (kg/m^2)	NRC
15 mm	Glass fibre rigid board	1.5	0.75
25 mm	Glass fibre rigid board	2.5	0.85
40 mm	Glass fibre rigid board	4.0	0.95
100 mm	Glass fibre rigid board	10.0	1.05

Figure 4 shows the sound absorption provided by the different thicknesses of the absorption installed in the plenum space. The random incidence sound absorption coefficients for the different thicknesses of acoustic absorption were determined using the method outlined in ISO 354:2003 mounted in Type-A, using the Reverberation Room at the University of Canterbury. As with typical acoustic panel absorbers, as the thickness of the material increases, a larger increase in absorption coefficient is seen in the lower frequencies, as shown in Figure 4.

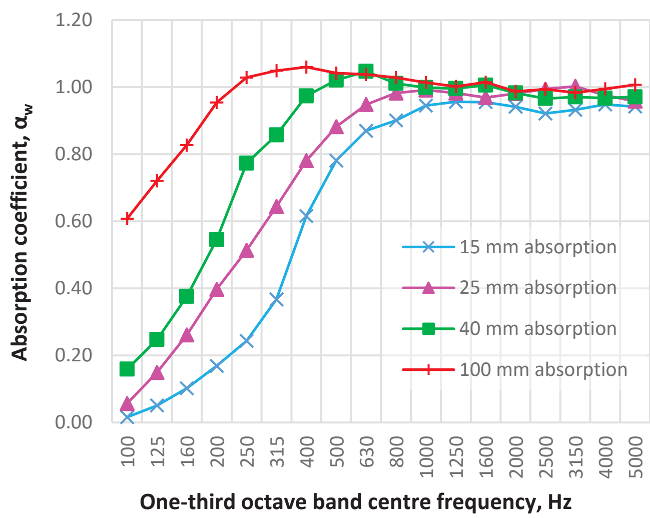

Figure 4: Absorption provided by the absorption installed in the plenum

Absorption coefficients greater than 1.0 were measured for some products that could be attributed to the 'edge effect' and change in diffusivity of the Reverberation Room around the product. Due to the highly absorptive products, the sound field is not fully diffuse around the test specimen. In addition, even though the side of the products were covered in steel angles the sides of the product some reverberant sound could be absorbed by the sides of the specimen, which then would provide a larger area of absorption than that used in the calculations (Bies and Hansen, 2005). These reasons may explain the unusually high absorption coefficients.

3.0 Influence of acoustic absorption on ceiling attenuation

Additional measurements of the ceiling attenuation of the four ceiling tile products as well as the four thicknesses of acoustic glass fibre absorption to that outlined by van Hout et al (2016) at the University of Canterbury's

CFN facility, in strict accordance with the methodology outlined in ASTM E1414. This was due to a different two-way suspended grid system used in the facility. A ceiling tile specimen was first installed to the manufacturer's specifications within the two-way grid, and the ceiling attenuation was measured three times at two different speaker positions. The four different thicknesses of fibrous absorption were laid directly over all the ceiling tiles in turn and measured with the same microphone and speaker positions. The Reverberation Time for each test in the receiving room was conducted to normalize the ceiling attenuation results to take into account the absorption provided by the ceiling tiles. The ceiling tile specimen was then substituted and the ceiling attenuation for this specimen and four thicknesses of acoustic absorption were then determined. This was then repeated for all four ceiling tile specimens. No seismic hold-down clips were used, as these are not used in the majority of locations around New Zealand. All ceiling tiles were checked before each test to ensure they were lying flat in the grid.

3.1 Ceiling attenuation of just the ceiling tiles

The normalized ceiling attenuation of the four ceiling tile products without acoustic absorption behind are presented in Figure 5.

The results are largely as expected, with ceiling tiles with a higher mass performing better than ceiling tiles with a lower mass. Ceiling tiles C and D exhibit a similar sound

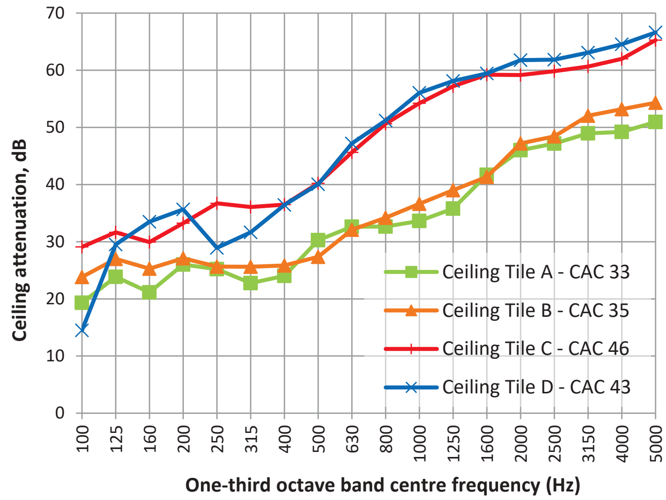

Figure 5: Ceiling attenuation of four ceiling tile products without absorption on the rear

transmission loss curve, as these ceiling tiles have a similar surface density (10.8 kg/m^2 for ceiling tile C and 10.2 kg/m^2 for ceiling tile D). The dip shown at 250 Hz for ceiling tile D is expected to be due to the acoustic modal coupling between the rear of the ceiling tile and the roof of the CFN facility, were the resonant sound in the plenum is transferred more easily through the plenum space, as the ceiling of the plenum (made from plywood) and the rear surface of the ceiling tile (made from plasterboard) are both acoustically reflective products. Ceiling tile A, with the lowest mass was generally shown to have the lowest ceiling attenuation, which was expected.

3.2 Ceiling attenuation with absorption over the ceiling tiles

Four different thicknesses of acoustic fibrous absorption were laid in turn over the rear face (facing the plenum) of the suspended ceiling system and tests were competed with each thickness of acoustic absorption installed. The different thicknesses of acoustic absorption were used to determine any trends between the increase of absorption in the plenum and the ceiling attenuation of each ceiling tile product. The resulting transmission loss with the four different acoustic absorption thicknesses are given in Figures 6 to 9.

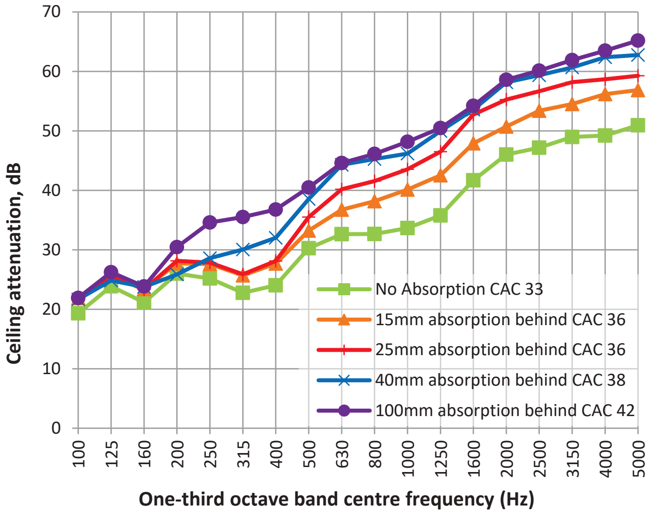

Figure 6: Transmission loss for ceiling tile A with various thicknesses of absorption in the plenum

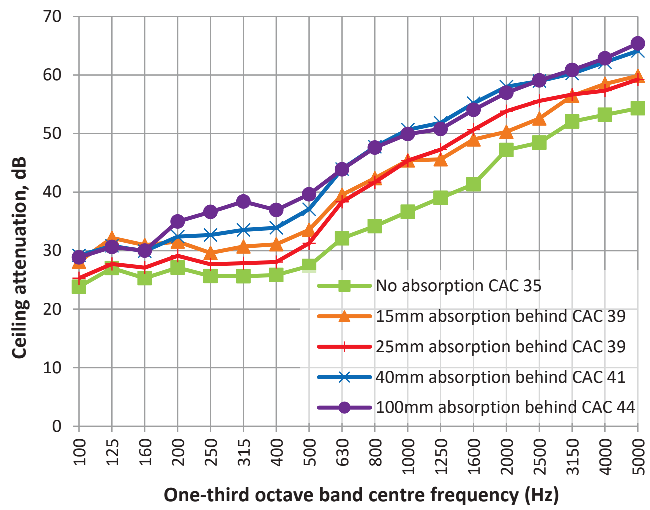

Figure 7: Transmission loss for ceiling tile B with various thicknesses of absorption in the plenum

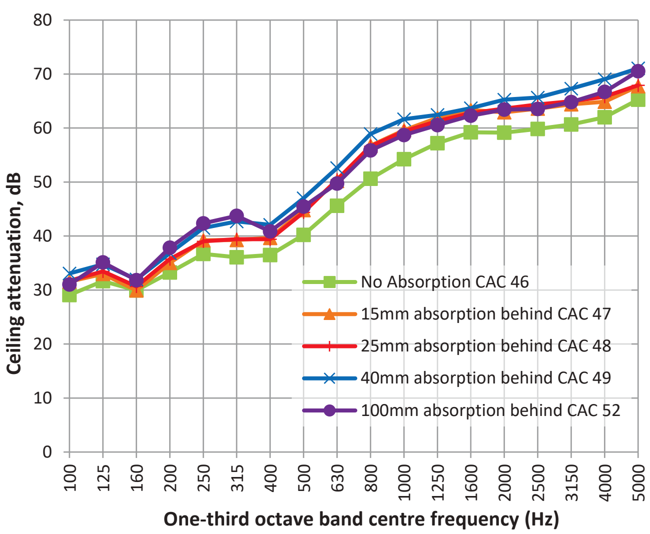

Figure 8: Transmission loss for ceiling tile C with various thicknesses of absorption in the plenum

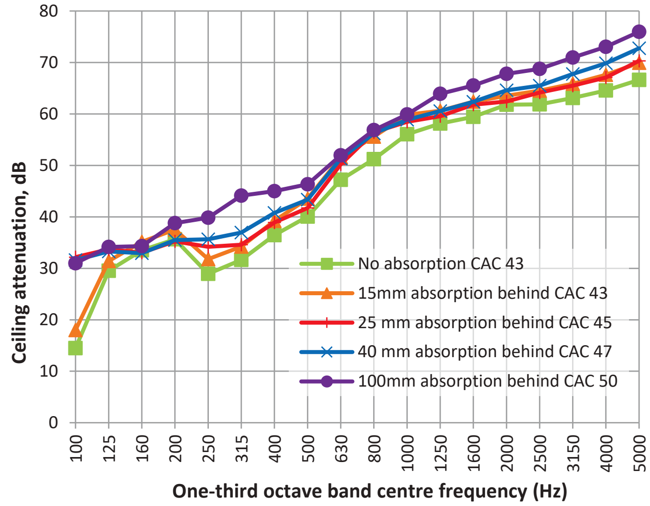

Figure 9: Transmission loss for ceiling tile D with various thicknesses of absorption in the plenum

It can be seen that as the thickness of the acoustic absorption laid on the rear of the ceiling tiles increases, the ceiling attenuation provided increases. A larger increase in the ceiling attenuation was provided to the lower mass ceiling tiles when the acoustic absorption was added to the plenum (ceiling tile A and ceiling tile B).

4.0 Discussion

4.1 Ceiling attenuation of ceiling tiles

Three general regions could be identified from the ceiling attenuation results provided by the ceiling tiles. The first region (below approximately 500 Hz) shows there is little increase in ceiling attenuation as the frequency increases through this region (approximately an increase of 2 dB per octave). The second region (between approximately 500 Hz and 1,600 Hz), shows that as frequency increases, the ceiling attenuation increases steeply, which is likely mass controlled, as high mass ceiling tiles exhibit a higher increase per octave than that of lighter ceiling tiles. Finally, above approximately 1,600 Hz, the ceiling attenuation continues to increase however at a lower rate.

On average between 500 Hz and 5,000 Hz, the ceiling attenuation provided in each one-third octave band increases by 12 dB as the surface density doubles. This can be seen when comparing ceiling tile B (4.7 kg/m^2 surface density – Figure 5) to ceiling tile D (10.2 kg/m^2 – Figure 7). Above 500 Hz, the average difference between ceiling tile B and D is approximately 15 dB, where below 500 Hz this is approximately 4 dB.

The overall ceiling attenuation trend for the ceiling tiles generally show a similar ceiling attenuation curve with the difference between the curves attributed to the difference in surface density. This can be best seen by comparing ceiling tile A (low mass ceiling tile, 3.3 kg/m^2) and ceiling tile C (high mass ceiling tile, 10.8 kg/m^2) as ceiling tile C has a surface density over three times that of ceiling tile A. The increase in ceiling attenuation between these ceiling tiles is on average 10 dB below 500 Hz, on average 17 dB between 500 Hz and 1,600 Hz, and on average 13 dB above 1,600 Hz, and is shown in Figure 10.

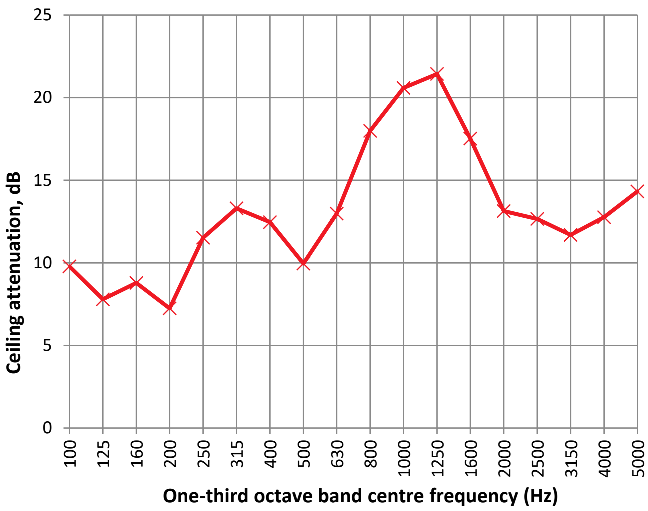

Figure 10: Difference in ceiling attenuation between ceiling tile A and ceiling tile C.

The decrease in ceiling attenuation seen in ceiling tile D at 250 Hz is probably due to the reflective surface of the roof of the plenum and the rear of the ceiling tile. When reviewing the back face absorption provided by ceiling tile D, this had the lowest absorption at this frequency compared to the other ceiling tiles measured in this research.

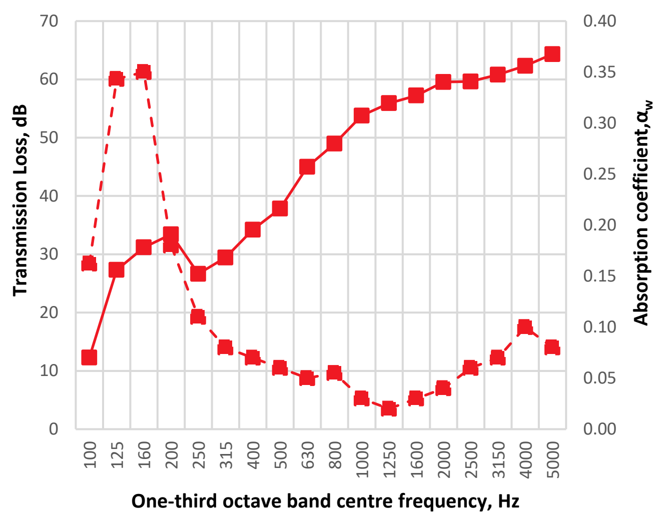

Figure 11: Ceiling attenuation (solid line) compared to the face absorption (dashed line) for ceiling tile

Figure 11 shows the ceiling attenuation provided by ceiling tile D and the absorption provided by the back face of the ceiling tile. The decrease at 250 Hz is attributed to a mode between the plasterboard backing of the ceiling tile and ceiling of the plenum above, as the height of the plenum from the back of the ceiling tile to the roof, corresponds well with a ½ wavelength at 250 Hz. The mineral fibre ceiling tiles used in this research did not show this trend probably due to these ceiling tiles having more absorptive backs and different thicknesses (so the standing wave may not be set up in the plenum).

4.2 Ceiling attenuation with acoustic absorption

4.2.1 15 mm acoustic absorption

With 15 mm of acoustic absorption added to the rear of the ceiling tiles, there is little increase in ceiling attenuation below 250 Hz compared to ceiling tiles without absorption to the rear. The highest increase seen in on ceiling tile B which shows a constant 1 – 4 dB increase though this range. Other ceiling tiles exhibit a 0 – 2 dB increase through this range. Between 250 Hz and 500 Hz, there is a small increase in the ceiling attenuation of ceiling tiles A, C, and D, with the ceiling attenuation of ceiling tile B staying constant as below 250 Hz.

Above 500 Hz, a larger increase in the ceiling attenuation is seen between the no absorption scenario and 15 mm absorption scenario. This increase is the highest for Ceiling tile A (lightest ceiling tile, 3.3 kg/m^2), with the smallest increase seen in ceiling tile D (high mass ceiling tile). The larger increase seen in ceiling tile A and B is probably due to the relative increase in mass over that of the tile itself (approximately 10 % increase in mass for ceiling tiles C and D, with approximately a 50 % increase for ceiling tile A).

Negligible increase was seen at the expected modal dip (250 Hz) for ceiling tile D. It was expected that the largest increase for this ceiling tile would be apparent at this frequency because of the absorption that is now present as well as the increased height of the tile. However, it could be deduced that the absorption may not be thick enough to absorb 250 Hz sound waves readily enough (therefore pass through the absorption layer rather than be 'absorbed').

4.2.2 25 mm acoustic absorption

An increase of the ceiling attenuation is shown most readily for ceiling tile D when 25 mm of acoustic absorption is installed to the rear of this ceiling tile specimen. The dip at 250 Hz (as well as the large drop off at 100 Hz) has been effectively removed from the ceiling attenuation curve, as shown in Figure 7.

As with the 15 mm absorption, generally there is little increase at the low frequencies, with increase between 0 and 4 dB below 500 Hz (apart from at 100 Hz and 250 Hz in ceiling tile D). The increase seen above 500 Hz (approximately 8 dB) is most prominent on the low density ceiling tiles (ceiling tiles A and B), but an increase is also seen in the higher density ceiling tiles, however to a much less extent (approximately 4 dB). The increase seen is expected to be due to the increase in mass that the acoustic absorption provides.

The increase above 500 Hz for ceiling tile C was on average 3 dB (ranging between 1 dB and 4 dB), with ceiling tile D average increase of 2 dB (ranging between 1 dB and 5 dB). Ceiling tile B showed an average increase above 500 Hz of 6 dB (ranging between 4 dB and 9 dB), and ceiling tile A showed an average increase of 7.5 dB (ranging between 4 and 10 dB). This increase is a bit more than that predicted by the mass law equation of doubling the surface density to increase the transmission loss of a product by 6 dB, as the surface density of ceiling tile A is 3.3 kg/m^2, and the surface density of 25 mm acoustic absorption was approximately 2.5 kg/m^2, however there is an average increase above 500 Hz of 7.5 dB. Therefore, it is expected that this additional increase seen over that predicted by mass law is from some sound being dissipated by the addition of the absorption in the plenum. This is also seen in the results of ceiling tile B, with a surface density of 4.7 kg/m^2, the increase in ceiling attenuation with the absorption added over should be less than 3 dB, however an average of a 6 dB increase is seen above 500 Hz.

4.2.3 40 mm acoustic absorption

With 40 mm of acoustic absorption laid over the ceiling tile products, little increase is seen below 250 Hz, however a marked improvement is seen for the low density ceiling tiles between 250 Hz and 500 Hz. An increase is now seen more readily in the higher mass ceiling tiles (as there is an approximately 40 % increase in mass with the absorption added to the rear of these ceiling tiles, compared to 25 % or less when less thick absorption was installed behind).

The ceiling attenuation afforded by ceiling tiles A and B are approaching that offered by a high mass ceiling tile without the addition of absorption to the rear, as the combination of densities are between 8 kg/m^2 and 9 kg/m^2. The increase in ceiling attenuation at 100 Hz and 250 Hz for ceiling tile D effectively flattens out the ceiling attenuation curve (as there are no large troughs), and shows a similar curve to that of the mineral fibre ceiling tiles used in this research.

The increase above 500 Hz for ceiling tile C was on average 3 dB (ranging between 2 dB and 5 dB), with ceiling tile D average increase of 4 dB (ranging between 2 dB and 6 dB). Ceiling tile B showed an average increase above 500 Hz of 8 dB (ranging between 6 dB and 11 dB), and Ceiling tile A showed an average increase of 11 dB (ranging between 10 and 12 dB). The increase above 250 Hz is more than that predicted by the mass law equation as described previously. Therefore, it is anticipated that some sound is dissipated with the addition of the absorption in the

...Continued on Page 21

for example the tragic loss of loved ones who are killed at railway level crossings by a train while wearing headphones or family and friends being injured while crossing a road when using headphones.

Headphone safety is an important issue for more information please visit: www.oneearout.org

Acoustical Society of New Zealand Member Profile - Dr John Cater

Location: Department of Engineering Science, Auckland University

Position: Deputy Head of Engineering, Senior Lecturer in Fluid Dynamics

Expertise: Engineering Aerospace and Aircraft

Qualifications: BE PhD, EUROMECH, FHEA, MAIAA, MASNZ

John developed an interest in aerospace and aircraft from a childhood collection of Lego. He studied for his first degree in Mechanical Engineering at Auckland, before leaving Aotearoa and starting a PhD at Monash University in Melbourne, Australia. John then moved to Europe to continue work in aerospace research programmes creating future aircraft technologies for Airbus and investigating aircraft noise reduction. He spent six years in Ireland and the UK, working as a research fellow at Trinity College Dublin & Trinity College Cambridge before becoming a permanent academic at Queen Mary, University of London in the East End of London. In 2008 John returned to The University of Auckland and joined Department of Engineering Science as a Senior Lecturer in Fluid Dynamics. He currently researches a variety of acoustic and fluid flows including aerodynamics and biological fluids using laser measurement techniques and computational models.

Work Questions

1. What three skills do you most need to be successful in your day to day work? *I now spend a lot of my time navigating university administrative processes, so a working knowledge of the Calendar is essential. Good, regular communication with my research students and collaborators also a must. Finally, data interpretation and some extreme google skills.*
2. What's your definition of success in your role? *I am successful when I can solve a complex problem and communicate the result. Sometimes the solutions are very short-term and may help a local company with a product. Others are longer term or larger scale and end up in a research publication. Preparing students for their future careers is also important and rewarding.*
3. What is the most satisfying project you have worked on and why? *The most fulfilling project was one on supersonic jet noise. I was awarded funding in a competitive process, and I ended up designing and building a Mach 2.3 jet and an anechoic chamber for acoustic testing. I employed a post-doc (who went on to work at Rolls-Royce) and trained a student through to getting his PhD. Along the way, I was able to spend many satisfying hours in the lab making laser flow measurements and microphone recordings.*
4. What is one unexpected outcome you have had on a project you're worked on and why? *I started work on a project related to the CO2 emissions from cattle, which ended up with making some measurements of the rheology (stickiness) of Manuka honey. The initial goals required making a computer model of a bovine rumen, which meant making measurements of cow stomach contents... which led to honey somehow.*
5. What professional goals do you still wish to attain? *Finding research funding for development projects and*

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We have a single decision to bring you this issue being the final decision concerning Windflow Technologies' application for the re-consent of the Gebbies Pass turbine, Banks Peninsula. Please see New Zealand Acoustics Volume 30, 2017 #1 for a summary of the substantive decision.

Following is a summary of the proceeding but a full copy of the decision and the final conditions of consent can be found on the RMA Net website at: www.rma.net

In the Environment Court

LUKE PICKERING – Appellant

CHRISTCHURCH CITY COUNCIL – Respondent

WINDFLOW TECHNOLOGY LTD – Applicant

[2017] NZEnvC 068, 16p, [25] paras, 10 May 2017

Summary of Facts

In Interim Decision [2016] NZEnvC 237 the Court granted consent to Windflow Technology Ltd for the re-consent of an existing wind turbine at Gebbies Pass, Banks Peninsula subject to confirmation of conditions. The residents of the neighbouring McQueen's Valley had experienced noise from the turbine which had intruded upon their general enjoyment of their properties and for some, disturbed and disrupted their sleep. The Court had been troubled that during the tenure of the original consent, Windflow did not undertake compliance monitoring within McQueen's Valley to confirm whether the turbine was operating within the conditions imposed on its consent. Instead, Windflow relied on predicted noise levels in the valley based on measurements undertaken at the turbine site. As such Windflow was met with strong opposition to the re-consent application.

The Court concluded that the noise from the turbine, including amplitude modulation, was a particular feature of the case due to the adverse effect on the amenity of the residents in the low background sound environment of McQueen's Valley. Overall the Court concluded restrictions on the hours of operation and ceasing operation of the turbine if verification measurements identified penalisable levels of amplitude modulation or tonality, were an appropriate response given Windflow's duty under s 16 RMA to avoid unreasonable noise.

The Court restructured and clarified the conditions and requested parties to responded. The Court confirmed conditions relating to the requirement and timing for an acoustic engineer to carry out measurement and monitoring. The Court also clarified that the fixed value of 35 dB in Condition 8 did not address the adverse effect of noise with amplitude modulation where the background sound was also low. The Court noted that the Advice Note to Condition 8 made it clear, mitigation was achieved through Condition 3 which restricted the hours of operation when wind speeds were less than 10 m/sec and Condition 7 where restrictions on the operation of the turbine were to apply if there was penalisable amplitude modulation at the turbine.

The Court also highlighted that if the predicted noise level of 25 dB at the representative receptor site in McQueen's Valley was erroneous and the measured noise was higher, that would be material inaccuracy for the purposes of s 128(c) RMA. Overall the Court was satisfied with the restrictions as proposed by the applicant and the City Council, with the greatest level of affect being on residential amenity during the evening.

Court held:

Appeal allowed to the extent that the application for resource consent granted subject to amended conditions of consent as attached to the decision.

Costs reserved.

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.*

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which is included is believed to be correct at the time of preparation, users of this paper should apply discretion and rely on their own judgments regarding the use of the above information. This publication is copyright, but material in it may be reproduced without formal permission or charge, if used for non-commercial gain or/ and provided suitable acknowledgement is made to this publication and the authors as the source.

Acknowledgements

The authors would like to specifically thank the contribution from our peer reviewer Mrs Marion Burgess, Editor of the Australian Acoustic Journal, 'Acoustics Australia', and staff member of the University of New South Wales, Australia. Marion is based in Sydney, Australia. The authors would also like to that this opportunity to thank those involved in the update of this important standard (including but not limited to) the Joint '*Technical Committee AV-004, Acoustics, and Architectural Acoustics*' as well as the Australia and New Zealand standards organisations and the Acoustical Society of New Zealand and the Acoustical Society of Australia.

...Continued from Page 17

plenum. Between 200 Hz and 500 Hz, the increase is over half that expected according to mass law of 4 dB.

4.2.4 100 mm acoustic absorption

With 100 mm of acoustic absorption installed to the rear of the ceiling tiles, an increase in ceiling attenuation is seen over all one-third octave band frequencies between 100 Hz and 5,000 Hz. The increase in surface density was approximately double for ceiling tiles C and D, as the acoustic absorption provided a mass of 10 kg/m^2 by itself (therefore a total mass of 20.8 kg/m^2 for ceiling tile C and 20.2 kg/m^2 for ceiling tile D). The total surface mass for ceiling tiles A and B were approximately 13.3 kg/m^2 and 14.7 kg/m^2 with the 100 mm of acoustic absorption installed in the plenum, however the ceiling attenuation curve of these ceiling tiles was only similar to the high mass ceiling tiles (ceiling tiles C and D) below 500 Hz and above 2,500 Hz. At the frequencies between these, the ceiling attenuation of ceiling tiles A and B was much lower than that of ceiling tiles C and D without acoustic absorption behind (by up to 10 dB at some frequencies). The material structure of the glass fibre therefore is expected to have an effect on the ceiling attenuation.

The increase at low frequencies had a large effect on ceiling tiles C and D that had a higher surface density, with a difference of approximately 3 dB below 200 Hz for ceiling tile C, and approximately 7 dB for ceiling tile D. The large increase seen in ceiling tile D is due to the large increase at 100 Hz. With this removed the average ceiling attenuation below 250 Hz is 3 dB. The lower mass ceiling tiles exhibited a lower increase in ceiling attenuation below 250 Hz, with an average increase of 2 dB for the ceiling tile B and 1.5 dB for ceiling tile A.

The increase above 250 Hz for ceiling tile C was on average 6 dB (ranging between 4 dB and 7 dB), with ceiling tile D average increase of 7 dB (ranging between 4 dB and 10 dB). Ceiling tile B showed an average increase above 250 Hz of 9 dB (ranging between 7 dB and 11 dB), and ceiling tile A showed an average increase of 12 dB (ranging between 11 and 13 dB). The increase above 250 Hz is more than that predicted by the mass law equation of doubling the surface density to increase the transmission loss of a product by 6 dB for the lower surface density ceiling tiles. The higher surface density ceiling tiles showed a trend very similar to the mass law. The surface density of the absorption was 10 kg/m^2, so for ceiling tile D, the mass was effectively doubled, and an average of a 7 dB increase was seen.

5.0 Acknowledgements

This work would not have been possible without the support of John Pearse from the University of Canterbury. The use of the use of the Ceiling Flanking Noise facility and the Reverberation Room that was extensively used in this research would not have been possible without his help.

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Can a connecting door between two apartments be compliant with Clause G6?

[1] Peter Horne

[1] Design Acoustics Auckland Ltd (DAAL), Auckland, New Zealand

Original peer-reviewed article

1. Introduction

A question recently arose as to whether a connecting fire door that had been added between a commercial space and a residential apartment was compliant with Clause G6 of the current *New Zealand Building Code*. The spaces were designed to be acoustically separate, the door was added by the builder during construction at the request of the new owner, who advised that he was to be the owner and occupier of both the apartment and commercial space. Does this arrangement comply with *Clause G6*?

2. Discussion

Clause G6.2 of the code states "*Building elements which are common between occupancies, shall be constructed to prevent undue noise transmission from other occupancies, ..., to the habitable spaces of household units*". Clause G6.3.1 provides a minimum performance specification of STC 55.

"Occupancies" is not defined in Clause G6, or in the Building Act 2004. However, in Determination 2015/004, it was noted that "*occupancy denotes a sense of ownership and not just usage*". Occupancy does seem to be related to ownership, for example, one may refer to car "occupants" but to bus "passengers".

However, not all apartment owners are occupiers, as in the case of absentee or investor landlords. In *Determination 2012/070*, consideration was given to the building layout and the facilities provided, and common ownership of the occupancies was not found to be a sufficient reason for non-compliance with the requirements of *Clause G6*.

In the case of two abutting occupancies (two spaces separated by a common wall or floor), as in Figure 1, consider the possible scenarios in Table 1.

Figure 1: Two abutting occupancies

The situation referred to in the introduction would fall into the last case in Table 1. This residential/commercial situation is close to that of a home occupation, and an argument could perhaps be made that in this case, the two spaces are not separate occupancies for the purposes of Clause G6 (although in this case fire separation requirements may still apply).

3. Conclusion

To return to the question posed above, whether a connecting door between apartments can be compliant with Clause G6, there are two possible outcomes:

1. If the two spaces separated by the connecting door are judged to be a single occupancy, the provisions of Clause G6 don't apply and the question is not relevant.
2. If the two spaces separated by the connecting door are judged to be separate occupancies, it is unlikely that without specialist design, a "typical" connecting door would meet the performance requirement of Clause G6.3.

Table 1: Possible scenarios for two abutting occupancies

Ownership	Occupiers	Example	Compliance with G6 required?
Different owners	Different occupiers	Fully occupier-owned apartment block	Yes
Common owner	Different occupiers	*Long term* - investor owned apartment block, apartment above a retail shop	Yes
		Short term - hotel, motel, boarding house	Not currently
		Short term – minor dwelling under a house for rent or "Airbnb"-type use	?
Same owner & occupier in both spaces		Apartment above a commercial space	?

Therefore, the outcome depends on the legal definition and assessment of occupancies, which would be outside the area of expertise of most construction companies and acoustic consultants. Therefore, it would be prudent not to provide direct connection or access in any situations where Clause G6 may be judged to apply.

This situation also highlights the importance of defining key terms such as "*occupancies*" in any future code revisions.

4. Disclaimers

Expert legal advice should be sought to determine the applicability of Clause G6 in all cases if this is in doubt.

Fire safety and separation issues apply and must be considered, these are outside the scope of this paper.

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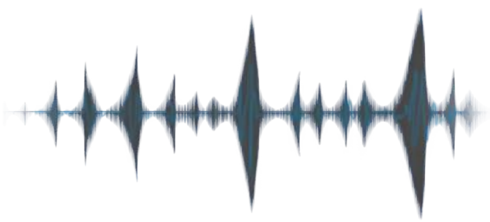


Acoustics Quiz -True or False?

Q1 True or False, RASTI is an acronym for Rapid Speech Transmission Intelligibility?

Q2 True of False, Sabine's Reverberation Equation is an approximation of Eyring Reverberation Equation?

Q3 True or False, the correct term for the unit of sound absorption is the term Sabine?

Q4 True or False, there is no such thing as dBD and dBW in acoustics?

Q5 True or False, in New Zealand the Exchange Rate used in occupation noise assessment is 5 dB?

Q6 True or False, there is no such term as Zwicker Loudness?

Q7 True or False, the term 'Isotropic' means non-uniform?

Q8 True or False, there are only three types of sound fields?

Q9 True or False, the Mass law is a doubling in Mass or Frequency which results in a 3 dB increase in the Sound Insulation of a single leaf partition over a defined frequency range?

Q10 True or False, Pink Noise is uniform and characterless meaning its Power Spectral Density is essentially independent of frequency?

Light, transparency and sound absorption

[1] Christian Nocke and [2] Jean-Marc Scherrer

[1] Akustikbüro Oldenburg, Oldenburg, Germany

[2] BARRISOL-Normalu S.A.S, Kembs, France

Abstract

Optically transparent sound absorbers made out of micro-perforated structures were introduced 20 years ago. In between various applications and developments have been conducted. In this paper lighting sound absorbers or sound absorbing daylight ceilings as well as fully transparent absorbers in front of glass facades are discussed. Representative sound absorption data for different set-ups are presented. Metal, wood, polycarbonate plates and foils as well as other sheet materials have been micro-perforated. A short review of the applications of various different materials with transparent micro-perforated sound absorbers is given.

Originally published in ACOUSTICS 2016, Brisbane, Australia

1. Introduction

Micro-perforated panel absorbers (MPA) were first described by D.-Y. Maa in 1975 (Maa, 1975). Further developments of the theory and applications are presented in various other papers (Maa, 1983, 1984, 1985, 1987, 1988, 1997). The potential of MPA is shown in a publication (Maa, 1998) together with some possible applications. The calculation and measurement of MPA in so-called random incidence or diffuse sound fields has been investigated in two publications (Liu, 2000, Nocke, 2000). Other aspects and further investigations on micro-perforated structures are described in (Maa, 2000 and 2001) or (Zha, 1998).

Stretched membrane ceilings were introduced around forty years ago. The stretched ceiling consists of a special flexible sheet, which is mounted in-situ by clamping to a frame. The sheet is heated before mounting and the membrane acquires its final tension after cooling. Nearly any shape can be built by this method. Over the last 40 years this kind of ceiling and wall covering has become a popular product. Until 10 years ago optical and other aspects of the product were of general interest. However, after first experiences with a micro-perforated polycarbonate foil (Zha, 1998) micro-perforation of stretched ceilings, to increase sound absorption was seen as a useful and innovative approach. The ability to provide sound absorption opened another range of applications for such ceilings. In November 1999, the first micro-perforated stretched ceiling was introduced and applied for room acoustic purposes.

The last section of this paper shows some, room acoustic applications of micro-perforated stretched ceiling technology. Several examples are shown, where micro-perforated stretched ceilings and/or panel absorbers have been successfully used to reduce reverberation.

2. Theoretical background

The theory of the micro-perforated panel absorber as initially presented in (Maa, 1975) is based on the classical treatment of sound propagation in short tubes. The derivation by Maa (Maa, 1975) delivers an approximation for the specific acoustic impedance Z_{MPP} for a micro-perforated panel of thickness *t* with holes of diameter *d* spaced at a distance *b* apart in front of an air cavity with a depth *D*, (refer Figure 1).

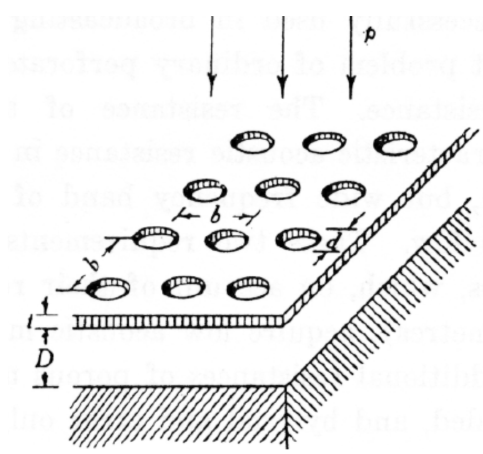


Figure 1: Micro-perforated panel absorber (MPA) according to (Maa, 1975) where *d* is the orifice diameter, *b*, the distance between orifices, *t*, panel thickness and *D* air cavity depth, between panel and backing wall.

From the angle-dependent impedance Z_{MPP} the sound absorption coefficient for normal and random incidence sound can be calculated using well-known principles (Maa, 1975), (Nocke, 2000).

The Maa's derivation gives an approximation for the specific acoustic impedance Z_{MPP} for a micro-perforated panel of thickness *t* as:

$$Z_{MPP} = r + j\omega\, m \qquad (1)$$

The corrected formulae for *r* and *m* are given below

(Nocke, 2000)

$$r = \frac{32\,\eta\, t}{p\,\rho\, c_0\, d^2}\left(\sqrt{1+\frac{k^2}{32}} + \sqrt{2}\,\frac{k\,d}{32t}\right) \qquad (2)$$

$$\omega\, m = \frac{\omega\, t}{p\, c_0}\left(\frac{1}{\sqrt{9+k^2/2}} + 0.85\,\frac{d}{t}\right) \qquad (3)$$

Where the parameter k is proportional to the ratio of the orifice radius $d/2$ and the thickness of the viscous boundary layer in the orifice, see (Nocke, 2000) for all details and quantities.

A micro-perforated panel in front of an air cavity forms a resonant system. The impedance of the system can be calculated using the impedance $Z_{AIR}(\theta)$ of the air cavity of depth D at an angle θ to the normal of the surface:

$$Z_{AIR}(\theta) = -j\ \cot(\omega D/c_0 \cos\theta) \qquad (4)$$

Using Z_{MPA} the impedance of the micro-perforated panel absorber (MPA) can be calculated as:

$$Z_{MPA}(\theta) = Z_{MPP}\cos\theta + Z_{AIR}(\theta) \qquad (5)$$

From $Z_{MPA}(\theta)$ the absorption coefficient $\alpha(\theta)$ for a plane wave incident at an angle θ can be calculated:

$$\alpha(\theta) = \frac{4\,Re\{Z_{MPA}(\theta)\}}{[1+Re\{Z_{MPA}(\theta)\}]^2 + [Im\{Z_{MPA}(\theta)\}]^2} \qquad (6)$$

The so-called statistical or random incidence sound absorption coefficient can thus be calculated using the well-known Paris' formula:

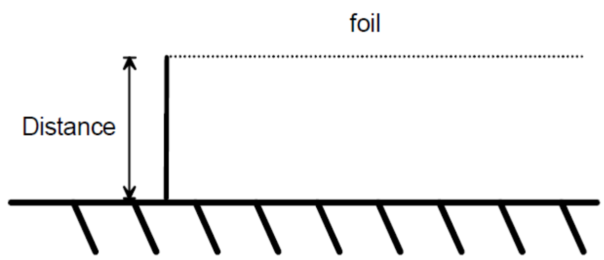
$$\alpha_{stat} = \int_{0^o}^{90^o} \alpha(\theta)\sin(2\theta)\, d\theta \qquad (7)$$

3. Laboratory results

In this and following sections, sound absorption results for different arrangements of micro-perforated stretched sheet materials are presented. Firstly set-ups using only micro-perforated sheet will be investigated. Furthermore, combinations of un-perforated and micro-perforated stretched materials are shown that can be applied as light ceilings.

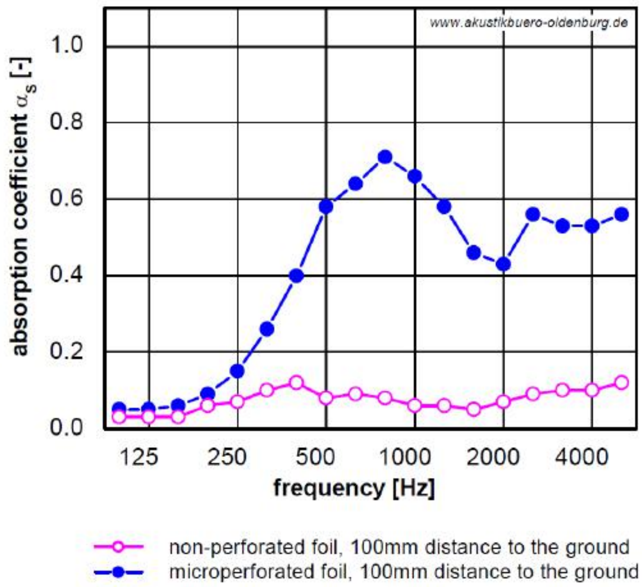
Figure 2 represents a sketch of a stretched ceiling as set-up for reverberation chamber measurements according to (Maa 1975). The foil is stretched on a frame spaced some distance from the backing wall or ceiling. Usually the wall or ceiling is acoustically hard. The distance between foil and backing can vary between a few centimetres to more than a metre. The sides are closed; the air volume has no connection to the outside.

Figure 2: Principal sketch of set-up of the stretched ceiling



/ foil.

Figure 3 shows ⅓ octave sound absorption coefficients measured according to (ISO 354, 2003) for a non-perforated and a micro-perforated stretched foil spaced 100 mm from the concrete floor of the test chamber. As may be noted the non-perforated foil provides little sound absorption. The coefficient of 0.12 occurs in the 400 Hz ⅓ octave band. The NRC-value according to ASTM C 423-01 (2001) is 0.05 whilst the SAA-value is 0.07. In contrast, the micro-perforated foil shows a maximum sound absorption coefficient of 0.69 at 800 Hz with the low frequency absorption approaching that of the non-



perforated foil.

Figure 3: Sound absorption coefficients according to (ISO 354, 2003) for non-perforated and micro-perforated foil.

For frequencies higher than 800 Hz the ⅓ octave sound absorption coefficients are everywhere higher than 0.4. The NRC-value for this example is NRC = 0.45 while the SAA-value is 0.45.

4. Applications with light and sound absorption

Sound absorbing "daylight" ceilings can be achieved using combinations comprising of an un-perforated stretched sheet and a micro-perforated sheet and/or two micro-perforated sheets. Lighting is installed behind the two layers. Fluorescent or LED lighting systems can be used.

Figure 4 shows one such sound-absorbing ceiling light. The system shown comprises of ceiling mounted LED elements, with an un-perforated translucent stretched sheet mounted some distance below them and a micro-perforated sheet below that. The system shown comprises of ceiling mounted LED elements, with an un-perforated translucent stretched sheet mounted some distance below them and a micro-perforated sheet below that. By varying

Figure 4: Typical stretched ceiling, sound absorbing lighting element.

Figure 5: Lighting system/sound absorbing ceiling in an office.


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Figure 6: Sound absorptive, micro-perforated "daylight ceiling" modules.

the distance between the un-perforated sheet and the lamps and between the two stretched sheets, the sound-absorption provided by the system can be customized.

Figure 5 shows a light emitting and sound absorbent ceiling made of translucent micro-perforated sheets.

Figures 6 to 9, give examples of applications using transparent and translucent sound absorbers using mono and multi-layer micro-perforated sheets.

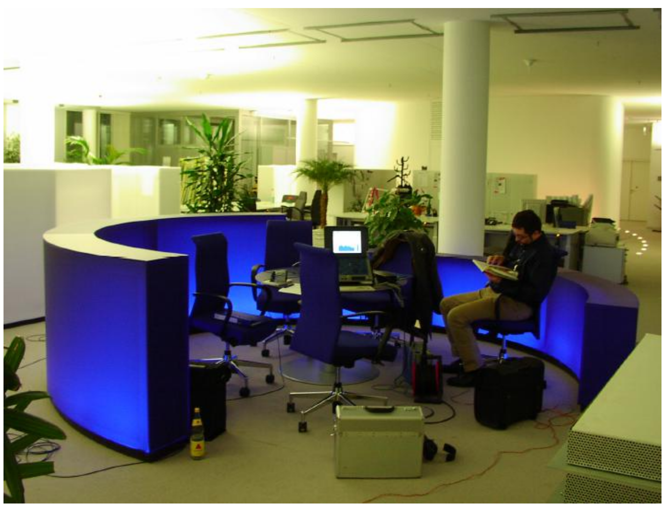

Figure 7: Backlit micro-perforated furniture.

Figure 10 provides sound absorption test results for some of the set-ups used in the various projects shown.

5. Conclusion

By suitable micro-perforation, stretched sheets can be given useful sound absorption characteristics for room acoustic purposes. Other properties of the film (moldability, installation arrangements, fire protection, and so forth) remain unchanged. The appeal from an architectural design perspective, is that even translucent and transparent films can be provided with micro-perforation and thus the ability to absorb sound. This creates new possibilities for brilliant acoustic ceilings.

Figure 8: Sound absorptive, micro-perforated polycarbonate ceiling above a swimming pool.


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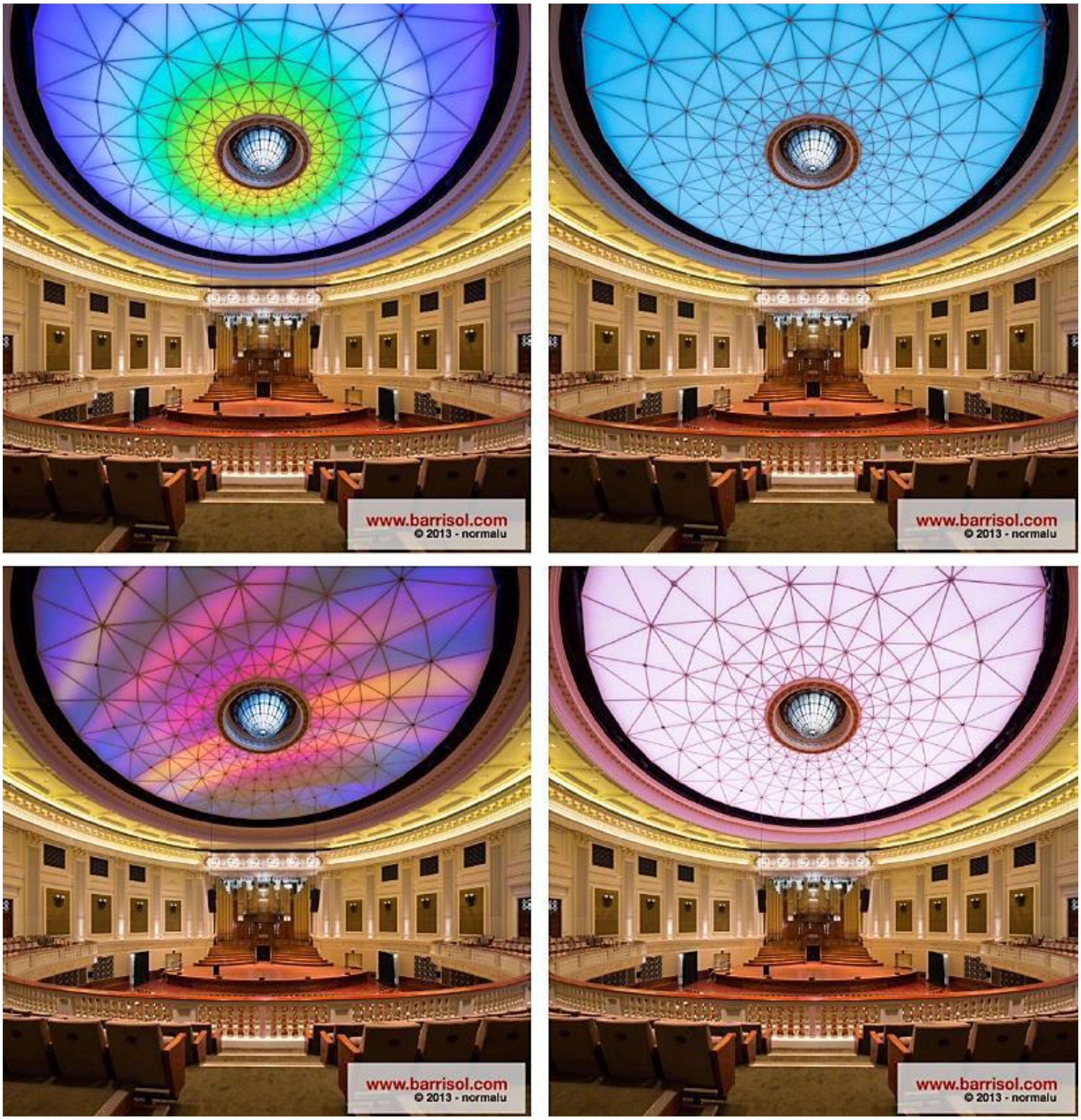

Figure 9: Translucent ceiling with changeable lighting, Brisbane City Hall

Acknowledgements

This work has kindly been supported by BARRISOL S.A.S, F–68680 Kembs, the manufacturer of BARRISOL® and micro-perforated BARRISOL® Acoustics® stretched ceiling.

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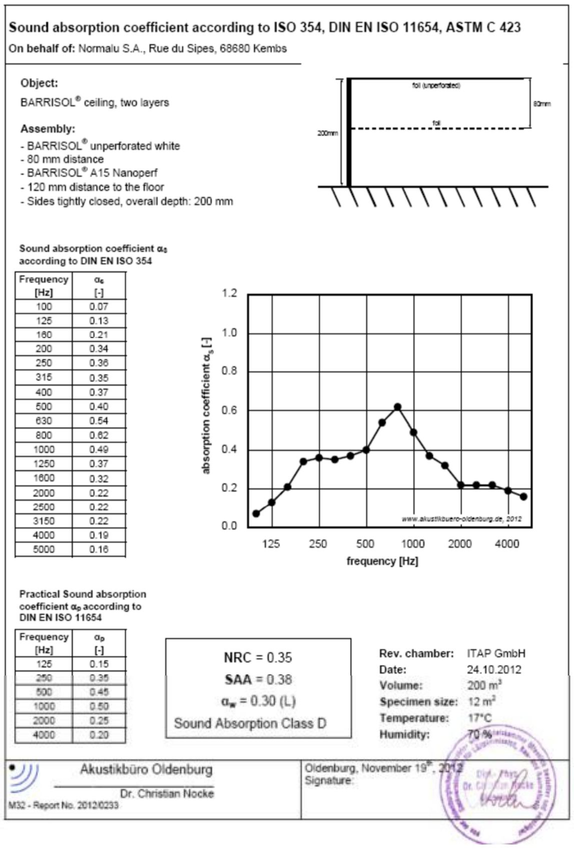


Sound absorption coefficient according to ISO 354, DIN EN ISO 11654, ASTM C 423
On behalf of: Normalu S.A., Rue du Sipes, 68680 Kembs

Object:
BARRISOL® ceiling, two layers

Assembly:
- BARRISOL® unperforated white
- 80 mm distance
- BARRISOL® A15 Nanoperf
- 120 mm distance to the floor
- Sides tightly closed, overall depth: 200 mm

Sound absorption coefficient α_s according to DIN EN ISO 354

Frequency [Hz]	α_s [-]
100	0.07
125	0.13
160	0.21
200	0.34
250	0.36
315	0.35
400	0.37
500	0.40
630	0.54
800	0.62
1000	0.49
1250	0.37
1600	0.32
2000	0.22
2500	0.22
3150	0.22
4000	0.19
5000	0.16

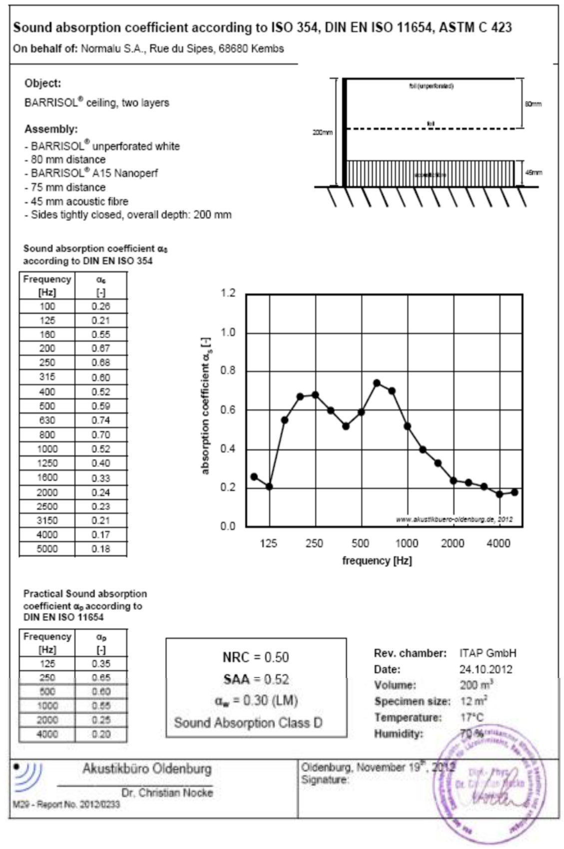
Practical Sound absorption coefficient α_p according to DIN EN ISO 11654

Frequency [Hz]	α_p [-]
125	0.15
250	0.35
500	0.45
1000	0.50
2000	0.25
4000	0.20

NRC = 0.35
SAA = 0.38
α_w = 0.30 (L)
Sound Absorption Class D

Rev. chamber: ITAP GmbH
Date: 24.10.2012
Volume: 200 m³
Specimen size: 12 m²
Temperature: 17°C
Humidity: 70 %

Akustikbüro Oldenburg
Dr. Christian Nocke
M32 - Report No. 2012/0233
Oldenburg, November 19th, 2012
Signature:



Sound absorption coefficient according to ISO 354, DIN EN ISO 11654, ASTM C 423
On behalf of: Normalu S.A., Rue du Sipes, 68680 Kembs

Object:
BARRISOL® ceiling, two layers

Assembly:
- BARRISOL® unperforated white
- 80 mm distance
- BARRISOL® A15 Nanoperf
- 75 mm distance
- 45 mm acoustic fibre
- Sides tightly closed, overall depth: 200 mm

Sound absorption coefficient α_s according to DIN EN ISO 354

Frequency [Hz]	α_s [-]
100	0.26
125	0.21
160	0.55
200	0.67
250	0.68
315	0.60
400	0.52
500	0.59
630	0.74
800	0.70
1000	0.52
1250	0.40
1600	0.33
2000	0.24
2500	0.23
3150	0.21
4000	0.17
5000	0.18

Practical Sound absorption coefficient α_p according to DIN EN ISO 11654

Frequency [Hz]	α_p [-]
125	0.35
250	0.65
500	0.60
1000	0.55
2000	0.25
4000	0.20

NRC = 0.50
SAA = 0.52
α_w = 0.30 (LM)
Sound Absorption Class D

Rev. chamber: ITAP GmbH
Date: 24.10.2012
Volume: 200 m³
Specimen size: 12 m²
Temperature: 17°C
Humidity: 70 %

Akustikbüro Oldenburg
Dr. Christian Nocke
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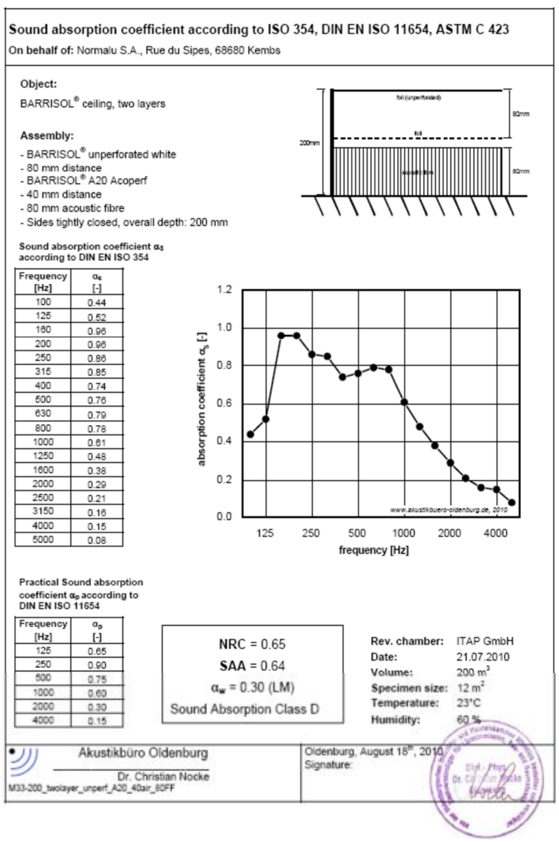

Sound absorption coefficient according to ISO 354, DIN EN ISO 11654, ASTM C 423
On behalf of: Normalu S.A., Rue du Sipes, 68680 Kembs

Object:
BARRISOL® ceiling, two layers

Assembly:
- BARRISOL® unperforated white
- 80 mm distance
- BARRISOL® A20 Acoperf
- 40 mm distance
- 80 mm acoustic fibre
- Sides tightly closed, overall depth: 200 mm

Sound absorption coefficient α_s according to DIN EN ISO 354

Frequency [Hz]	α_s [-]
100	0.44
125	0.52
160	0.96
200	0.96
250	0.86
315	0.85
400	0.74
500	0.76
630	0.79
800	0.78
1000	0.61
1250	0.48
1600	0.38
2000	0.29
2500	0.21
3150	0.16
4000	0.15
5000	0.08

Practical Sound absorption coefficient α_p according to DIN EN ISO 11654

Frequency [Hz]	α_p [-]
125	0.65
250	0.90
500	0.75
1000	0.60
2000	0.30
4000	0.15

NRC = 0.65
SAA = 0.64
α_w = 0.30 (LM)
Sound Absorption Class D

Rev. chamber: ITAP GmbH
Date: 21.07.2010
Volume: 200 m³
Specimen size: 12 m²
Temperature: 23°C
Humidity: 60 %

Akustikbüro Oldenburg
Dr. Christian Nocke
M33-200_twolayer_unperf_A20_40air_80FF
Oldenburg, August 18th, 2010
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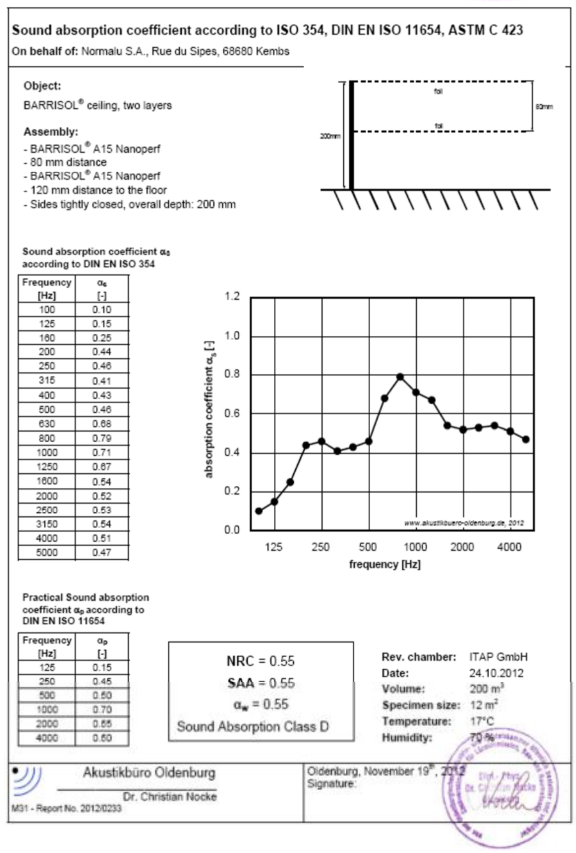

Sound absorption coefficient according to ISO 354, DIN EN ISO 11654, ASTM C 423
On behalf of: Normalu S.A., Rue du Sipes, 68680 Kembs

Object:
BARRISOL® ceiling, two layers

Assembly:
- BARRISOL® A15 Nanoperf
- 80 mm distance
- BARRISOL® A15 Nanoperf
- 120 mm distance to the floor
- Sides tightly closed, overall depth: 200 mm

Sound absorption coefficient α_s according to DIN EN ISO 354

Frequency [Hz]	α_s [-]
100	0.10
125	0.15
160	0.25
200	0.44
250	0.46
315	0.41
400	0.43
500	0.46
630	0.68
800	0.79
1000	0.71
1250	0.67
1600	0.54
2000	0.52
2500	0.53
3150	0.54
4000	0.51
5000	0.47

Practical Sound absorption coefficient α_p according to DIN EN ISO 11654

Frequency [Hz]	α_p [-]
125	0.15
250	0.45
500	0.50
1000	0.70
2000	0.55
4000	0.50

NRC = 0.55
SAA = 0.55
α_w = 0.55
Sound Absorption Class D

Rev. chamber: ITAP GmbH
Date: 24.10.2012
Volume: 200 m³
Specimen size: 12 m²
Temperature: 17°C
Humidity: 70 %

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Dr. Christian Nocke
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Oldenburg, November 19th, 2012
Signature:

Figure 10: Results from laboratory tests for different set-ups

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...Continued from Page 18

engineering ideas is difficult in New Zealand at the moment. I would like to lead a national team working on fluid mechanics and aeroacoustics problems, and be able to sustain the group over a number of years (at the moment projects & students come and go). In the shorter term, I am part of a group at the University of Auckland who are building a small satellite (CubeSat), I would like to see this make it to orbit!

Personal Questions

1. What is something we should know about you that is not on your CV? *Probably that I am mildly addicted to PC gaming.*
2. Other than acoustics what are you passionate about? *I am a keen tramper and passionate about the New Zealand wilderness. I plant native trees and get involved in various environmental causes. For eight years I have been president of the University Tramping club.*
3. Would you rather be liked or respected? *Respected by my peers.*
4. Is it better to be perfect and late, or good and on time? *Good and on time (or in many cases, early & good enough).*
5. If you were a brand what would your motto be? *'Guide, don't control'*

Specific Questions

1. You worked in aerospace research programmes creating future aircraft technologies for Airbus and investigating aircraft noise reduction. Aircraft noise is a complex matter that has been studied for decades but still remains the focus of much research today, what do you believe is the single biggest issue facing aircraft manufacturers regarding noise reduction at present? *The primary drivers in the civil aerospace sector are capacity and cost, often discussed using a measure called revenue passenger kilometres (RPK). There are many promising (and some proven) methods for reducing*

the acoustic footprint of a passenger aircraft (and the CO_2 emissions), but they cost a bit more and the market pressures are not there for them to be widely adopted at the moment. Aircraft manufacturers like Airbus and Boeing have recently decided to invest in manufacturing evolutionary updates to existing models (e.g. the A320neo, or B737 MAX), rather than some of the more radical design changes that are likely to be needed for significantly quieter aircraft, due to customer (airline) specifications. So the biggest issue is probably economic, rather than technical.

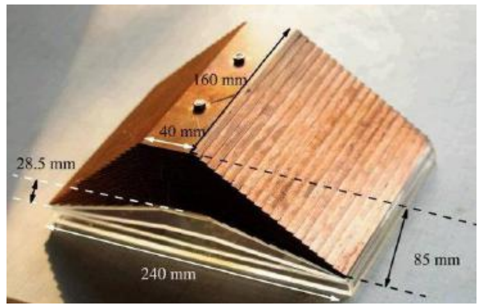
New Kapiti Expressway noise complaints

Stuff has reported residents living alongside the $630 million Kapiti Expressway North of Wellington are calling for a wall to be built along its 18 km length as residents complain of noise pollution. Stuff reports that one Raumati resident has gone so far as to board up his bedroom window in an effort to get a night's sleep. The New Zealand Transport Agency (NZTA) says its measurements have shown noise levels are within the consented conditions but it has agreed to start monitoring as a result of the residents' concerns. To find out more visit: www.stuff.co.nz

Researcher hopes making joints 'noisy' will help prevent injuries

A researcher at the University of Calgary hopes to prevent injuries by increasing joint sensitivity. A new research project involves placing a simple cuff over the knee that has small transmitters inside that stimulate the nerves to just under the level that the patient would notice. Researchers are testing the cuff on patients with and without previous injuries. Athletes are hopeful the device will help protect people from serious injuries.

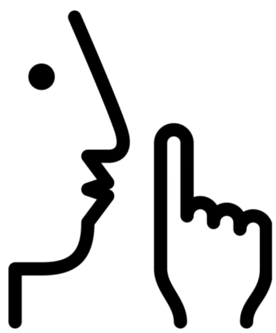
Making things acoustically invisible underwater



In a study published in Scientific Reports, researchers at the Institute of Acoustics of the Chinese Academy of Sciences describe an acoustic invisibility cloak that can work underwater.

An acoustic cloak is a material shell that can control the propagation direction of sound waves to make a target undetectable in an acoustic system. The carpet cloak modifies the acoustic signature of the target and mimics the acoustic field obtained from a reflecting plane, so that the cloaked target is indistinguishable from the reflecting surface. The field of transformation acoustics focuses on the design of new acoustic structures. To find out more visit: www.asianscientist.com

174 Noise Complaints and 40 Excessive Noise Directions from One House



Judge David Kirkpatrick ordered a west Auckland man to pay $1500 for failing to comply with a direction by Auckland Council noise officers to reduce the noise coming from his home. The charge related to a single Excessive Noise Direction (END) notice issued on September 1 and breached on September 3rd , 2016. The court was told that between September 6th 2013 and 2016, 40 Excessive Noise Direction [END] notices arising from 174 noise complaints had been issued to occupants of a property in Avondale, Auckland. The judge noted the outcome from about three-quarters of the complaints found noise to not be excessive. In determining the sentence, Judge Kirkpatrick said the history of excessive noise directions provided a basis on which the imposition of a sentence should indicate "enough is enough", and "there should be an end to this behaviour".

Music to my ears: Researcher explores link between music and hearing

As we get older we start to lose our hearing. But what if you could do something to keep your auditory abilities sharp, well into your senior years?

Researchers with a new program at Memorial University's Grenfell Campus in Corner Brook are working on an approach that may literally be music to your ears — they'll soon be testing seniors to examine whether music training may be the key to better hearing. Dr. Ben Zendel has spent the last two years getting the project going. He serves as the Canada Research Chair in Aging and Auditory Neuroscience at Memorial University. His previous studies took him to Toronto and Montreal and his focus has remained consistent when it comes to the issue of hearing and seniors — being able to pick out what someone close by is saying amid a lot of distracting noise. Zendel said musicians seem to have an edge, according to patterns that emerged in his research.

People who have been trained to make music are always trying to process sound and to pay very close attention to the details and "this seems to translate to other auditory tasks, the big one being understanding speech in noise," Zendel said. To find out more visit: www.cbc.ca

NFD Silent Leadership Challenge

Hearing loss is an invisible disability affecting over one in six Kiwis, that over 800,000 New Zealanders and by 2015 it is predicted that this number will affect one in four of the population. The National Foundation for the Deaf (NFD) is again running its popular 'Silent Leadership Challenge' which will takes place on Friday 4 August 2017. On that day, corporate and community leaders and teams who take part will be tackling four communication challenges while wearing hearing protectors to simulate deafness. Funds raised will help sustain The National Foundation for the Deaf's vital advocacy, prevention and support work. Please support our colleague at the foundation. To find out more please visit www.silentleadershipchallenge.com

Using music to ease hearing loss

A retired school teacher and principal, Linda White, is part of a group of people testing out a different intervention for dealing with hearing loss: learning music. Mrs White is part of an ongoing study organized by Frank Russo, a professor of psychology and director of the Science of Music, Auditory Research and Technology Lab, or SMART Lab, at Ryerson University in Toronto. Professor Russo says understanding speech in noise is a top complaint among older adults with hearing loss. Previous research has found that aging musicians fare better than non-musicians when it comes to distinguishing speech from noise, even when their overall hearing is no better than that of non-musicians. So Professor Russo and his colleagues are getting older adults to join a choir, with no musical experience or talent required, and then testing whether it changes how their brains process speech in noisy environments. The purpose being to see how short-term could we make the musical training. To find

Answers

To the Ten Question Quiz (on page 23)

A1 False. RASTI is an acronym for Rapid Speech Transmission Index not Intelligibility.

A2 False. The Sabine Equation is not an approximation to the Eyring Equation. The Sabine and Eyring equations were derived under different assumptions. The Sabine Equation assumes that as a sound wave travels around a room it encounters surfaces "one after another." The Eyring Equation assumes that all the surfaces are simultaneously impacted by the initial sound wave, and that successive simultaneous impacts, each diminished by the average room absorption coefficient, are separated by mean free paths.

A3 False. The correct term is a 'Sabin' which is a unit of Sound Absorption of a surface. Note although Wallace Sabine developed his well-known Formulae for reverberation the unit is the Sabin, not sabine.

A4 False. There is a D (frequency)-weighing developed for measuring high level aircraft noise especially non-bypass military engines. D-weighting it is no longer in common use since IEC 61672 2003. There is also a dBW which is 'decibel watt' being a unit for the measurement of the strength of a signal expressed in decibels relative to one watt and there are many other short-hand dBX forms in electronic engineering. For example, dBd (decibels related to dipole antenna) is a measure of the gain of an antenna system relative to a dipole antenna at radio frequency. A dipole antenna has a gain of 0 dBd.

A5 False. In New Zealand the Exchange Rate used in occupation noise assessment is 3 dB, which is the increase in noise level that corresponds to a doubling of the noise level. Under-pinning this is the equal-energy hypothesis, so a 3 dB increase corresponds to a doubling of the sound exposure.

A6 False. Zwicker Loudness is a technique developed by the late Prof. Dr. E. Zwicker for calculating a real-time estimate for the Loudness of sound as perceived by the human ear (See: ISO 532B).

A7 False. The term Isotropic is derived from Isotropy meaning uniform in all directions. In acoustics, it is sometimes used to describe noise sources like loudspeakers arrange in a Dodecahedron format to give uniform sound output levels in all direction

A8 False There are more than three types of sound fields, but the common ones for sound level measurement are: 1. Free field – Sound waves are free to expand outwards forever from the source (most common type outdoors); 2. Diffuse field (or a random incidence field) – Where the sound waves arrive equally from all directions; 3. Pressure field – Where the sound pressure has the same magnitude and phase at any position in the sound field

A9 False. The Mass law is a doubling in Mass or Frequency which results in a 6 dB increase not 3 dB.

A10 False The Pink Noise spectrum falls at 3 dB per Octave; so the energy content is inversely proportional to frequency i.e. -3 dB per octave or -10 dB per decade. It is White Noise that is generally viewed as uniform and characterless.

2017

27-30 August: Hong Kong. 46th International Congress and Exposition on Noise Control Engineering (INTER-NOISE 2017)
www.internoise2017.org

3-8 September: Skiathos Island, Western Aegean, Greece. 4th Underwater Acoustics Conference and Exhibition (UACE2017)
www.uaconferences.org

19-22 November: Perth, Australia, The annual conference of the Australian Acoustical Society
www.acoustics2017.com

4-8 December: New Orleans, Louisiana, USA. 174th Meeting of the Acoustical Society of America
www.acousticalsociety.org

18-20 December: Honolulu, Hawaii, USA , 2017 International Congress on Ultrasonics
http://www4.eng.hawaii.edu/~icu2017

2018

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

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

27-31 May: Heraklion, Crete, Greece , EURONOISE 2018
. www.euracoustics.org/events/eaa-conferences

26-29 August: Chicago, USA, 47th International Congress and Exposition on Noise Control Engineering (INTER-NOISE 2018)
www.i-ince.org

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

2019

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

out more visit www.npr.org

West Coast couple's fine for noise complaint over classical music dismissed by judge

Greymouth couple Edgar Rochwalski and Janice Lee successfully disputed a $500 fine for playing classical music excessively in their garage. A West Coast couple accused of playing Radio New Zealand Concert too loudly have successfully challenged a council fine in court. Greymouth man Edgar Rochwalski disputed the $500 fine, saying their radio was not that loud and they turned down the volume after the Grey District Council issued a written notice. He appealed the infringement and defended himself at a hearing in the Greymouth District Court on January 25th and February 27th . Judge Robert Murfitt ruled the verbal warning meant to be given before the written notice was not valid due to a "cultural miscommunication" between Rochwalski and the noise control officer.

Sounds of the City: Why urban acoustics matter

In Switzerland, some local governments are turning to sound specialists to make cityscapes easier on the ears. "*We pay a great deal of attention to building good acoustics in concert halls*", notes Fabian Neuhaus, an acoustician. "*But when it comes to urban design, the sound dimension is still usually overlooked. But poor acoustics in a public space cause dissonance and an annoying cacophony just like an ill-conceived hall.*" Neuhaus runs a firm that specializes in "*sound architecture. Neuhaus notes that outdoor spaces need to be properly 'tuned' to produce pleasant sounds,*" he says. "*Unfortunately, it's rarely a priority in an urban project. Instead of fighting against noise pollution afterward, we should include the acoustic dimension in the project from the very beginning,*" the Swiss acoustician says. "*Rather than enduring noises, we should control sounds*". To find out more visit www.worldcrunch.com

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New Zealand Acoustics aims at least three times per year, in April, August and December.

The Deadline for material for inclusion in the journal is 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

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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.ac.nz or contact the Secretary; secretary@acoustics.org.nz