



A Case for Review of Part F7 of NCC BCA 2022

Sasho Temelkoski (1), Bojan Todorovski (2) and Bradley Thompson (3)

(1) Noise & Vibration, ATP Consulting Engineers, Gold Coast, Australia

(2) Noise & Vibration, ATP Consulting Engineers, Gold Coast, Australia

(3) Noise & Vibration, ATP Consulting Engineers, Brisbane, Australia

Abstract - This paper presents examples of the legacy sound transmission issues, inherited from the poor sound insulation requirements for walls and floors as applicable in Queensland up to 2009. Lessons learned from application of the requirements for sound insulation from BCA 2009 onwards, are also presented. Propositions for amendments to some of the sound insulation ratings for floors and walls are provided as a contribution towards discussion on the improvement of the sound insulation requirements in the next edition of NCC BCA.

1 INTRODUCTION

Australia has a checkered history when it comes to unifying the national building regulations. The official website of the Australian Building Codes Board acknowledges that the complexity of Australia's building regulatory system has created a legislative maze for building practitioners. There has been a gradual improvement in the unification of the building regulations since the early 1970's when the Interstate Standing Committee on Uniform Building Regulations (ISCUBR) has issued the Australian Model Uniform Building Code (AMUBC).

The history of the gradual unification of the building regulations in Australia is summarised in Table 1.

Table 1 – History of building regulations in Australia

| Period | Regulatory Authority | Regulatory Document |
|----------------|--|--|
| 1965 - 1970 | Interstate Standing Committee on Uniform Building Regulations (ISCUBR) | Australian Model Uniform Building Code" (AMUBC) |
| 1980 - 1990 | Australian Building Regulations Coordinating Council (AUBRCC) | Building Code of Australia (BCA) 1988 |
| 1994 - 2003 | Australian Building Codes Board (ABCB) | Building Code of Australia (BCA96) 1996 |
| 2004 - 2011 | Australian Building Codes Board (ABCB) | Building Code of Australia (BCA 2004) 2004 to 2011 with annual amendments to the BCA. |
| 2011 - 2016 | Australian Building Codes Board (ABCB) | National Construction Code (NCC 2011) by amalgamation of Plumbing Code of Australia (PCA) and the Building Code of Australia (BCA), referred to NCC, Volume One BCA; Volume Two BCA; and Volume Three PCA. |
| 2016 - Present | Australian Building Codes Board (ABCB) | National Construction Code (NCC 2016) with two BCA and one PCA volumes issued at a 3- year amendment cycle (NCC 2019, and NCC 2022) |

Whilst the gradual introduction of uniform regulatory documents has resulted in improvement in building design throughout Australia, the sound transmission and insulation requirements often have been subject of State and Territory exclusions, presented as Appendices to BCA.

This paper presents examples of the legacy sound transmission issues, inherited from the poor sound insulation requirements for walls and floors as applicable in Queensland up to 2009. Lessons learned from application of the requirements for sound insulation from BCA 2009 onwards, are also presented. Propositions for amendments to some of the sound insulation ratings for floors and walls are provided as a contribution towards discussion on the improvement of the sound insulation requirements in the next edition of NCC BCA.

2 CASE STUDY 1 – FLOOR IMPACT SOUND INSULATION

In 2007, a high-rise building has been constructed on the Gold Coast with architectural acoustic design specifications based on BCA 2006. For the floors separating sole-occupancy units the requirements under Appendix Queensland Part F5 of BCA 2006 have been applicable. Appendix Qld F5.3 specifies that “a floor separating sole-occupancy units must have an R_w not less than 45” (ABCB, 2006).

This requirement considers only airborne sound transmission, with no concern for impact sound transmission through the floor. The construction outcome has been 150mm thick concrete slab floor between the apartments with no suspended ceilings, except for a bulkhead above the kitchens.

Photo of a stipple finish to the concrete slab ceiling in a typical apartment is presented in Figure 1.



Figure 1 – Stipple finish to the 150mm thick concrete slab ceiling

The Body Corporate has received a number of requests for replacement of the carpets with alternative hard flooring systems (i.e. tiles, engineered timber, hybrid vinyl planks, etc...). As a result, in early 2024, the Body Corporate has updated its by-laws by provision of specific requirements for hard flooring, as follows:

The Owner provides the Committee with evidence which satisfies the Committee that the proposed hard flooring will, as far as reasonably practicable, not cause a nuisance or sound disturbance to other Lot Owners, and achieve at least rating of $L_{nT,w}$ 45 dB (5 Star) as per the AAAC Guidelines, being supported or evidenced by either:

1. A report prepared by a suitably qualified acoustic expert has determined that the impact sound transmission of the proposed hard flooring, once installed, will comply with the relevant standard set in the Building Code of Australia ("the Standard"); or
2. A report prepared by a suitably qualified acoustic expert who certifies that, based on previous testing on a building of the same construction and slab thickness as the Scheme, the impact sound transmission of the proposed hard flooring, once installed, will achieve the Standard... (Body Corporate for Reflection Two Community Title Scheme 37679, 2024).

There are obvious discrepancies between the requirements for the hard flooring to achieve $L_{nT,w}$ 45 dB and the compliance with the standard set in the BCA. Even under the current NCC BCA 2022, "the Standard" is $L_{nT,w}$ 62 dB, which is very lenient compared to the desired 5 Star rating under the AAAC Guidelines. The Body Corporate is considering rewriting the Hard Flooring section of the by-laws to introduce realistic impact sound reduction requirements, somewhere between the minimum $L_{nT,w}$ 62 under NCC BCA and the demanding $L_{nT,w}$ 45 dB.

3 CASE STUDY 2 – SOUND INSULATION OF SERVICES

A seven storey residential building has been constructed in 2018 on the Sunshine Coast with architectural acoustic design specifications provided in accordance with Part F5 of NCC BCA 2016. For the sound insulation of the internal services, the following has been recommended:

If a duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with an $R_w + C_{tr}$ (airborne) not less than —

40 if the adjacent room is a habitable room (other than a kitchen); or

25 if the adjacent room is a kitchen or non-habitable room (ABCB, 2016).

The assumption made by the designer is that there is a clear distinction between a kitchen and a habitable room, therefore two separate design specifications have been provided, as presented in Table 2.

Table 2 – Design solutions for the hydraulic services

| Location | Sound Insulation Rating | Design Solution |
|---|-------------------------|---|
| Habitable Room (other than a kitchen). | $R_w + C_{tr} \geq 40$ | <ul style="list-style-type: none"> • Pipe lagged with Pyrotek Soundlag 4525C 5 kg/m². • 50mm EarthWool 11 kg/m³ or 60mm polyester ASB3 insulation in cavity. • 1 layer of 10mm MastaShield plasterboard if there are no downlights. • 2 layers of 10mm MastaShield plasterboard if there is 1 downlights per 5 m². |
| Non-habitable Room (kitchen or non-habitable room) | $R_w + C_{tr} \geq 25$ | <ul style="list-style-type: none"> • Unlagged pipe. • No insulation in cavity. • 2 layer of 10mm MastaShield plasterboard. |

The fact that the kitchens are not isolated rooms, separate from the habitable rooms, but are part of what is essentially an open plan living, dining and kitchen area, has not been considered neither by the designer nor by the construction contractor. The construction outcome has been a bulkhead with a major airflow grill and unlagged, albeit Raupiano Plus pipe, running from the sink on the upper floor through the bulkhead above the kitchen at each identical apartment, as presented in Figure 2.



Figure 2 – Bulkhead in the kitchen with return air grill facing the dining area

Complaints to audible “waterflow” noise have been made to the Body Corporate as soon as the apartments have been occupied. On site noise measurements identified presence of audible noise in the dining room adjacent to the kitchen. The relationship between the background and the noise levels (Z-weighted) when the sink at the upper floor apartment was used, is presented in Figure 3.

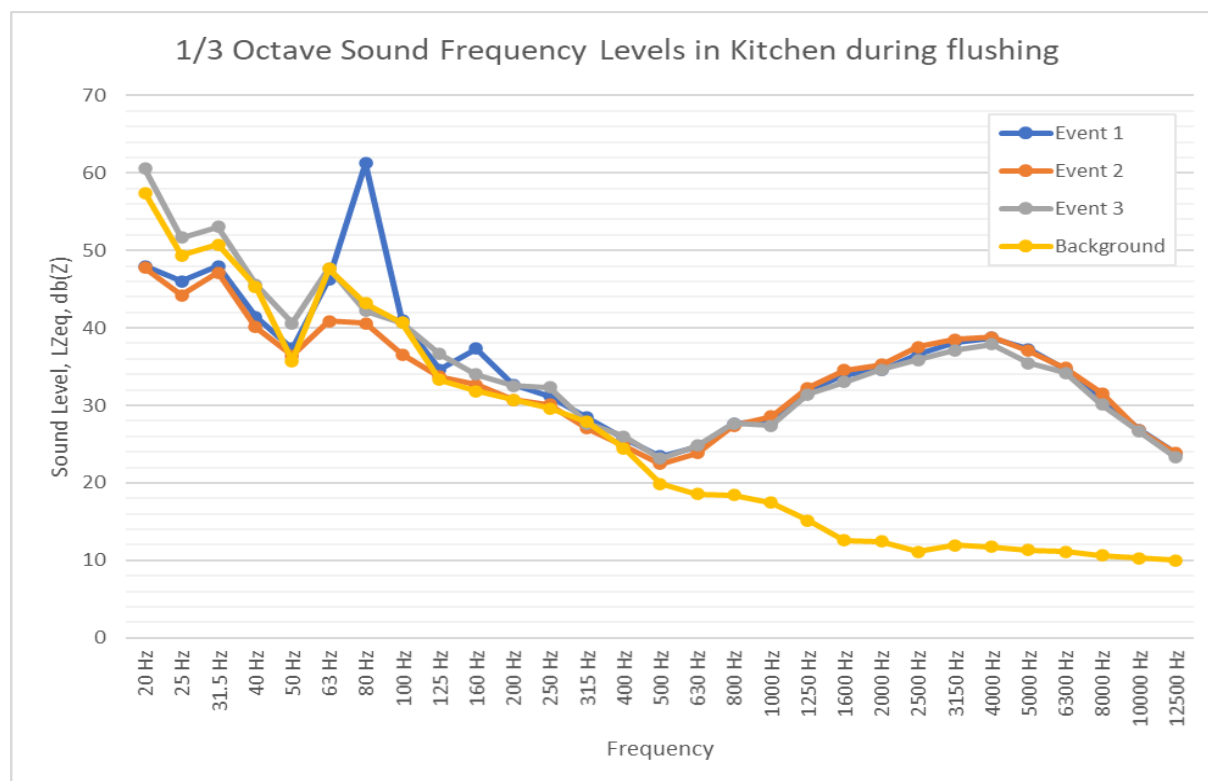


Figure 3 – Noise measurement results at the dining area (1/3 octave bands, Z-weighted)

By considering that unlagged Raupiano pipes will achieve an $R_w + C_{tr}$ 28, the hydraulic system has comprised of unlagged pipes run through the bulkhead in the kitchen. As a result, whenever the sink was used, clearly audible water flow noise could be heard mostly in the dining room (habitable area). Retrofit solutions had to be implemented to most of the kitchen bulkheads throughout the building to achieve internal noise amenity acceptable to the owners.

4 CASE STUDY 3 – PLANT ROOM SOUND INSULATION

The Body Corporate of a high-rise building, constructed in a developed central area of Gold Coast in 2021, has received a complaint to annoying mechanical noise. It has been alleged that there is mechanical noise present at the apartment, particularly noticeable at the master bedroom, which shares a partition wall with a plant room (dedicated service area).

The high-rise building has been designed and constructed to comply with the requirements under Part F5 of NCC BCA 2019. For the walls in Class 2 or 3 buildings the sound insulation requirements under NCC BCA 2019 are as follows:

A wall in a Class 2 or 3 building must—

- (i) have an $R_w + C_{tr}$ (airborne) not less than 50, if it separates sole-occupancy units; and

- (ii) have an R_w (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and
- (iii) comply with F5.3(b) if it separates—
 - (A) a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or
 - (B) a sole-occupancy unit from a plant room or lift shaft (ABCB, 2019).

Compliance with F5.3(b) for Class 2 or 3 building requires discontinuous construction which means a “wall having a minimum 20mm cavity between 2 separate leaves, and (i) for masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and (ii) for other than masonry, there is no mechanical linkage between leaves except at the periphery” (ABCB, 2019).

The partition wall between the plant room and the master bedroom is of light-weight (non-masonry) construction. Under verification method FV5.2 of NCC BCA 2019 the partition wall had to comply with the following: - “a wall separating a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby, or the like, or parts of a different classification, has a weighted sound level difference ($D_{nT,w}$) not less than 45, when determined under AS/NZS ISO 717.1” (ABCB, 2019).

No specific airborne sound transmission measurement through the partition wall was carried out. However, based on the noise measurement results at the plant room and the master bedroom, the partition wall is likely to achieve the required $D_{nT,w}$ not less than 45.

An investigation of the internal noise amenity at the apartment was carried including determination of the background noise levels (in terms of $L_{Aeq,T}$ under day, evening and night-time conditions), attended background noise measurements and simultaneous noise measurements at the master bedroom and at the adjacent plant room. The results of the investigations are presented in Table 3.

Table 3 - Noise measurement results

| $L_{eq,15min}$ dB(A) | $L_{eq,15min}$ dB(C) | Tonality? | Low frequency noise? | Penalty* dB | Resultant value dB | Compliance with AS/NZS 2107:2016 |
|-------------------------|-------------------------|-----------|-------------------------|----------------|-----------------------|-------------------------------------|
| 31 | 49 | No | Yes | +5 | 36 | Yes |

*Correction to the measured noise levels with a low frequency noise correction factor (penalty).

The conclusion was that the noise level at the master bedroom is within the design sound level from Table 1 of AS/NZS 2107:2016, when the mechanical plant is operating and the relevant penalty for low-frequency noise is applied. However a clarifying comment was also provided, as follows:

The unattended noise measurements as carried out at the master bedroom of Unit 8 identified that the background noise levels at this apartment are very low, when the windows are closed and the unit is unoccupied. Although during the unattended noise measurements there have been some intermittent higher noise level episodes, the noise levels, particularly during night-time, have been very low. In this quiet environment, every sound, particularly if it has characteristics which sensitive people can find annoying, is perceived as a major noise impact (ATP Consulting Engineers, 2023).

The dominant noise was generated by the exhaust fan expelling the heat from the air-conditioning units to the outside of the plant room. There have been some attempts to reduce the fan noise by retrofit installation of an attenuation plenum, as presented in Figure 3.



Figure 3 – Exhaust fan at the plant room of a high-rise building in central Gold Coast

The partition wall between the plant room and the master bedroom, which has been designed to achieve compliance with Part F5 of NCC BCA 2019, has not provided sufficient attenuation to the low frequency noise, resulting in an annoying rumble. Legally the internal noise criteria, after application of low-frequency noise penalty, have been met. However, in the very quiet internal noise environment, the low frequency noise sounds like a constant “rumble” which can cause sleep disturbance.

5 CONCLUSION AND RECOMENDATIONS

In the daily practice ATP Consulting has had to provide professional acoustic advice in number of disputes between owners of adjacent units or owners and body corporates over sound transmission issues at residential buildings. Most of these issues has arisen following upgrades and refurbishments of apartments which have been built on the Gold Coast in the last 20 years.

The common element in these cases has been a discrepancy between the expectations of the owners and the actual sound insulation performance of the building components. Replacement of carpets in apartments built in the late 1990's and early 2000's have resulted in poor outcomes relative to expectations of impact sound insulation as per the requirements of the current NCC BCA. Most apartment owners are not aware that the residential buildings in Queensland have been built with no consideration of impact sound transmission until the BCA 2009 was adopted. Up to the adoption of BCA 2009 on 1 May 2009, the high-rise buildings in Queensland have been built in accordance with the requirements adopted on 1 July 1997, under Part F5 of BCA96.

Better acoustic design outcomes have been achieved following on the adoption of BCA 2009. However, the lessons learned from application of the sound insulations ratings of floors and walls since 2009, indicate room for improvement. Experience shows that the key issues are associated with the following:

- Impact sound insulation of floors, which currently is $L_{nT,w}$ 62 dB;
- Insufficient sound insulation rating of services with R_w+C_{tr} (airborne) 25 applicable if the adjacent room is a kitchen;
- Insufficient sound insulation of wall which is required to have an R_w (airborne) not less than 50, if it separates sole-occupancy unit from plant room; and
- Limited recognition of the low frequency noise impacts (except when considering C_{tr} adjustment factor which is mainly applied due to low-frequency bass noise from home theatre or sound systems).

The three case studies presented in this paper, based on actual problems encountered in the professional practice, indicate that there is a room for further improvement in the requirements for building design under Part F7 (Sound Transmission and Insulation) of NCC BCA.

Specifically it is proposed to consider the following amendments in the next edition of NCC BCA: -

- A floor separating sole-occupancy units or a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor public lobby, or the like, or parts of a different classification, must minimise the transmission of airborne and impact generated sound such that the separating floor, including the effect of services and their penetrations, has...—
 - b) *a weighted standardised impact sound pressure level ($L_{nT,w}$) not more than 55 for impact generated sound¹.*
- If a duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with an $R_w + C_{tr}$ (airborne) not less than —
 - a) *40 if the adjacent room is a habitable room, including a kitchen²; or*
 - b) *25 if the adjacent room is a non-habitable room.*
- A wall in a Class 2 or 3 building must —
 - (a) have an $R_w + C_{tr}$ (airborne) not less than 50, if it separates sole-occupancy units; and
 - (b) *have an $R_w + C_{tr}$ (airborne)³ not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and*
 - (c) comply with F7D4(2) if it separates—

¹ Applicable to Performance Requirements, Part F7P1; and Verification Methods Part F7V1 and Part F7V3.

² Applicable to Performance Requirements, Part F7D7.

³ Applicable to Performance Requirements, Part F7D6.

- (i) a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or
- (ii) a sole-occupancy unit from a plant room or lift shaft.

The above amendments to the next edition of NCC BCA are proposed on the basis of problems encountered during acoustic investigations long after the buildings have been constructed based on the sound insulation requirements at the time of design. They are propositions to be considered as a contribution towards discussion on the improvement of the sound insulation requirements in the next edition of NCC BCA.

REFERENCES

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