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IMPACT NOISE TESTING

TIMBER FLOORING & ACOUSTIC UNDERLAY TESTING

ECO FLOORING SYSTEMS

Date: Monday, 11th May 2015
File Reference: 2707C20150511mfcEcoFlooringSystems

Koikas Acoustics Pty Ltd
Commercial 1, Unit 27,
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DOCUMENT CONTROL	
Project Title	Impact Noise Testing Timber Flooring & Acoustic Underlay Testing Eco Flooring Systems
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Prepared By	Michael Fan Chiang
Approved By	Nick Koikas 
Client	Eco Flooring Systems Attention: Lee Zhang Email:bamboo@ecoflooring.com.au

IMPACT NOISE TESTING

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ECO FLOORING SYSTEMS

CONTENTS

1.0 CONSULTANT'S BRIEF

Koikas Acoustics was requested by Eco Flooring Systems to conduct impact noise tests on three (3) different timber floor systems. Impact noise tests were conducted with one type of timber flooring on three (3) different underlays. Testing was undertaken between two sole occupancy units in Campsie.

The aim of the test was to calculate the impact isolation performance of the timber flooring used in conjunction with the three (3) different underlays. Test results were compared to the acoustics requirements of ***Part F5 of BCA (Building Codes of Australia)*** and the standards prescribed by the ***Association of Australian Acoustical Consultants (AAAC)***.

2.0 TESTING SAMPLES AND CONDITIONS

Koikas Acoustics has been advised that the ceiling/floor system between the living/dining/kitchen areas of residential units is constructed with following building materials:

Living/Dining/Kitchen Areas

- 200 mm thick concrete slab;
- Approximately 80 mm deep suspended ceiling cavity;
- 50 mm insulation batts fitted in the ceiling cavity, and
- 13 mm thick plasterboard ceiling.

Hereafter is referred to as the "*existing ceiling/floor system*" "ECFS".

The tests were conducted on the existing ceiling/floor system (ECFS) with the following timber flooring and acoustic underlays:

- Test 1: 14 mm bamboo timber flooring over Eco flooring Ezi-lay Ultra
- Test 2: 14 mm bamboo timber flooring over Eco flooring Ezi-lay Premium
- Test 3: 14 mm bamboo timber flooring over Eco flooring Ezi-lay Standard

3.0 IMPACT NOISE CRITERION

3.1 BCA REQUIREMENT

In accordance with current BCA, a floor in a Class 2 or 3 building must have an $D_{nTw}+C_{tr}$ (airborne) not less than 45 and an $L_{nTw}+Ci$ (impact) not more than 62 if it separates-

(i) sole-occupancy units; or

(ii) a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.

3.2 AAAC STAR RATING PERFORMANCE REQUIREMENTS

Reproduced from the AAAC Guideline for Apartment and Townhouse Acoustic Ratings, the following Table (Section C) describes the acoustic ratings with reference to the Star Rating System.

Table 1. Star Rating requirements for Inter-tenancy Activities – Published by the AAAC

INTER-TENANCY ACTIVITIES	2 Star	3 Star	4 Star	5 Star	6 Star
(a) Airborne sound insulation for walls and floors					
- Between separate tenancies $D_{nTw}+C_{tr} \geq$	35	40	45	50	55
- Between a lobby/corridor & bedroom $D_{nTw}+C_{tr} \geq$	30	40	40	45	50
- Between a lobby/corridor & living area $D_{nTw}+C_{tr} \geq$	25	40	40	40	45
(b) Corridor, foyer to living space via door(s) $D_{nTw} \geq$	20	25	30	35	40
(c) Impact isolation of floors					
- Between tenancies $L_{nTw} \leq$	65	55	50	45	40
- Between all other spaces & tenancies $L_{nTw} \leq$	65	55	50	45	40
(d) Impact isolation of walls					
- Between tenancies	No	Yes	Yes	Yes	Yes
- Between common areas & tenancies	No	No	No	Yes	Yes

4.0 IMPACT NOISE TESTING

The testing of the ceiling/floor system with the 14 mm bamboo flooring and three (3) different underlays were conducted inside the unfurnished living/dining/kitchen spaces from one residential unit (upper floor level) to another unit (lower floor level) directly below within a residential building in Campsie on Thursday 7th May 2015.

4.1 ASSESSMENT PROCEDURES

Spectrum sound level measurements of transmitted impact noise were recorded in 1/3 octave band centre frequencies between 50 and 10,000 Hertz.

A standardised BSWA Technology Co. Type TM002 S/N 440504 Tapping Machine was used to generate the sound field in the source rooms for the impact noise test. Impact noise measurements were carried out in accordance with the recommendations of AS/NZS ISO 140.7:2006 *"Field measurements of impact sound insulation of floors"*. This document provides information on appropriate measurement equipment and the proper implementation of measurement practices so as to achieve reliable results of impact sound insulation between rooms in buildings.

For determining a single number quantity for impact sound insulation between rooms in buildings when measurements are conducted "in-situ", $L_{nT,w}$ + Ci (weighted standardised impact sound pressure level + spectrum adaptation term), the relevant standard is AS/NZS ISO 717.2-2004 *"Impact sound insulation"*. The calculated $L_{nT,w}$ + Ci derived from applying the formulae in this standard allows for a comparison between these calculated levels and the nominated acceptable levels outlined in the *Verification Methods* of the Building Code of Australia (BCA).

4.2 AMBIENT BACKGROUND NOISE MEASUREMENT

A measure of the underlying ambient noise was taken in the receiving rooms to account for the perceived noise floor in the space. Inaccuracies in the measurements and calculations can occur in areas of high ambient noise however the location of the site and receiver rooms meant little ambient noise was evident in this case.

Ambient noise levels in each 1/3 octave frequency bands were measured to take into account the effect of ambient noise during the recording of the transmitted impact noise levels.

4.3 REVERBERATION TIME MEASUREMENTS

To determine the $L_{nT,w}$ + Ci or L_{nw} , reverberation time measurements need to be performed in the receiving rooms. The reverberation time in the receiver room is calculated to 'standardise' the airborne/impact noise transmission measurements to reference reverberation time of 0.5 seconds as required by AS/NZS ISO 140.7:2006 Section 3.4, and AS ISO 140.4-2006 Section 3.4.

Reverberation time measurements were conducted using the balloon source method. This consisted of bursting a large balloon and measuring the decay of sound pressure level using a spectrum analyser. This transient response was analysed by the sound level meter and a measure of the reverberation time in 1/3 octave bands was used to calculate the standardised impact noise rating.

4.4 INSTRUMENTATION AND CALIBRATION

NTi XL2 Type Approved (TA) precision spectrum analyser S/N A2A-06312-E0 was used to measure the impact noise levels. The equipment used for taking noise level measurements is traceable to NATA certification. Field calibrations were taken before and after the measurements with a NATA calibrated field calibrator. There was no system drifts.

5.0 MEASURED RESULTS

The results of the impact noise test is summarised in Table 2 Below.

Table 2. Impact Noise Insulation Performance Summary					
Testing Samples	L'_{nTw}, (Ci)	BCA Criterion	AAAC Star Rating	FIIC	Increase in Acoustic Rating L'_{nTw}[1]
Test 0: ECFS	60 (-10)	N/A	2	42	-
Test 1: 14 mm bamboo + Ezi-lay Ultra + ECFS	49 (-1)	L_{nTw}+Ci ≤ 62	4	60	11
Test 2: 14 mm bamboo + Ezi-lay Premium + ECFS	48 (0)		4	60	12
Test 3: 14 mm bamboo + Ezi-lay Standard + ECFS	48 (-1)		4	60	12

1. All testing were compared to the acoustic rating with the bare concrete floor (Test 0) and increase in L_{nTw} rating is specified.

The following are also noted:

- All tests were undertaken with 200 mm thick concrete sub-base, 50 mm insulation batts fitted in 80 mm ceiling cavity and one layer of 13mm suspended plasterboard ceiling.

- The relation between Field Impact Isolation Class (FIIC) and Impact Isolation Class (IIC) can be described by the formula FIIC + 5 ≈ IIC.

- All the ceiling/floor system tested have also met the BCA 2013 criterion (L_{nTw}+Ci ≤ 62) for impact noise insulation. The lower the rating number the better the acoustic performance.

- The concrete slab is joined to the concrete wall which is a homogenous wall connecting from residential units on the upper floor level to the lower floor level.

- Ceiling/floor cavities without insulation batts will provide less impact insulation. It is expected that the acoustic performance will be worse by 5 rating points.

Detail calculations of the impact noise insolation of ceiling/floor system are attached as **Appendix A**.

6.0 CONCLUSION

Koikas Acoustics was requested by Eco Flooring Systems to undertake impact noise tests on ceiling/floor system with 14 mm bamboo timber flooring and three (3) different types of underlay samples. The acoustic performances of various ceiling/floor configurations were calculated and compared against the acoustic requirements of the current BCA and AAAC star ratings.

The calculated acoustic rating of each tested flooring sample was summarised and presented in **Table 2** of this report. Detailed graphically presentation of the acoustic performance of each tested flooring sample is attached as **Appendix A**.

All tested flooring samples have complied with current BCA acoustic requirements and achieved AAAC Star Rating of 4.

It is recommended that testing be conducted prior to any full fit-out as the sub-base ceiling floor system and the wall junctions can impact upon the resultant flanking noise in the unit below. The above report should be reproduced in full including the attached Appendix.

APPENDIX A

APPENDIX A

APPENDIX A

FIELD MEASUREMENTS OF IMPACT SOUND INSULATION OF FLOORS (TEST 1)

KOIKAS ACOUSTICS PTY LTD

Date of Test :	Thursday, 7 May 2015
Project No. :	2707
Testing Company :	Koikas Acoustics
Checked by :	Nick Koikas
Place of Test:	Residential Flat Unit in Campsie
Client	Eco Flooring System
Client Address	Residential Flat Unit in Campsie

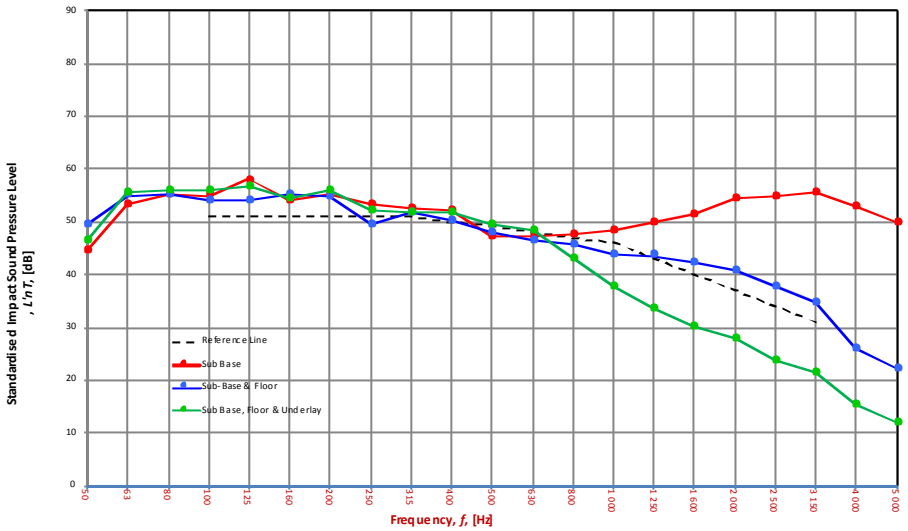
	Name	Thickness (mm)	Density (Sl)
Description of Floor System	14 mm bamboo flooring	14	--
	Eco flooring Ezi-lay Ultra	2	--
	200 mm concrete slab + 80 mm ceiling cavity + 50 mm insulation b	--	--
	13 mm Plasterboard ceiling	13	--

Room Floor Dimensions	Width :	3.5	m
	Length :	5.5	m
	Area :	19.25	m^2
Sample Dimensions	Width :	1	m
	Length :	1	m
	Area :	1	m^2

	Location	Width	Length	Area	Height	Volume
Receiver Rm	Unit 211	3.5	5.5	19.25	2.5	48.125

Room Surfaces		
Walls	Floor	Ceiling
Plasterboard	concrete	Plasterboard

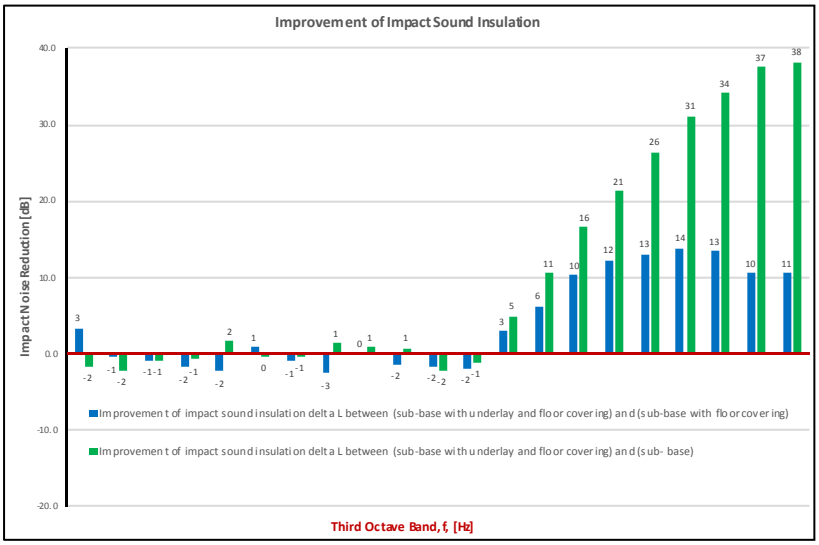
Frequency f Hz	L'nT (one-third octave) dB		
	Sub Base	Sub Base Floor	Sub Base Floor Underlay
50	44.7	49.7	46.5
63	53.4	55.0	55.6
80	55.1	55.1	56.0
100	55.0	53.9	55.8
125	58.1	54.1	56.5
160	54.0	55.1	54.4
200	55.4	54.8	55.9
250	53.4	49.4	52.1
315	52.7	52.0	52.0
400	52.3	50.2	51.7
500	47.4	48.0	49.7
630	47.3	46.6	48.6
800	47.7	45.8	42.9
1 000	48.2	43.8	37.7
1 250	50.0	43.7	33.5
1 600	51.6	42.5	30.4
2 000	54.3	41.0	28.0
2 500	54.9	37.7	23.9
3 150	55.5	34.8	21.4
4 000	53.0	26.0	15.6
5 000	49.9	22.4	11.8



Sub Base		
L'nT,w	60	AS ISO 717.2 - 2004
Ci	-1.0	AS ISO 717.2 - 2004
Ci(50-2500)	-9	AS ISO 717.2 - 2004
Ci(63-2000)	-1.0	AS ISO 717.2 - 2004
AAAC ★	2 Star	AAAC Guidleline
FIIC	42	ASTM E1007-14

Sub Base & Floor		
L'nT,w	49	AS ISO 717.2 - 2004
Ci	-2	AS ISO 717.2 - 2004
Ci(50-2500)	0	AS ISO 717.2 - 2004
Ci(63-2000)	0	AS ISO 717.2 - 2004
AAAC ★	4 Star	AAAC Guidleline
FIIC	59	ASTM E1007-14

Sub Base, Floor & Underlay		
L'nT,w	49	AS ISO 717.2 - 2004
Ci	-1	AS ISO 717.2 - 2004
Ci(50-2500)	1	AS ISO 717.2 - 2004
Ci(63-2000)	1	AS ISO 717.2 - 2004
AAAC ★	4 Star	AAAC Guidleline
FIIC	60	ASTM E1007-14



Definitions of Noise Metrics

FIIC:
Field Impact Insulation Class is a single-number rating of how well a floor system attenuates impact type sounds, such as footsteps. Calculated from third-octave band normalised impact sound pressure level data and referenced to 10 m^2 as described in ASTM E989. The higher the single-number rating, the better its impact insulation performance.

L'nT,w:
The Weighted Standardised Impact Sound Pressure Level when measured in situ referenced to a reverberation time (RT60) of 0.5 seconds. Used by the AAAC to determine their respective Star Rating.

Ci:
Spectrum adaption term is a low frequency correction factor. Typically for massive floors such as concrete, the values are about zero while for timber joist floors Ci is positive because of the low resonant frequencies. Considers frequency range between 100 - and 2500 Hz.

Ci(50-2500):
Same as above, but for the frequency range 50 - 2500 Hz.

Ci(125-2000):
Same as above, but for the frequency range 125 - 2000 Hz.

AAAC Star R.	2	3	4	5	6
L'nT,w	65	55	50	45	40
FIIC	45	55	60	65	70
Comments	Below BCA62	Clearly Audible	Audible	Barely Inaudible	Normally Inaudible

FIELD MEASUREMENTS OF IMPACT SOUND INSULATION OF FLOORS (TEST 2)

KOIKAS ACOUSTICS PTY LTD

Date of Test :	Thursday, 7 May 2015
Project No. :	2707
Testing Company :	Koikas Acoustics
Checked by :	Nick Koikas
Place of Test:	Residential Flat Unit in Campsie
Client	Eco Flooring System
Client Address	Residential Flat Unit in Campsie

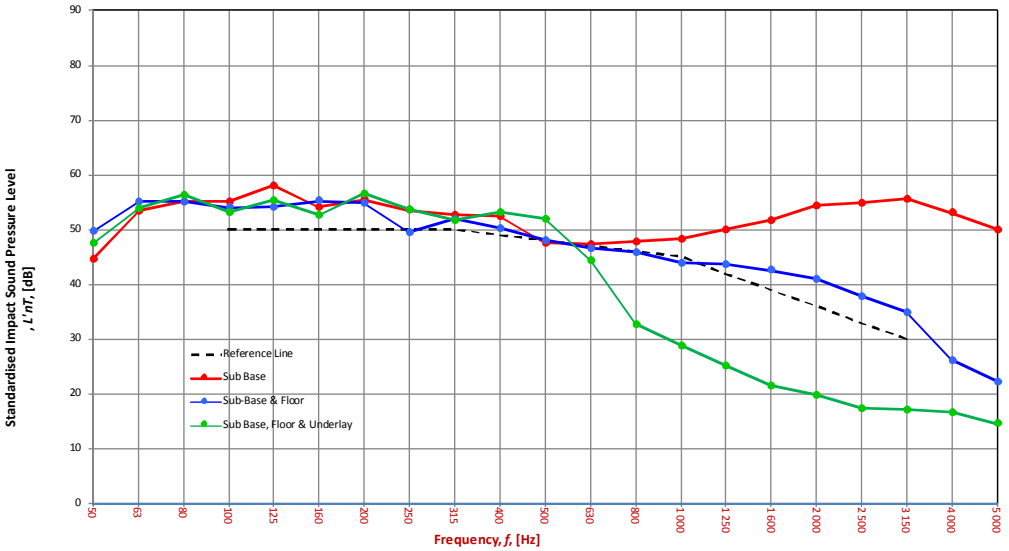
	Name	Thickness (mm)	Density (SI)
Description of Floor System	14 mm bamboo flooring	14	--
	Eco flooring Ezi-lay Premium	2	--
	200 mm concrete slab + 80 mm ceiling cavity + 50 mm insulation ba	--	--
	13 mm Plasterboard ceiling	13	--

Room Floor Dimensions	Width :	3.5	m
	Length :	5.5	m
	Area :	19.25	m^2
Sample Dimensions	Width :	1	m
	Length :	1	m
	Area :	1	m^2

	Location	Width	Length	Area	Height	Volume
Receiver Rm	Unit 211	3.5	5.5	19.25	2.5	48.125

Room Surfaces		
Walls	Floor	Ceiling
Plasterboard	concrete	Plasterboard

Frequency f Hz	L'nT (one-third octave) dB		
	Sub Base	Sub Base Floor	Sub Base Floor Underlay
50	44.7	49.7	47.4
63	53.4	55.0	53.8
80	55.1	55.1	56.2
100	55.0	53.9	53.0
125	58.1	54.1	55.2
160	54.0	55.1	52.6
200	55.4	54.8	56.6
250	53.4	49.4	53.6
315	52.7	52.0	51.6
400	52.3	50.2	53.1
500	47.4	48.0	51.9
630	47.3	46.6	44.3
800	47.7	45.8	32.5
1 000	48.2	43.8	28.8
1 250	50.0	43.7	25.2
1 600	51.6	42.5	21.4
2 000	54.3	41.0	19.7
2 500	54.9	37.7	17.2
3 150	55.5	34.8	17.1
4 000	53.0	26.0	16.6
5 000	49.9	22.2	14.5



Sub Base		
L'nT,w	60	AS ISO 717.2 - 2004
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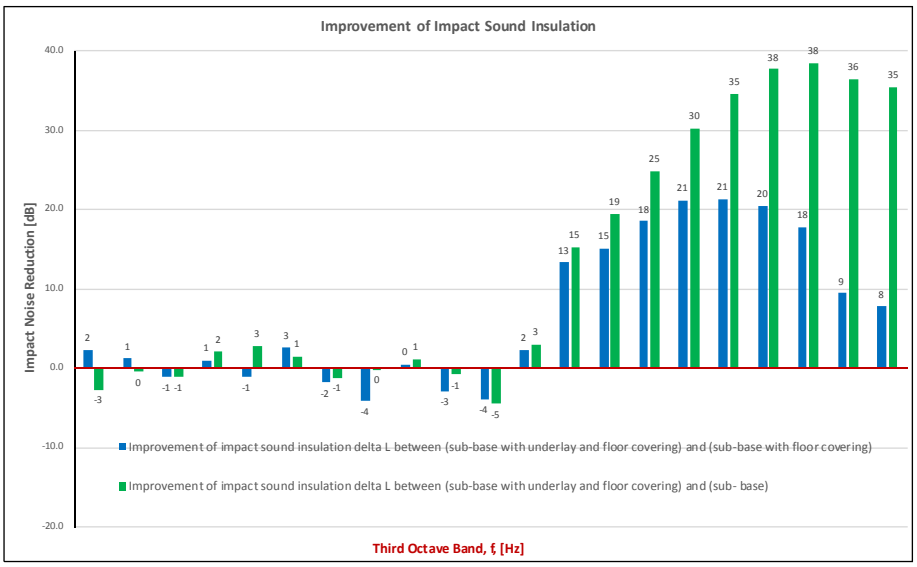
Ci(50-2500)	-9	AS ISO 717.2 - 2004
Ci(63-2000)	-10	AS ISO 717.2 - 2004
AAAC ★	2 Star	AAAC Guidleline
FIIC	42	ASTM E1007-14

Sub Base & Floor		
L'nT,w	49	AS ISO 717.2 - 2004
Ci	-2	AS ISO 717.2 - 2004
Ci(50-2500)	0	AS ISO 717.2 - 2004
Ci(63-2000)	0	AS ISO 717.2 - 2004
AAAC ★	4 Star	AAAC Guidleline
FIIC	59	ASTM E1007-14

Sub Base, Floor & Underlay		
L'nT,w	48	AS ISO 717.2 - 2004
Ci	0	AS ISO 717.2 - 2004
Ci(50-2500)	1	AS ISO 717.2 - 2004
Ci(63-2000)	1	AS ISO 717.2 - 2004
AAAC ★	4 Star	AAAC Guidleline
FIIC	60	ASTM E1007-14



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L'nT,w:
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Ci:
Spectrum adaption term is a low frequency correction factor. Typically for massive floors such as concrete, the values are about zero while for timber joist floors Ci is positive because of the low resonant frequencies. Considers frequency range between 100 -and 2500 Hz.

Ci(50-2500):
Same as above, but for the frequency range 50 -2500 Hz.

Ci(125-2000):
Same as above, but for the frequency range 125 -2000 Hz.

AAAC Star R.	2	3	4	5	6
L'nT,w	65	55	50	45	40
FIIC	45	55	60	65	70
Comments	Below BCA 62	Clearly Audible	Audible	Barely Inaudible	Normally Inaudible

FIELD MEASUREMENTS OF IMPACT SOUND INSULATION OF FLOORS (TEST 3)

KOIKAS ACOUSTICS PTY LTD

Date of Test :	Thursday, 7 May 2015
Project No. :	2707
Testing Company :	Koikas Acoustics
Checked by :	Nick Koikas
Place of Test:	Residential Flat Unit in Campsie
Client	Eco Flooring System
Client Address	Residential Flat Unit in Campsie

Description of Floor System	Name	Thickness (mm)	Density (Sl)
	14 mm bamboo flooring	14	--
	Eco flooring Ezi-lay Standard	2	--
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	13 mm Plasterboard ceiling	13	--

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	Area :	19.25	m^2
Sample Dimensions	Width :	1	m
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	Location	Width	Length	Area	Height	Volume
Receiver Rm	Unit 211	3.5	5.5	19.25	2.5	48.125

Room Surfaces		
Walls	Floor	Ceiling
Plasterboard	concrete	Plasterboard

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50	44.7	49.7	48.5
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200	55.4	54.8	56.5
250	53.4	49.4	52.5
315	52.7	52.0	51.0
400	52.3	50.2	51.6
500	47.4	48.0	50.8
630	47.3	46.6	47.1
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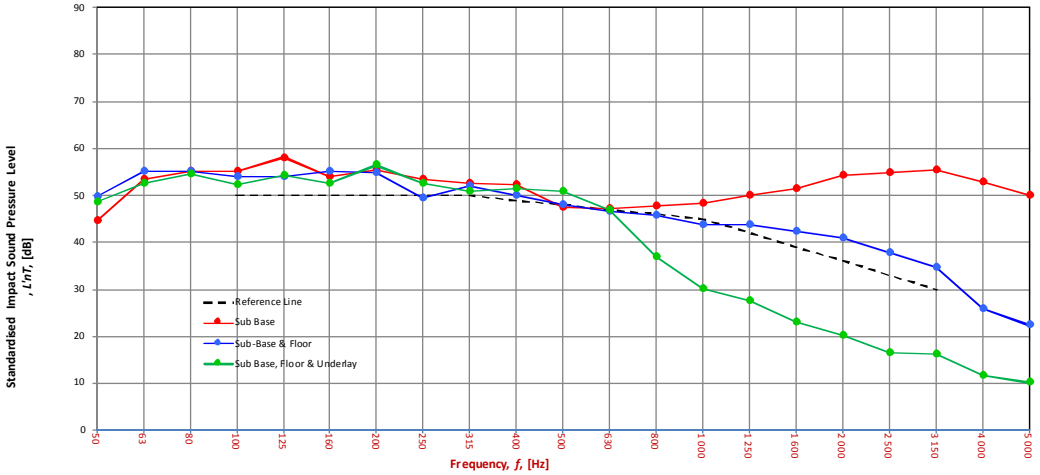

Sub Base		
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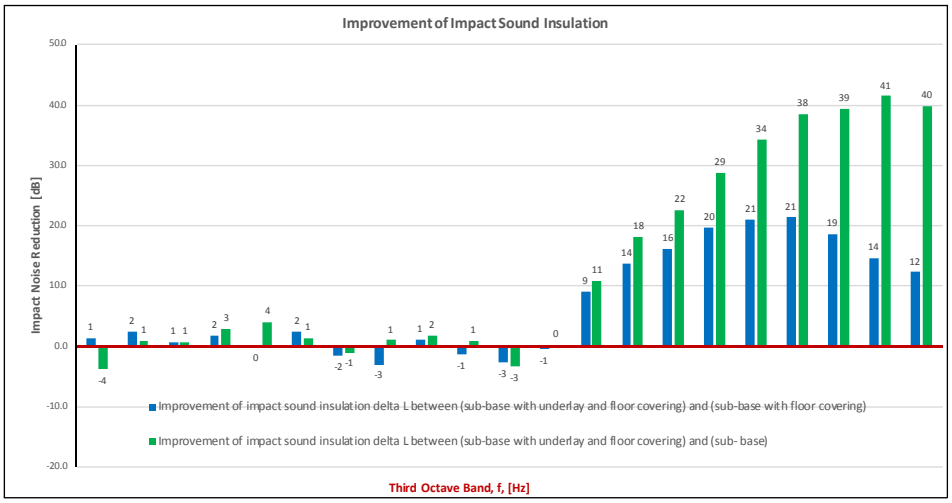
Ci(63-2000)	0	AS ISO 717.2 - 2004
AAAC ★	4 Star	AAAC Guidleline
FIIC	59	ASTM E1007-14

Sub Base, Floor & Underlay		
L'nT,w	48	AS ISO 717.2 - 2004
Ci	-1	AS ISO 717.2 - 2004
Ci(50-2500)	0	AS ISO 717.2 - 2004
Ci(63-2000)	0	AS ISO 717.2 - 2004
AAAC ★	4 Star	AAAC Guidleline
FIIC	60	ASTM E1007-14



Definitions of Noise Metrics

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Spectrum adaption term is a low frequency correction factor. Typically for massive floors such as concrete, the values are about zero while for timber joist floors Ci is positive because of the low resonant frequencies. Considers frequency range between 100 -and 2500 Hz.

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Same as above, but for the frequency range 50 -2500 Hz.

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Same as above, but for the frequency range 125 -2000 Hz.

AAAC Star R.	2	3	4	5	6
L'nT,w	65	55	50	45	40
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Comments	Below BCA 62	Clearly Audible	Audible	Barely Inaudible	Normally Inaudible