

Project: **Acoustic Opinion: CLT Floors with covers and ceilings**

Prepared for: **Woodland Lifestyle**

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1.0 INTRODUCTION

Marshall Day Acoustics has been engaged by Woodland Lifestyles Ltd to provide an opinion of the acoustic performance of a range of Cross-Laminate Timber (CLT) floor/ceiling systems based, in part, on recently measured sound insulation performance data for eight (8) different Woodland Lifestyle floor covering systems.

The floor/ceiling systems considered for this opinion include four different CLT floor slabs as well as three types of suspended ceiling.

This acoustic opinion considers both the airborne sound insulation performance of the floor/ceiling systems as described by Sound Transmission Class (STC) ratings and the impact sound pressure levels of these systems as described by Impact Isolation Class (IIC).

The performance estimates are intended to be equivalent to the product performance, as it would be under laboratory test conditions according to the standards detailed in Table 1.

Table 1: Standards relevant for the acoustic opinion

Rating	Standard
STC	ASTM E 90 <i>Method for laboratory measurement of airborne sound transmission loss of building partitions</i>
IIC	ASTM E 492 <i>Test method for laboratory measurement of impact sound transmission through floor-ceiling assemblies using the tapping machine</i>

Higher STC and IIC ratings indicate that less noise is transmitted to the room below. The NZ Building Code requires that new inter-tenancy floors have a laboratory rating of STC 55 and IIC 55 or higher.

A glossary of acoustic terminology is provided in Appendix A.

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2.0 FLOOR/CEILING SYSTEMS

The systems considered in this opinion include eight floor cover systems, four different CLT floor slabs and three configurations of suspended ceiling. Details for these items are provided below.

2.1 CLT Floor Slabs

Four thicknesses of CLT floor slab have been considered, based on systems currently available from Red Stag. The assumed properties of the floor slabs are set out in Table 2 below.

Table 2: CLT Floor Slabs

Floor Slab	No. of Laminate layers	Density (Kg/m ²)	Thickness (mm)
3/104	3	450	104*
3/126	3	450	126
5/166	5	450	166*
5/210	5	450	210

* Comprising an array of laminate layers with thickness 20 mm and 42 mm

2.2 Floor Covers

Details for the eight floor covers considered are provided in Table 3 below. The floor covers are multi-layer systems. They all include at least one layer of PhoneStar Tri, typically installed beneath a load-spreading layer such as plywood.

Table 3: Floor Covers

Floor Cover	Details
FC1	1 layer of 5 mm plywood (3 ply with thin veneer facings) loose laid on 1 layer of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The layer of PhoneStar Tri is loose laid on 1 layer of 2 mm thick floorMuffler loose laid on the CLT base floor
FC2	1 layer of 5 mm plywood (3 ply with thin veneer facings) loose laid on 2 layers of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The 2 layers of PhoneStar Tri are loose laid on 1 layer of 2 mm thick ultraSeal floorMuffler loose laid on the CLT base floor.
FC3	1 layer of 5 mm Native Vinyl Plank loose laid on 1 layer of 5 mm plywood (3 ply with thin veneer facings) loose laid on 2 layers of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The 2 layers of PhoneStar Tri are loose laid on 1 layer of 2 mm thick ultraSeal floorMuffler loose laid on the CLT base floor.
FC4	1 layer of 18 mm Plywood (7ply) loose laid on 1 layer of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The layer of PhoneStar Tri is loose laid on 1 layer of 17 mm GenieMat FF17. The GenieMat FF17 is loose laid (dimple side down) on the CLT base floor
FC5	1 layer of 5 mm Plywood (3 ply with thin veneer facings) loose laid on 2 layers of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The 2 layers of PhoneStar Tri are loose laid on 1 layer of 17 mm GenieMat FF17. The GenieMat FF17 is loose laid (dimple side down) on the CLT base floor
FC6	1 layer of 18 mm Plywood (7ply) loose laid on 1 layer of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The layer of PhoneStar Tri is loose laid on 1 layer of 20 mm Wolf Bavaria Wolf MiWo compressed Rock wool board. The Wolf Bavaria Wolf MiWo is loose laid on the CLT base floor
FC7	1 layer of 18 mm Plywood (7ply) loose laid on 2 layers of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The 2 layers of PhoneStar Tri are loose laid on 1 layer of 20 mm Wolf Bavaria Wolf MiWo compressed Rock wool board. The Wolf Bavaria Wolf MiWo is loose laid on the CLT base floor
FC8	1 layer of 5 mm plywood (3 ply with thin veneer facings) loose laid on 1 layer of 15 mm thick Wolf Bavaria PhoneStar Tri (1200 kg/m ³). The layer of PhoneStar Tri is adhered to the CLT base floor with ARDEX AF 460 Engineered Wood Adhesive using a 7 mm x 7 mm V-Notched trowel with notches spaced at 18.5 mm centre to centre.

2.3 Ceiling Construction

The ceiling systems considered in this opinion are detailed in Table 4 below.

Table 4: Ceiling Constructions

Ceiling	Details*
C1	Suspended light steel grid with 13 mm Gib Standard plasterboard 200mm cavity with 90mm glass wool (10 kg/m ³)
C2	Suspended light steel grid with 2 x 13 mm Gib Standard plasterboard 200mm cavity with 90mm glass wool (10 kg/m ³)
C3	ST001 type acoustic clips with 2 x 13 mm Gib Standard 70mm cavity with 50mm Bradford Acoustigard glass wool insulation R1.3 (14 kg/m ³)
* 13 mm Gib Standard plasterboard assumed to have a density of approximately 640 kg/m ³	

3.0 ASSESSMENT METHOD

The sound insulation performance of the proposed floor/ceiling systems can be estimated with reference to measured or published sound insulation performance of equivalent systems.

The sound insulation performance can also be estimated using established theoretical and empirical models. The models consider the surface mass of the linings, the stiffness and hence critical frequency of the linings, the air gaps between linings and the type of acoustic absorption within the cavity.

4.0 TEST RESULTS

A campaign of sound insulation testing was carried out in May 2025 by the University of Auckland Acoustic Testing Service to establish the performance of the floor covers described in Section 2.2 above.

Each floor cover was installed on a bare CLT slab. The CLT slab comprised 3 laminate layers with a total thickness of 126 mm (3/126). There was no ceiling installed beneath the slab.

The results of the floor cover tests are summarised in Table 5 below.

Table 5: STC, IIC Summary for floor covers tested on a 3/126 CLT floor slab

Floor cover	Test reference	Sound Transmission Class (STC)	Impact Insulation Class (IIC)
None	T2511-1-ATS	34	19
FC1	T2511-2-ATS	40	44
FC2	T2511-3-ATS	42	47
FC3	T2511-4-ATS	44	48
FC4	T2511-5-ATS	45	42
FC5	T2511-6-ATS	47	42
FC6	T2511-7-ATS	48	43
FC7	T2511-8-ATS	49	46
FC8	T2511-9-ATS	35	38

5.0 OPINION

5.1 Airborne Sound Insulation

Estimated laboratory sound insulation performance values are detailed in Table 6 below for a range of floor cover, CLT floor slab and ceiling combinations. The estimates are expressed as Sound Transmission Class (STC) ratings.

Table 6: Estimated Sound Transmission Class (STC)

		Sound Transmission Class (STC)							
		Floor Covering							
Ceiling	CLT	FC1	FC2	FC3	FC4	FC5	FC6	FC7	FC8
Nil	3/104	35	38	39	37	39	42	43	31
	3/126	40*	42*	44*	45*	47*	48*	49*	35*
	5/166	40	42	44	45	47	48	49	37
	5/210	45	47	48	45	48	50	51	41
C1	3/104	49	51	52	46	47	46	47	47
	3/126	51	53	53	47	46	45	47	48
	5/166	52	54	54	48	47	46	48	51
	5/210	54	56	56	51	52	53	54	54
C2	3/104	52	53	54	47	48	49	50	49
	3/126	53	55	55	48	49	48	50	51
	5/166	54	56	56	50	51	50	51	53
	5/210	55	57	58	52	53	56	58	56
C3	3/104	54	54	54	49	50	51	53	49
	3/126	55	58	59	53	54	54	54	51
	5/166	58	60	61	53	54	57	58	53
	5/210	60	62	63	57	58	57	58	57
1	Where the New Zealand Building Code sound insulation requirements are achieved, the results are highlighted in blue.								
*	ATS laboratory test results (reference T2511, May 2025)								

5.2 Impact Sound Pressure Levels

Estimated laboratory impact sound insulation performance values are detailed in Table 7 below for a range of floor cover, CLT floor slab and ceiling combinations. The estimates are expressed as Impact Isolation Class (IIC) ratings.

Table 7: Estimated Impact Insulation Class (IIC)

		Impact Insulation Class (IIC)							
		Floor Covering							
Ceiling	CLT	FC1	FC2	FC3	FC4	FC5	FC6	FC7	FC8
Nil	3/104	39	42	41	38	39	40	43	29
	3/126	44*	47*	48*	42*	42*	43*	46*	38*
	5/166	45	48	49	42	42	43	46	41
	5/210	45	47	48	45	48	50	51	41
C1	3/104	43	45	47	38	37	38	40	41
	3/126	46	49	50	41	40	42	43	44
	5/166	51	53	54	46	45	46	48	49
	5/210	54	57	59	50	49	50	52	53
C2	3/104	45	48	50	41	40	41	43	43
	3/126	48	51	53	44	43	44	46	47
	5/166	53	56	58	49	48	49	51	51
	5/210	57	60	61	53	52	53	54	55
C3	3/104	48	51	53	48	47	44	46	46
	3/126	52	55	56	51	50	48	50	50
	5/166	56	59	61	55	54	52	54	54
	5/210	55	59	60	55	54	51	53	54
1	Where the New Zealand Building Code sound insulation requirements are achieved, the results are highlighted in blue.								
*	ATS laboratory test results (reference T2511, May 2025)								

6.0 LIMITATIONS

The above opinions are estimates of the laboratory performance not the field performance.

The estimates are based on the original laboratory tests, the materials as currently manufactured and the construction details set out above. Readers are advised to check that this opinion has not been revised by a later issue.

STC estimates are expected to be in error by less than 3 rating points.

IIC estimates are expected to be in error by less than 4 rating points.

6.1 Floor cover variability

The test standards that describe a measurement method for assessing the improvement of Impact Sound Pressure Levels from floor coverings (ΔL) provide detailed guidance for measurements on massive floor systems such as concrete floor slabs as well as light weight floor systems comprising joists and membrane type floor linings. However, at present, these standards do not provide a methodology for assessing ΔL values on CLT floor slabs. Nor is guidance offered about how ΔL values may vary when a given floor cover is installed on different types of CLT floor slabs ~ for example, slabs with a different total thickness or with a different arrangement of laminate layers.

The IIC estimates prepared for this acoustic opinion have been developed with the assumption that, for each floor cover, the ΔL values measured using the 3/126 type CLT slab are valid for the three other CLT slab types considered¹. Due to the lack of a standardised ΔL measurement methodology for CLT slabs, this assumption introduces an additional amount of uncertainty for the IIC estimates.

6.2 Field Performance

To ensure that on-site measurements are similar to laboratory results, the products must be installed and constructed in a similar way to the laboratory tests and any substitution of materials must be approved by the project's Acoustic Consultant. In addition, potential flanking paths, such as external walls, need to be considered and mitigated against.

Structure-borne vibration is readily transmitted in all directions in flooring substructures. There is often little difference between measured impact noise levels in rooms directly below the source room compared with rooms that are diagonally below. Therefore, the impact isolation to rooms other than those directly below the floor area should also be considered.

The use of materials other than those referred to in Section 2.0 or the introduction of additional materials (e.g. underfloor heating), including the lack of any perimeter isolation, can significantly affect the field performance rating (i.e. may result in a failure in accordance with the NZ Building Code). We strongly recommend trial performance testing on site before proceeding with full installation.

For IIC ratings in particular, the impact performance provided by an underlay system is the results of the combination and interaction of all components including, but not limited to, the underlay adhesive. For the predicted results to be accurate, the underlay and all associated products must be installed as undertaken in the laboratory. Adequate perimeter isolation must also be used.

¹ That is, CLT slab types 3/104, 5/166 and 5/210

APPENDIX A GLOSSARY OF TERMINOLOGY

Sound Insulation	Provision of a degree of acoustical separation between two spaces such that sound is reduced in travelling between the two spaces.
Impact sound	Sound produced by an object impacting directly on a building structure, such as footfall noise or chairs scrapping on a floor.
Flanking Transmission	Transmission of sound energy through paths adjacent to the building element being considered. For example, sound may be transmitted around a wall by travelling up into the ceiling space and then down into the adjacent room.
Structure-Borne Transmission	The transmission of sound from one space to another through the structure of a building.
IIC	<u>Impact Insulation Class</u> A single number system for quantifying the transmission loss due to impact noise produced by a standard “Tapper Machine” through a building element.
FIIC	The ‘field’ or in situ measurement of Impact Insulation Class. Building tolerances and flanking noise have an effect on the performance of a partition when it is actually installed, which result in FIIC values lower than the laboratory derived IIC values, typically 5 dB less.
$L_{n,w}$	<u>Weighted, Normalized Impact Sound Pressure Level</u> A single number rating of the impact sound insulation of a floor/ceiling when impacted on by a standard ‘tapper’ machine. $L_{n,w}$ is measured in a laboratory. The lower the $L_{n,w}$, the better the acoustic performance.
$L'_{nT,w}$	<u>Weighted, Standardised Impact Sound Pressure Level</u> A single number rating of the impact sound insulation of a floor/ceiling when impacted on by a standard ‘tapper’ machine. $L'_{nT,w}$ is measured on site. The lower the $L'_{nT,w}$, the better the acoustic performance.