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Fishnet and Bottle System	Report G1253
Assessment of Acoustic Performance	
Panel 1	Wall constructed by hand-placed used PET bottles filled with sand, soil and fly-ash used as bricks bonded with a cement-sand slurry and reinforced with nylon fishnet. Plastered both sides with 25 mm thick cement.
For: Agrement SA	Issued: 29-Feb-2016

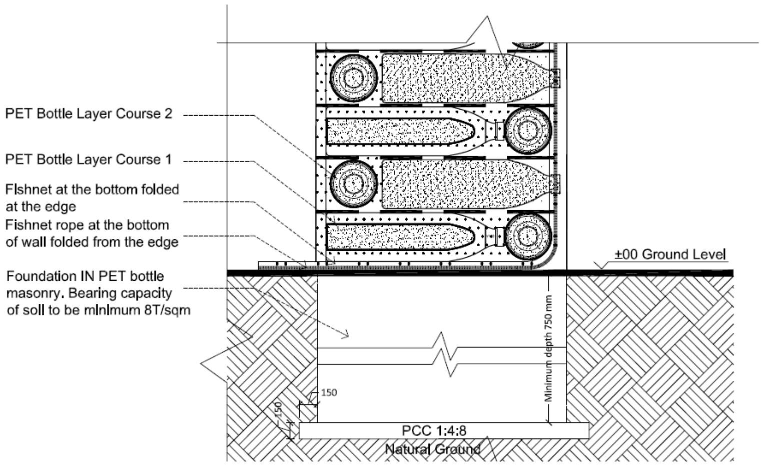
1 Scope

This report presents the results of a theoretical analysis conducted to assess the sound insulation performance of the Fishnet and Bottle Building System and to evaluate its compliance with Agrement certification requirements.

2 Product and system specification

As a rule, the sound insulation requirements for internal walls in any building application are considerably higher than the corresponding requirements for external walls. For that reason, the acoustical assessment of building systems for Agrement certification is based primarily on the sound insulation performance of internal walls. The specification of internal wall panels in the Fishnet and Bottle System is as follows:

Panel 1 — Wall constructed by hand-placed used PET bottles filled with sand, soil and fly-ash used as bricks bonded with a cement-sand slurry and reinforced with nylon fishnet. Plastered both sides with 25 mm thick cement. Typical overall thickness of plastered wall 280 mm.



Note:

This evaluation determines the characteristic sound insulation performance of the system panels, excluding any doors or windows and assuming that there are no openings or weak areas, such as would be constituted by double-sided electrical fittings. This is also how the system would be tested in a standard laboratory test and the rating obtained in this way, represents the maximum sound insulation potential of the wall panel.

For such homogeneous panels, the sound insulation performance depends only on the cross-sectional dimensions of the material layers, cavities, fillings, laminations and interconnections. The surface dimensions (width and height) of the panel have no relevance.

3 Criteria for the rating of air-borne sound insulation

Depending on the purpose of assessment, air-borne sound insulation may be quantified in terms of different indices. The inherent or characteristic sound insulation of a wall or floor panel is given by the air-borne sound reduction index R, a figure that only depends on the configuration, thickness and physical constants of materials used in the construction of the wall. It is a characteristic property of the wall, independent of the dimensions and acoustical properties of the rooms or spaces on either side of the wall. The actual difference in noise level between two rooms divided by such a wall depends on R as well as the acoustical properties (e.g. reverberation time) of the receiving room.

In order to obtain a measure of the expected level difference between two typical furnished rooms in a building with dividing walls, floor, or roof deck constructed of the panel under assessment, the standardised level difference D_{nT} calculated in accordance with ISO 140/IV[1], may be used. In real terms, D_{nT} represents the level difference between two rooms of the same dimensions as those in which an actual measurement was performed, but with the receiving room assigned a reference reverberation time T = 0,5 s. It may also be interpreted as the level difference between two rooms where the amount of absorption A_0 in the receiving room is related to the volume V by

$$A_0 = 0{,}32V$$

Consider a test conducted in a building with Rooms 1 and 2 separated by the dividing wall or floor under assessment and with a noise source generating a sound level L_1 dB in Room 1 (Refer to ISO 140/IV). If the resulting noise level in Room 2 is L_2 dB, i.e. if the level difference

$$D = L_1 - L_2 \quad \text{dB}$$

D_{nT} is given by:

$$D_{nT} = D + 10\log\left(\frac{T}{T_0}\right) \quad \text{dB}$$

where T is the reverberation time of the receiving room (Room 2) and T_0 = 0,5 s.

The relation between D_{nT} and R is given by:

$$D_{nT} = R + 10\log\left(\frac{0{,}16V}{T_0}\right) - 10\log S \quad \text{dB}$$

where V = Volume of the receiving room [m^3];
S = Surface area of the dividing wall [m^2].

The sound insulation of any panel is frequency dependent. Single-number ratings $D_{nT,w}$ and R_w of frequency-weighted average performance is determined in accordance with ISO 717/1[2].

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1 *ISO 140/IV – Measurement of sound insulation in buildings and of building elements – Part IV: Field measurements of airborne sound insulation between rooms.*

2 *ISO 717 – Rating of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation in buildings and of interior building elements.*

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Unlike R, the standardised level difference D_{nT} depends on the volume of the receiving room in which the measurements were conducted and on the surface area of the dividing partition. When used in conjunction with field data, D_{nT} is a suitable measure of the actual (measured) performance attained under such field conditions. For purposes of acoustic design, however, the rating of the sound insulation performance of panels, walls and building elements, whether determined by theoretical analysis or laboratory tests, is generally based on the characteristic parameter R, rather than D_{nT}. The difference between the values of R and D_{nT}, if derived from the same set of measurements, is usually small.

In this assessment, to avoid confusion with regard to the difference in meaning between R and D_{nT}, theoretical and measured values of D_{nT} are standardised with respect to a partition surface area $S = 10\ m^2$, receiving room volume $V = 31{,}25\ m^3$ and receiving room reverberation time $T = 0{,}5$ s. For these values, D_{nT} is numerically equal to R.

4 Theoretical analysis

Theoretical assessment of sound insulation in this investigation is based on computation of the random incidence sound reduction index R as a function of frequency by mathematical modelling of the system. The validity of the mathematical model developed by the author, has been verified against laboratory and field test data over many years.

Assumptions and conditions

The results of the analyses are valid for the specific thickness and combinations of materials specified in the panel definitions. In order to assess the maximum potential of a composite wall or floor panel, it is assumed that there are no openings, hatches or electrical fittings connecting through the panel, that no leaks occur at panel joints or around the perimeter and that flanking transmission via other routes is negligible.

It should also be noted that

(a) In laboratory and field tests, due to less than perfect sealing of joints and around the perimeter of the test panel, the measured insulation at high frequencies is invariably lower than the potential performance. Poor sealing of laboratory test samples may easily degrade the effective R_w from 50 to 40 dB.

(b) When comparing predicted results with laboratory test results, it should be borne in mind that laboratory results are not absolute. Even with the most modern equipment and test facilities, results between successive tests by the same operator on the same test sample and using the same procedure, will be subject to variance and limitations with regard to precision, repeatability and reproducibility.

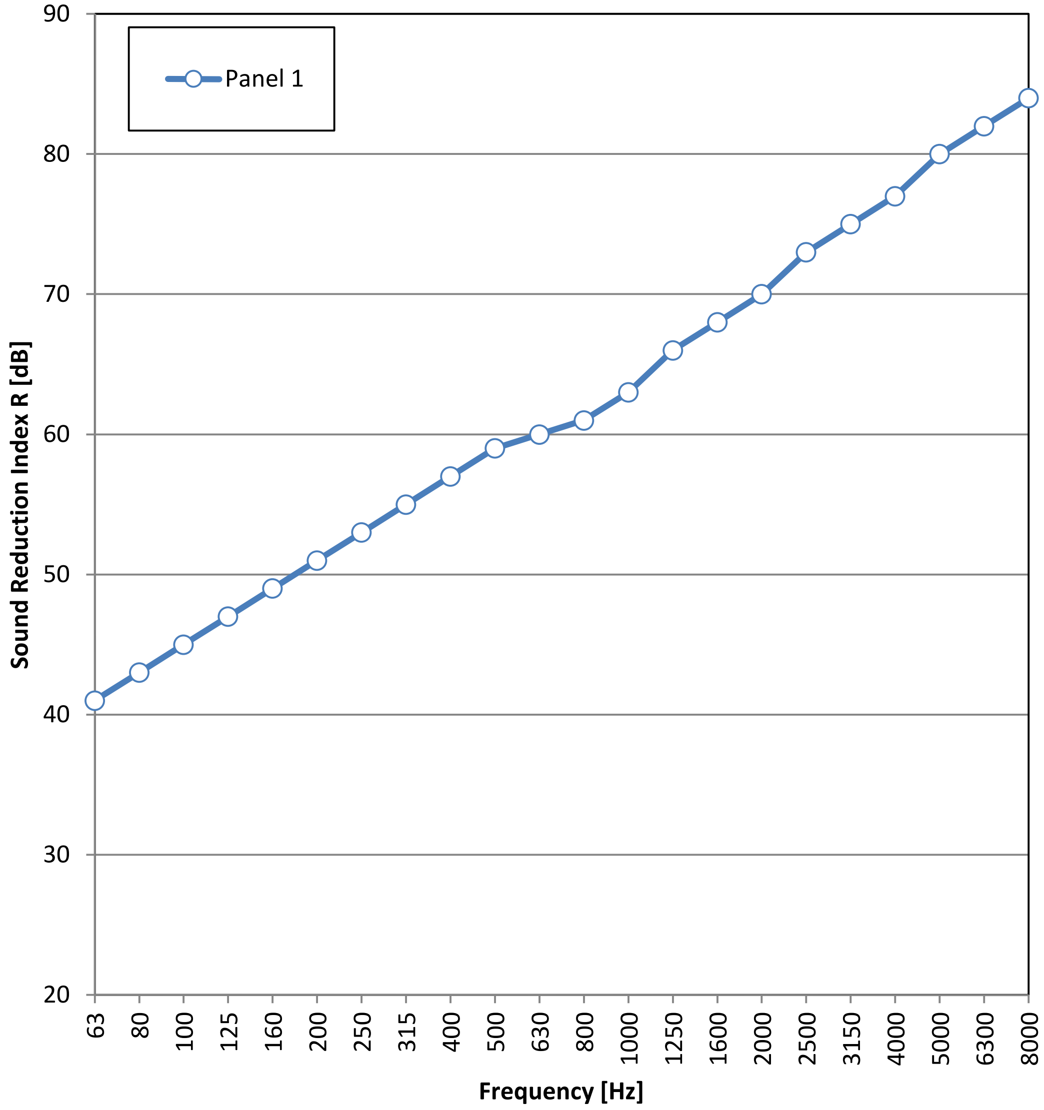
5 Results

Third-octave band random incidence air-borne sound reduction indices for the panels analysed in this assessment are shown graphically in Figure 5.1. The frequency-weighted sound reduction index R_w (estimate of D_{nT}) determined in accordance with ISO 717, serves as a single-figure measure of the overall sound insulation performance.

Compliance with Agrement certification criteria is summarised in Table 5.1.

Sound reduction index R [dB]

Determined by theoretical analysis



Frequency [Hz]	R [dB]
63	41
80	43
100	45
125	47
160	49
200	51
250	53
315	55
400	57
500	59
630	60
800	61
1 000	63
1 250	66
1 600	68
2 000	70
2 500	73
3 150	75
4 000	77
5 000	80
6 300	82
8 000	84
R_w	63

Figure 5.1

Fishnet and Bottle Building System

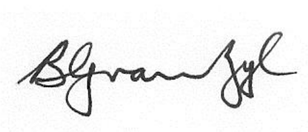
Panel 1 Wall constructed by hand-placed used PET bottles filled with sand, soil and fly-ash used as bricks bonded with a cement-sand slurry and reinforced with nylon fishnet. Plastered both sides with 25 mm thick cement.

Table 5.1

Agrement compliance evaluation

Fishnet and bottle Building System			D nT,w
Panel 1	230 mm soil-filled bottle wall plastered 25 mm both sides		63
	Estimated D nT,w = 63 dB	Acoustic evaluation	dB

Occupancy		Agrement Criteria			
Class	**Building Type**	**Between Space 1**	**And Space 2**	**D nT,w [dB]** Minimum	**Comply**
A3	Schools + Instruction	Classrooms, offices, libraries	Classrooms, offices	42	YES
			Outside (External Walls)	30	YES
B2+B3	Commercial	Shops	Offices same tenancy	37	YES
		Shops & Offices	Outside (External Walls)	30	YES
D2+D3	Industrial	Workshops	Offices same tenancy	37	YES
		Workshops & Offices	Outside (External Walls)	30	YES
F1	Shop Large	Shops	Offices same tenancy	37	YES
		Shops & Offices	Outside (External Walls)	30	YES
F2+F3	Shops Small	Shops	Offices same tenancy	37	YES
		Shops & Offices	Outside (External Walls)	30	YES
G1	Offices & Day Clinics	Offices	Offices other tenants	45	YES
		Offices	Offices same tenancy	37	YES
		Offices	Outside (External Walls)	30	YES
H1	Hotel	Bedroom	Bedroom	48	YES
		Bedroom	Recreation	48	YES
		Bedroom	Corridor, stairwell, laudry	48	YES
		Bedroom	Foyer, Lounge	43	YES
		Bedroom	Outside (External Walls)	30	YES
H2	Dormitories	Dormitories	Other dormitories	37	YES
	Hostels & Old Age	Bedroom	Bedrooms	42	YES
	School Residences	Bedroom	Bedrooms	45	YES
		Bedroom	Outside (External Walls)	30	YES
H3	Dwellings Attached	Dwelling	Dwelling Attached	45	YES
		Dwelling Rooms	Rooms same dwelling	33	YES
		Dwelling Rooms	Outside (External Walls)	30	YES
H4	Dwellings Detached	Dwelling	Detached dwellings	30	YES
		Dwelling Rooms	Rooms same dwelling	33	YES
		Dwelling Rooms	Outside (External Walls)	30	YES
E2+E3	Hospitals, Clinics	Theatres	Offices, Public Spaces	52	YES
		Wards	Consulting rooms, wards, ICU	47	YES
		Dispensaries, offices	Kitchens, machinery rooms	47	YES
		Theatres, wards, consulting	Outside (External Walls)	30	YES
		Consulting Rooms	Consulting rooms, wards, ICU	47	YES
		Consulting Rooms	Outside (External Walls)	30	YES



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