Prepare to be MATELYS *approved !*

Version 7.0

Validation Booklet

Ref. 2015-AlphaCell-v7.0-VB

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More information:

Full User's Guide

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Introduction

Welcome to the *Alpha*Cell validation booklet.

*Alpha*Cell is a software dedicated to the prediction of the acoustic performances of poroelastic materials. Not only its objective is to provide accurate results but also relevant results. It is aimed to be used by researchers, engineers, technicians and also by the developers themselves.

This booklet presents comparisons of simulations obtained using *Alpha*Cell with results reported in literature[1]. Simulation results are compared with experimental data and calculation results obtained using other approaches or software products. The corresponding references are given for each configuration.

Results are presented in the form of the 2 pages' report generated automatically with *Alpha*Cell. Sound absorption and sound transmission issues are presented. All sound excitations available are reviewed and documented. Discussed configurations include various types of materials: porous, screens, solids, perforated layers, double porosity materials, multi-layers systems ...

In the following configuration nomenclature,

- *Abs.* stands for sound absorption,
- *TL.* stands for sound transmission loss,
- *NI* stands for Normal Incidence (plane wave),
- *OI* stands for Oblique Incidence (plane wave)
- *DF* stands for Diffuse field,
- *TMM* corresponds to infinite lateral dimensions of the system,
- *FTMM* corresponds to finite lateral dimensions of the system.

The following simulations are compared with data extracted from copied or original PDF documents. Reader's attention is paid to the number of issues which may infer in the comparisons :

- different methods of calculation between *Alpha*Cell and reported results (diffuse field, spatial windowing, ...),
- missing, erroneous or misprinted informations concerning : materials parameters, dimensions, ... ,
- errors in the estimations of the missing informations,
- poor quality of copied documents resulting in errors in reported results.

[1] Literature data have been extracted using Plot Digitizer and Engauge Digitizer software products.

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1 *Abs. NI TMM : Single porous layer*

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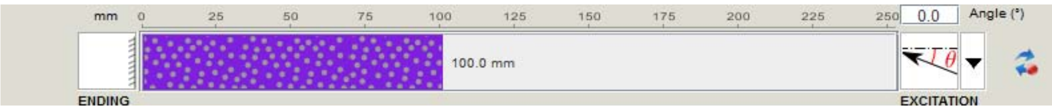
ValEx All93 Fig 5-15 ReZs

Geometry of the system



Plane wave (Angle 0.0°)

Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Fibrous AA09	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 100.0 (mm) σ = 9000 (N.s.m-4) φ = 0.99 α_infinity = 1 Λ = 1.92E-04 (m) Λ' = 3.84E-04 (m) ρ = 16 (kg.m-3) E = 440000 (Pa) η = 0.1 ν = 0

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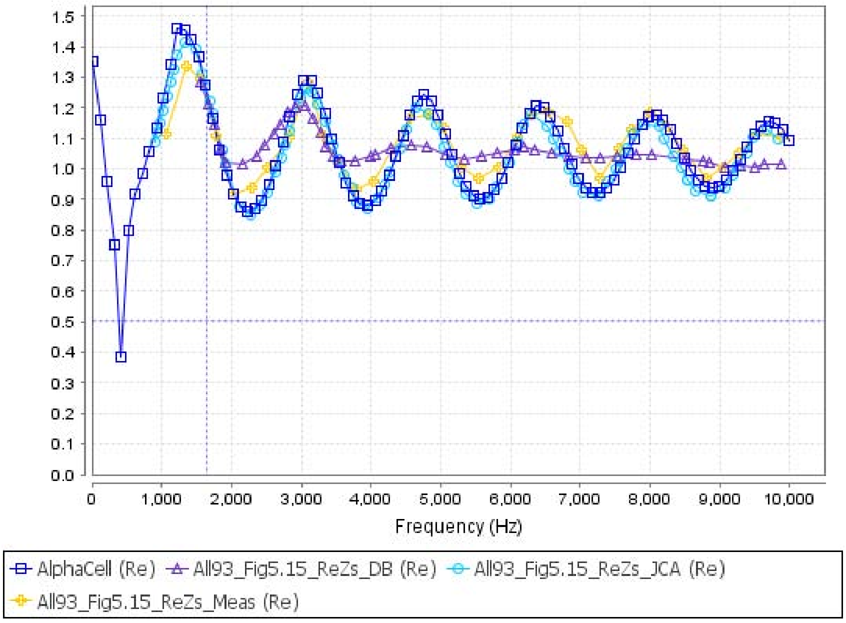
Simulation results

Normalized surface impedance (-)



Comments

Ref.
[1] Allard, J.-F., Propagation of Sound in Porous Media, Elsevier, Applied Science, New York, 283, (1993)
Fig 5.15 p. 108 - Real part

A good correspondance is observed between simulation results and measured data and data reported in [1] for the JCA model. However, for the DB model, correspondence is poor

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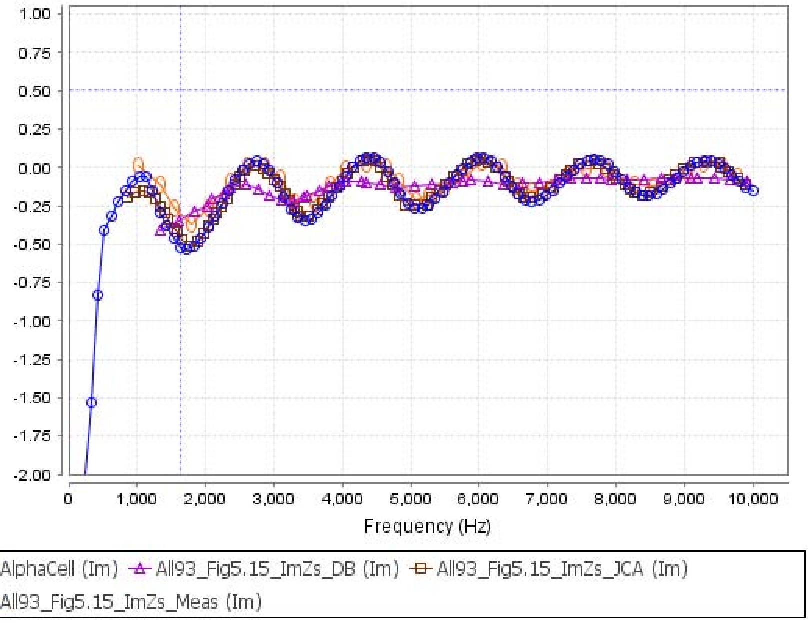
Simulation results

Normalized surface impedance (-)



Comments

Ref.
[1] Allard, J.-F., Propagation of Sound in Porous Media, Elsevier, Applied Science, New York, 283, (1993)
Fig 5.15 p. 108 - Imaginary part

A good correspondance is observed between simulation results and measured data and data reported in [1] for the JCA model. However, for the DB model, correspondence is poor

2 *Abs. NI TMM : Multi-layer system #1*

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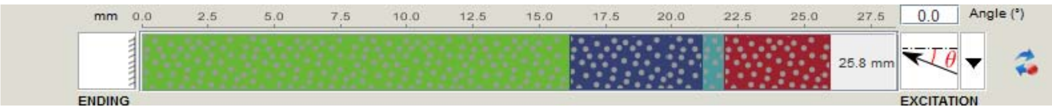
ValEx AA09 Fig 11-11 ReZs

Geometry of the system



Plane wave (Angle 0.0°)

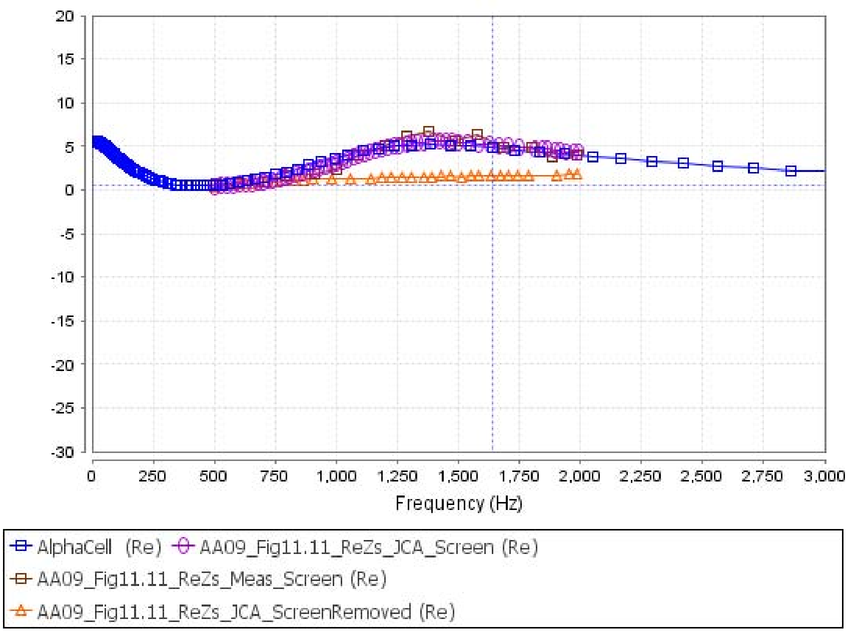
Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Foam 4 AA09 Fig11.11	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 16.0 (mm) σ = 65000 (N.s.m-4) φ = 0.99 α_infinity = 1.98 Λ = 3.7E-05 (m) Λ' = 1.2E-04 (m) ρ = 16 (kg.m-3) E = 46800 (Pa) η = 0.1 ν = 0.3
2	Foam 3 AA09 Fig11.11	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 5.0 (mm) σ = 87000 (N.s.m-4) φ = 0.97 α_infinity = 2.52 Λ = 3.6E-05 (m) Λ' = 1.18E-04 (m) ρ = 31 (kg.m-3) E = 143000 (Pa) η = 0.06 ν = 0.3
3	Screen 2 AA09 Fig11.11	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 0.8 (mm) σ = 3200000 (N.s.m-4) φ = 0.8 α_infinity = 2.56 Λ = 6E-06 (m) Λ' = 2.4E-05 (m) ρ = 125 (kg.m-3) E = 2600000 (Pa) η = 0.1 ν = 0.3
4	Blanket 1 AA09 Fig11.11	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 4.0 (mm) σ = 34000 (N.s.m-4) φ = 0.98 α_infinity = 1.18 Λ = 6E-05 (m) Λ' = 8.6E-05 (m) ρ = 41 (kg.m-3) E = 286000 (Pa) η = 0.01 ν = 0.3

Simulation results

Normalized surface impedance (-)



Comments

Ref.
[1] Allard, J. and Atalla, N., Propagation of sound in porous media: modelling sound absorbing materials, Wiley, 358, (2009)
Fig 11.11 p. 270 - Real part

A good correspondance is observed with results of [1].

Note that the value ranges of the Young moduli for the Foams are erroneous. One should read 10^3 instead of 10^6.

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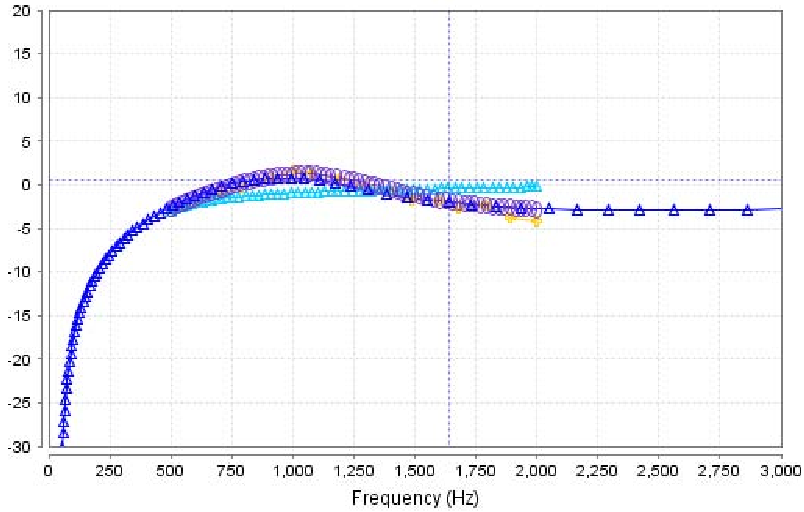
Simulation results

Normalized surface impedance (-)



AlphaCell (Im) AA09_Fig11.11_ImZs_JCA_Screen (Im)
AA09_Fig11.11_ImZs_JCA_ScreenRemoved (Im)
AA09_Fig11.11_ImZs_Meas_Screen (Im)

Comments

Ref.
[1] Allard, J. and Atalla, N., Propagation of sound in porous media: modelling sound absorbing materials, Wiley, 358, (2009)
Fig 11.11 p. 270 - Imaginary part

A good correspondance is observed with results of [1].

Note that the value ranges of the Young moduli for the Foams are erroneous. One should read 10^3 instead of 10^6.

3 *Abs. NI TMM : Screen + plenum, radiation correction*

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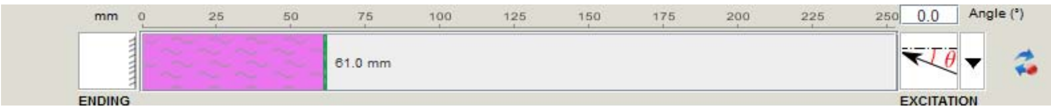
ValEx AS07 Fig 3

Geometry of the system



Plane wave (Angle 0.0°)
Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Air gap 60 mm AS07 Fig3	Acoustic: Air Elastic: None Heterogeneous: None	thickness: 60.0 (mm)
2	Panel 1 AS07 Fig 3	Acoustic: Screen Elastic: None Heterogeneous: None	thickness: 1.0 (mm) σ = 23440 (N.s.m-4) φ = 0.03 Correction = Static

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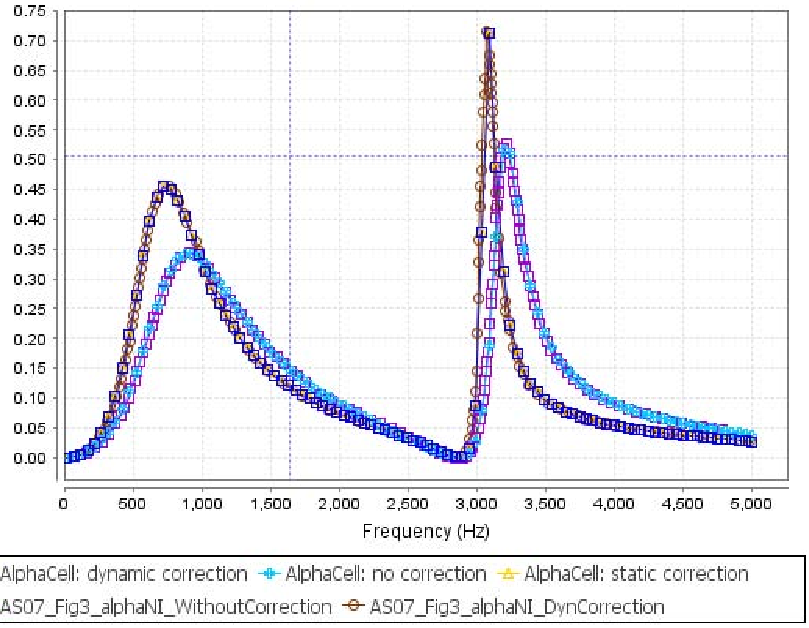
Simulation results

Sound absorption coefficient (-)



Comments

Ref
[1] Atalla, N. and Sgard, F., Modeling of perforated plates and screens using rigid frame porous models, J. Sound Vib., Vol. 303 (1-2), pp. 195-208 (2007)
Fig 3 p. 203 - Sound absorption

A good correspondance is observed with simulation results for both cases with and without tortuosity correction.

4 *Abs. NI TMM : Screen + porous + air plenum*

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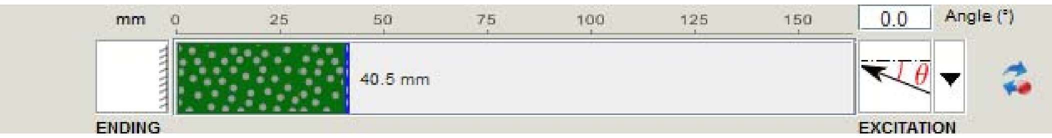
ValEx R200917 Without Plenum

Geometry of the system



Plane wave (Angle 0.0°)
Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Mineral wool R200917	Acoustic: JCAL Elastic: Rigid body Heterogeneous: None	thickness: 40.0 (mm) σ = 45200 (N.s.m-4) φ = 0.96 α_infinity = 1.08 Λ = 3.7E-05 (m) Λ' = 8.9E-05 (m) k'0 = 1E-09 (m-2) ρ = 89 (kg.m-3)
2	Screen R200917	Acoustic: Screen Elastic: None Heterogeneous: None	thickness: 0.5 (mm) σ = 826700 (N.s.m-4) φ = 0.16 Correction = Dynamic

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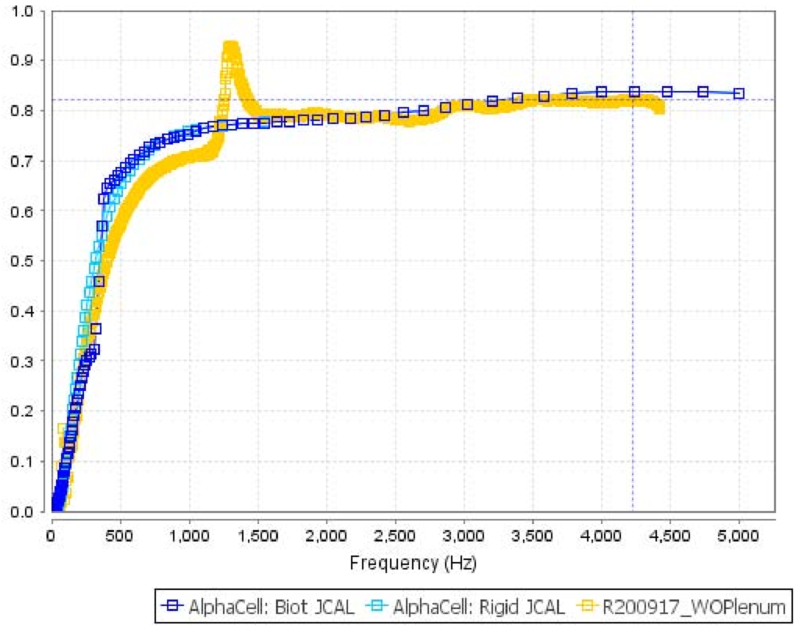
Simulation results

Sound absorption coefficient (-)



Comments

Ref.
MATELYS internal characterisation report R200917.

A good correspondence is observed between the simulation results and the measured data.

The simulation results have been obtained after the characterisation of the individual components of the muti-layer system considered here.

The deviations observed are mainly due to structural effects which are difficult to estimate in the impedance tube.

Note that the frequency range of validity of the measurements starts from 250 Hz

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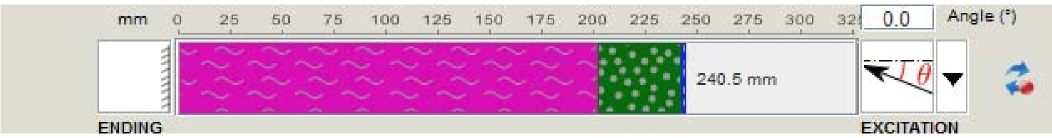
ValEx R200917 With Plenum

Geometry of the system



Plane wave (Angle 0.0°)
Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Air gap R200917	Acoustic: Air Elastic: None Heterogeneous: None	thickness: 200.0 (mm)
2	Mineral wool R200917	Acoustic: JCAL Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 40.0 (mm) σ = 45200 (N.s.m-4) φ = 0.96 α_infinity = 1.08 Λ = 3.7E-05 (m) Λ' = 8.9E-05 (m) k'0 = 1E-09 (m-2) ρ = 89 (kg.m-3) E = 250000 (Pa) η = 0.07 ν = 0
3	Screen R200917	Acoustic: Screen Elastic: None Heterogeneous: None	thickness: 0.5 (mm) σ = 826700 (N.s.m-4) φ = 0.16 Correction = Dynamic

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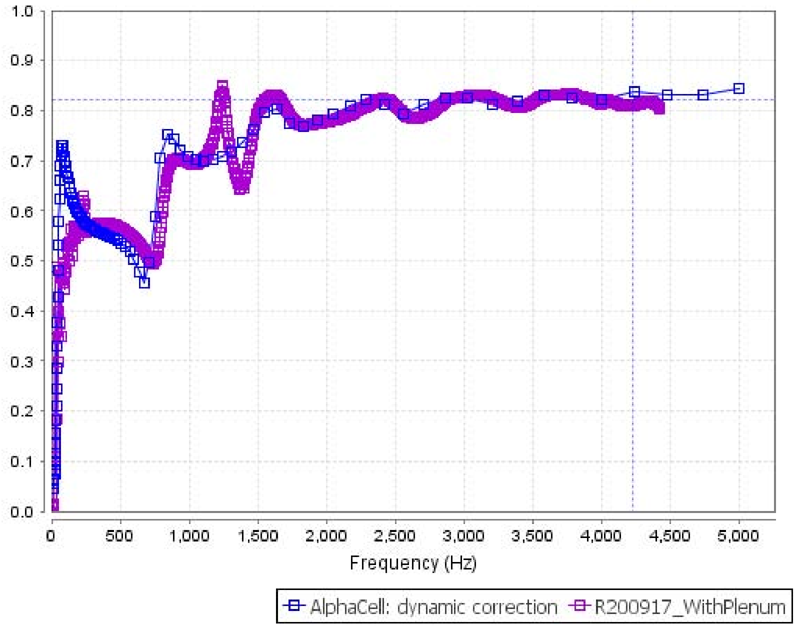
Simulation results

Sound absorption coefficient (-)



Indicators:

Simulation	αw	Rw (C; Ctr)	Lnw	ΔLw
AlphaCell: dynamic correction				
R200917_WithPlenum	0.65(H)			

Comments

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Ref.
MATELYS internal characterisation report R200917.

The Fibrous+Screen material considered previously is backed here by a 200 mm thick air plenum with no dissipation.

A good correspondence is observed between the simulation results and the measured data.

The simulation results have been obtained after the characterisation of the individual components of the muti-layer system considered here.

The deviations observed are mainly due to structural effects which are difficult to estimate in the impedance tube.

Note that the frequency range of validity of the measurements starts from 250 Hz.

5 Abs. NI TMM : Deformable double porosity medium

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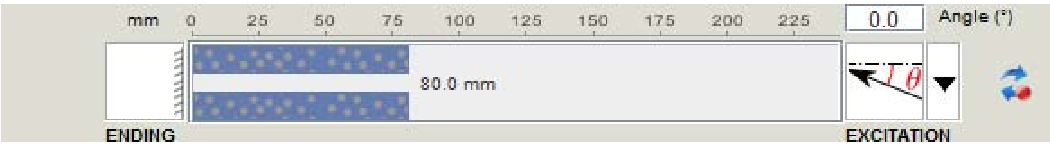
ValEx Double porosity with elastic effects

Geometry of the system



Plane wave (Angle 0.0°)
Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Fibrous SP Elastic DBJ12 Fig7	Acoustic: JCAL Elastic: Elastic (isotropic) Heterogeneous: Double Porosity	thickness: 80.0 (mm) σ = 88400 (N.s.m-4) φ = 0.97 α_infinity = 1.01 Λ = 2.3E-05 (m) Λ' = 5.1E-05 (m) k'0 = 1.3E-09 (m-2) ρ = 156 (kg.m-3) E = 5500000 (Pa) η = 0.3 ν = 0 φp = 0.2 Lp = 4.5E-02 (m) Pressure diffusion effect type: square in square Lpattern = 1E-01 (m)

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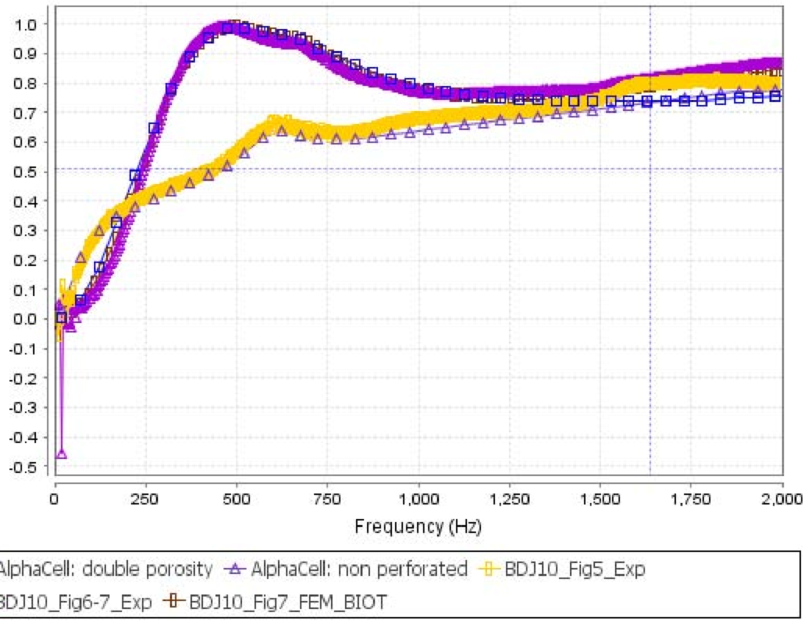
Simulation results

Sound absorption coefficient (-)



Comments

Ref.
[1] Dazel, O. and Bécot, F.-X. and Jaouen, L., Biot effects for sound absorbing double porosity materials, Acta Acustica united with Acustica, Vol. 98 (4), pp. 567-576 (2012) Fig 7

A good correspondence is observed between the simulations and the experimental data for both non perforated and perforated - double porosity materials.
The effects of the porous frame deformation is visible around 680 Hz.

6 *Abs. NI TMM : JCAPL model*

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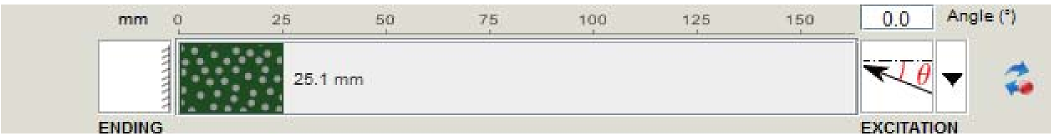
ValEx JCAPL model

Geometry of the system



Plane wave (Angle 0.0°)
Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Foam R1 PHBC+ Fig3a	Acoustic: JCA Elastic: None Heterogeneous: None	thickness: 25.05 (mm) σ = 7159 (N.s.m-4) φ = 0.98 α_infinity = 1.02 Λ = 2.91E-04 (m) Λ' = 4.99E-04 (m)

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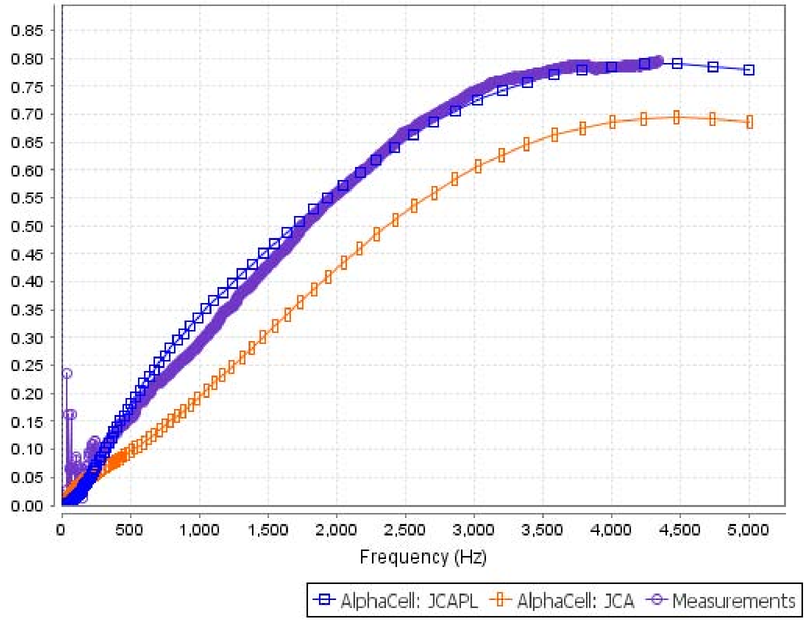
Simulation results

Sound absorption coefficient (-)



Comments

Ref.
[1] Perrot, C. and Chevillotte, F. and Hoang, M. T. and Bonnet, G. and Becot, F.-X. and Gautron, L. and Duval, A., Microstructure, transport, and acoustic properties of open-cell foam samples: Experiments and three-dimensional numerical simulations, Journal of Applied Physics, Vol. 111 (1), pp. 014911 (2012)

The correspondence between the simulations using the JCAPL model (8 parameters) and the measured data is good while the correspondence with the JCA model is poor.

7 *Abs NI : Impervious Screen*

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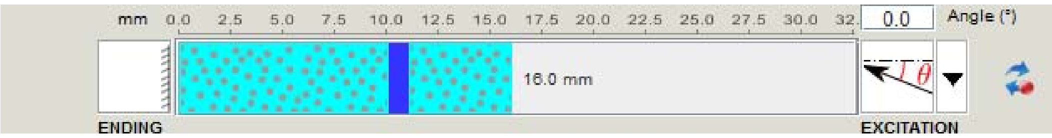
Impervious Screen Vs Septum modelling

Geometry of the system



Plane wave (Angle 0.0°)
Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Fibreux PoroEl	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 10.0 (mm) σ = 120000 (N.s.m-4) φ = 0.95 α_infinity = 1.01 Λ = 1E-04 (m) Λ' = 2E-04 (m) ρ = 120 (kg.m-3) E = 1000000 (Pa) η = 0.1 ν = 0
2	septum	Acoustic: None Elastic: Septum Heterogeneous: None	thickness: 1.0 (mm) ρ = 100 (kg.m-3) Bonded = true
3	Fibreux PoroEl	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 5.0 (mm) σ = 120000 (N.s.m-4) φ = 0.95 α_infinity = 1.01 Λ = 1E-04 (m) Λ' = 2E-04 (m) ρ = 120 (kg.m-3) E = 1000000 (Pa) η = 0.1 ν = 0

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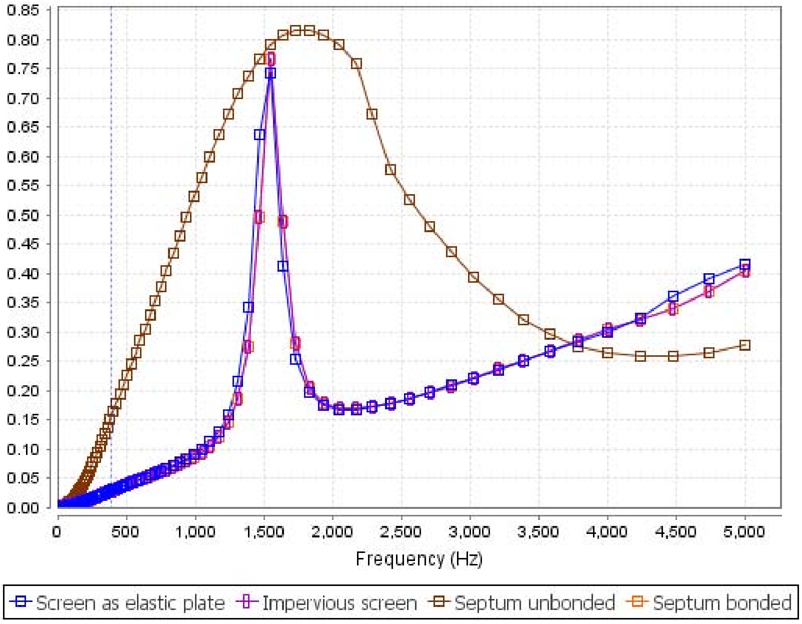
Simulation results

Sound absorption coefficient (-)



Comments

These simulations show that the "imprevious screen" model is equivalent to the "septum bonded" model.

The effect of the non-bonding condition is clearly observed when comparing the "septum unbonded" model with the two above simulations.

Finally, when comparing with the "elastic plate" model, it may be concluded that the Young's modulus has very little effect. This is due to the fact that the screen is very thin.

Note : the bonded condition (or not-bonded) is applied simultaneously on both faces of the septum.

8 *Abs. DF FTMM : Single porous layer #1*

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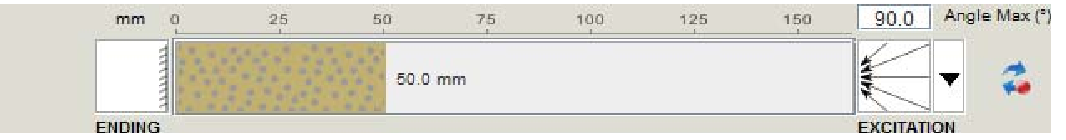
ValEx FTMM Absorption

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Mineral wool Ham84 Fig1	Acoustic: Delany-Bazley-Miki Elastic: None Heterogeneous: None	thickness: 50.0 (mm) σ = 11400 (N.s.m-4)

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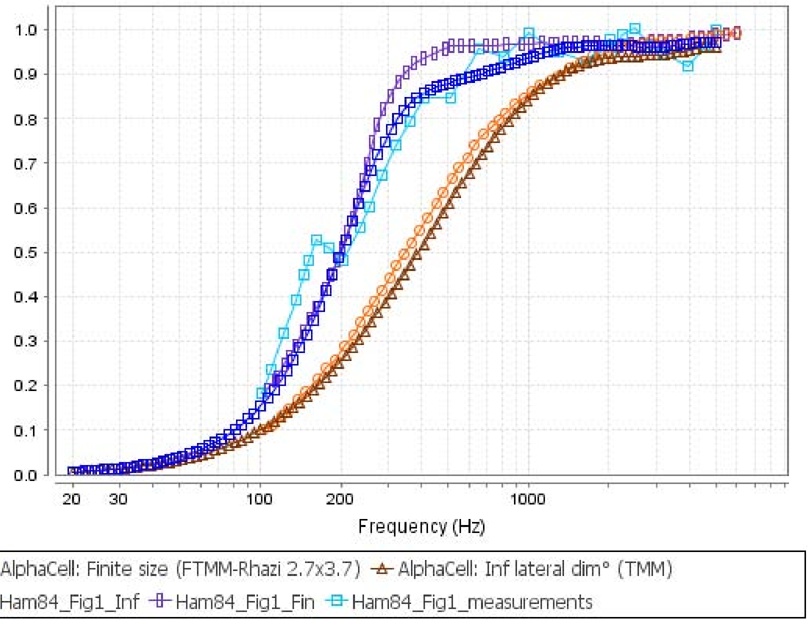
Simulation results

Sound absorption coefficient (-)



Indicators:

Simulation	αw	LiA	Lnw	ΔLw
AlphaCell: Finite size (FTMM-Rhazi 2.7x3.7)	0.9			
AlphaCell: Inf lateral dim° (TMM)	0.6(MH)			
Ham84_Fig1_Inf	0.65(H)			
Ham84_Fig1_Fin	0.95			
Ham84_Fig1_measurements	0.85			

Comments

Ref.
[1] Hamet, J. F., Coefficient d'absorption acoustique en champ diffus d'un matériau plan, rectangulaire, de dimensions finies, posé sur une surface infinie parfaitement réfléchissante, Revue d'Acoustique, Vol. 71 pp. 204-210 (1984)

A good correspondence is observed between the simulated results using the spatial windowing and the experimental data.

9 *Abs. Modal : Single porous layer*

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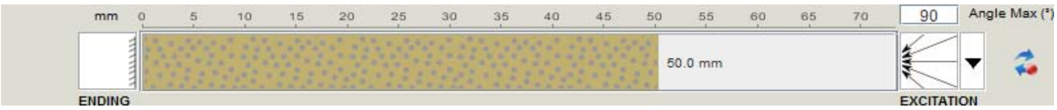
ValEx Modal Sound Field Absorption

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: None

Materials and Models

	Layer name	Model	Parameters
1	Mineral wool Ham84 Fig1	Acoustic: Delany-Bazley-Miki Elastic: None Heterogeneous: None	thickness: 50.0 (mm) σ = 11400 (N.s.m-4)

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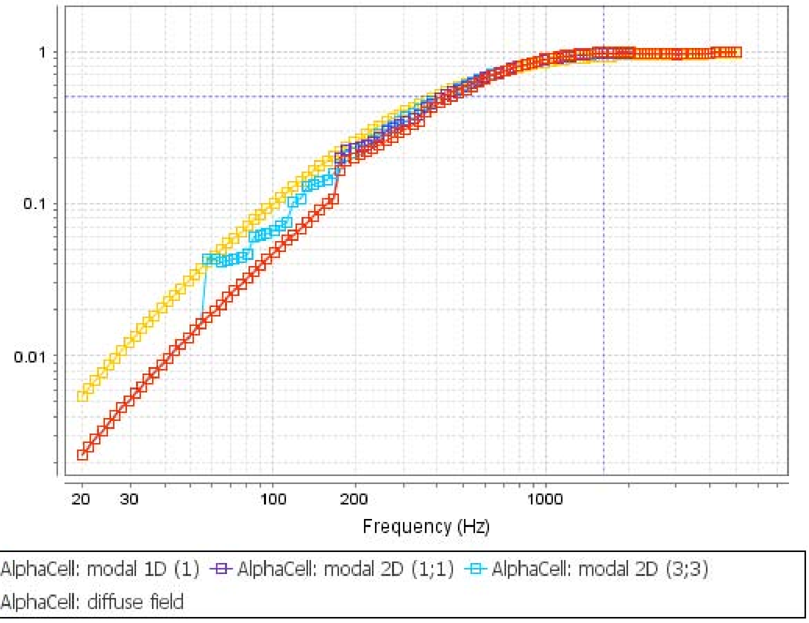
Simulation results

Sound absorption coefficient (-)



Indicators:

Simulation	α_w	NRC	SAA	ΔL_w
AlphaCell: modal 1D (1)	0.55(MH)	0.65	0.67	
AlphaCell: modal 2D (1;1)	0.6(MH)	0.7	0.68	
AlphaCell: modal 2D (3;3)	0.6(MH)	0.7	0.68	
AlphaCell: diffuse field	0.6(MH)	0.7	0.68	

Comments

This figure compares the sound absorption coefficient calculated for three types of excitations :
- 1D modal sound field (red)
- 2D modal sound field (purple)
- 2D modal sound field with a higher modal density (blue)
- diffuse sound field conditions (yellow)

These results show that the modal sound field excitation tends to diffuse sound field with an increasing number of modes accounted for in the computation.

This observation is also valid for sound transmission loss computations.

10 *TL NI TMM : Porous layer + Solid*

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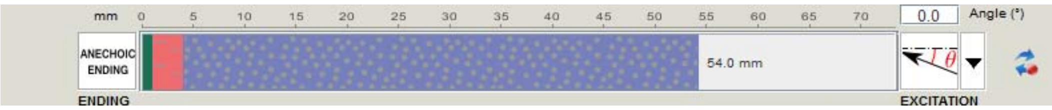
ValEx AA09 Fig 11.18

Geometry of the system



Plane wave (Angle 0.0°)
Spatial windowing: None

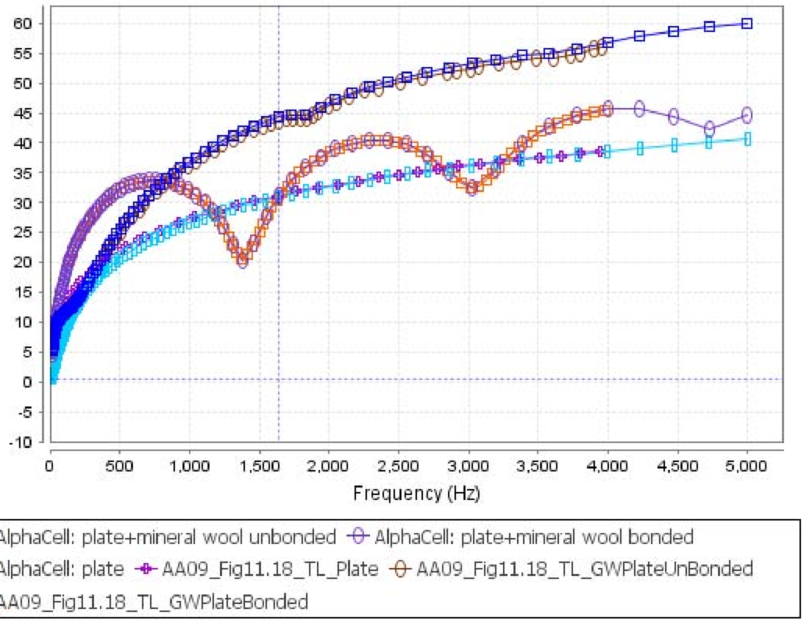
Materials and Models

	Layer name	Model	Parameters
1	Plate AA09 Fig11.18	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 1.0 (mm) ρ = 2800 (kg.m-3) E = 70000000000 (Pa) η = 0.01 ν = 0.3
2	Air gap 3 mm	Acoustic: Air (Dissipative) Elastic: None Heterogeneous: None	thickness: 3.0 (mm) R = 2.3E-02 (m)
3	Glass wool AA09 Fig11.18	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 50.0 (mm) σ = 40000 (N.s.m-4) φ = 0.94 α_infinity = 1.06 Λ = 5.6E-05 (m) Λ' = 1.1E-04 (m) ρ = 130 (kg.m-3) E = 4400000 (Pa) η = 0.1 ν = 0

2/2/2015

Simulation results

Transmission loss (dB)



Comments

Ref.
[1] Allard, J. and Atalla, N., Propagation of sound in porous media: modelling sound absorbing materials, Wiley, 358, (2009)
Fig 11.18 p. 276

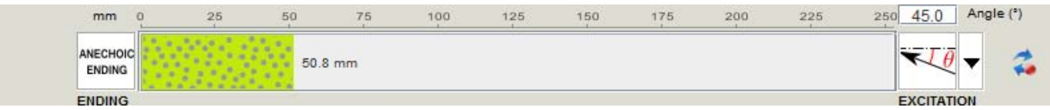
A good correspondance is observed with results of [1] for the three configurations tested here.

11 *TL OI FTMM : Porous layer*

2/2/2015

ValEx ASA06 Fig4

Geometry of the system



Plane wave (Angle 45.0°)

Spatial windowing: D. Rhazi, Lx = 0.5 m, Ly = 0.5 m

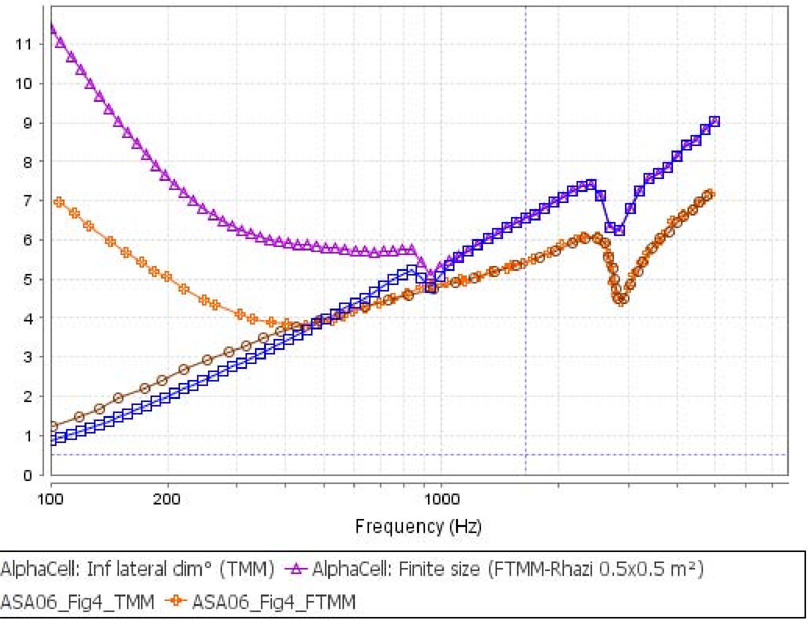
Materials and Models

	Layer name	Model	Parameters
1	Foam ASA06 Fig4	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 50.8 (mm) σ = 10900 (N.s.m-4) φ = 0.99 α_infinity = 1.02 Λ = 1.3E-04 (m) Λ' = 1.92E-04 (m) ρ = 8.43 (kg.m-3) E = 195000 (Pa) η = 0.05 ν = 0.42

2/2/2015

Simulation results

Transmission loss (dB)



Comments

Ref
[1] Atalla, N. and Sgard, F. and Amedin, C. K., On the modeling of sound radiation from poroelastic materials, J. Ac. Soc. Am., Vol. 120 (4), pp. 1990-1995 (2006)

The general behaviour observed here when taking into account the finite lateral dimensions of the tested sample corresponds to that observed in [1].

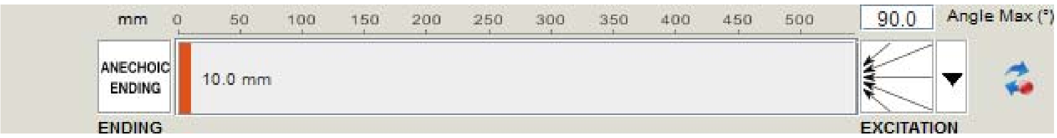
The levels compare well with those reported in [1] above 400 Hz, probably because of erroneous informations about the material parameters.

12 TL DF FTMM : Solid single layer

3/2/2015

ValEx VG05 Fig6

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: D. Rhazi, Lx = 1.48 m, Ly = 1.23 m

Materials and Models

	Layer name	Model	Parameters
1	Glazing VG05 Fig6	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 10.0 (mm) ρ = 2500 (kg.m-3) E = 62000000000 (Pa) η = 0.05 ν = 0.22

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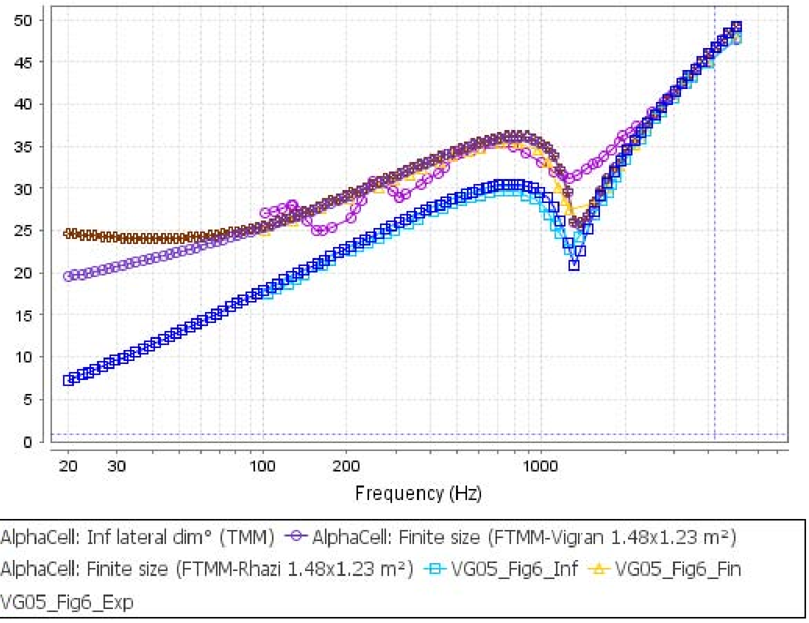
Simulation results

Transmission loss (dB)



Indicators:

Simulation	Rw (C; Ctr)	Lnw	ΔLw	NRC
AlphaCell: Inf lateral dim° (TMM)	30.0 (-2.0;-3.0)	86.0		
AlphaCell: Finite size (FTMM-Vigran 1.48x1.23 m²)	34.0 (-2.0;-2.0)	85.0		
AlphaCell: Finite size (FTMM-Rhazi 1.48x1.23 m²)	35.0 (-3.0;-3.0)	85.0		
VG05_Fig6_Inf	-1.0 (-1.0;-1.0)			
VG05_Fig6_Fin	-1.0 (-1.0;-1.0)			
VG05_Fig6_Exp	-1.0 (-1.0;-1.0)			

Comments

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3/2/2015

Ref.
[1] Villot, M. and Guigou, C., Using spatial windowing to take the finite size of plane structures into account in sound transmission, In Proceedings of NOVEM 2005 (2005) Fig 6 p.7

A good correspondence is observed between the simulations and the experimental data for both infinite size and spatially windowed system.

Indicators are not computed for imported (calc & meas) data because the frequency range do not match the required bands of ISO 717-1.

13 *TL DF FTMM : Solid double layer*

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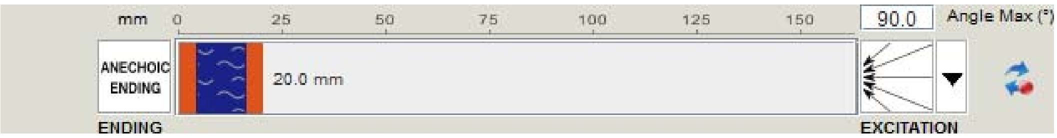
ValEx VG05 Fig7

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: D. Rhazi, Lx = 1.48 m, Ly = 1.23 m

Materials and Models

	Layer name	Model	Parameters
1	Glazing VG05 Fig7	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 4.0 (mm) ρ = 2500 (kg.m-3) E = 62000000000 (Pa) η = 0.05 ν = 0.22
2	Air gap 12 mm VG05 Fig7	Acoustic: Air (Dissipative) Elastic: None Heterogeneous: None	thickness: 12.0 (mm) R = 1E-02 (m)
3	Glazing VG05 Fig7	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 4.0 (mm) ρ = 2500 (kg.m-3) E = 62000000000 (Pa) η = 0.05 ν = 0.22

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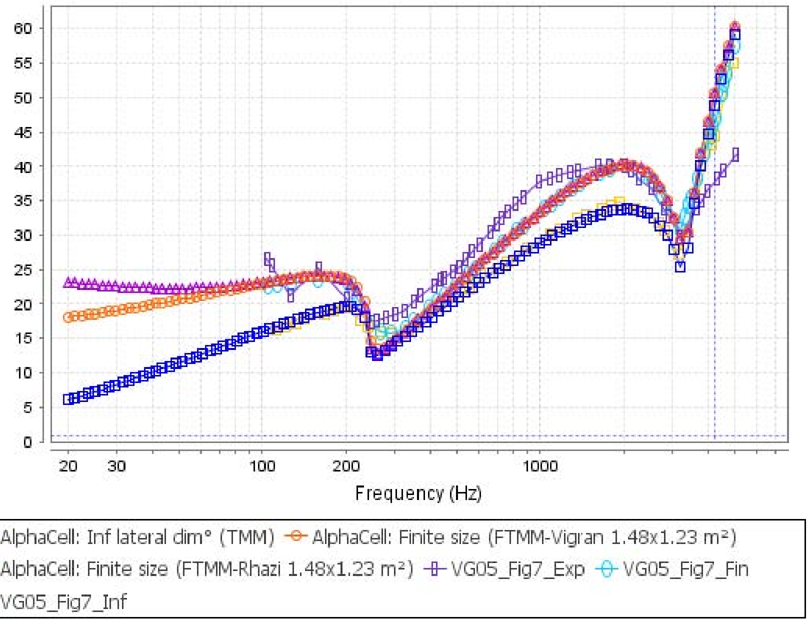
Simulation results

Transmission loss (dB)



Indicators:

Simulation	Rw (C; Ctr)	Lnw	ΔLw	NRC
AlphaCell: Inf lateral dim° (TMM)	25.0 (0.0;-3.0)	88.0		
AlphaCell: Finite size (FTMM-Vigran 1.48x1.23 m²)	27.0 (0.0;-3.0)	85.0		
AlphaCell: Finite size (FTMM-Rhazi 1.48x1.23 m²)	28.0 (-1.0;-4.0)	85.0		
VG05_Fig7_Exp	-1.0 (-1.0;-1.0)			
VG05_Fig7_Fin	-1.0 (-1.0;-1.0)			
VG05_Fig7_Inf	-1.0 (-1.0;-1.0)			

Comments

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3/2/2015

Ref.
[1] Villot, M. and Guigou, C., Using spatial windowing to take the finite size of plane structures into account in sound transmission, In Proceedings of NOVEM 2005 (2005) Fig 7 p.7

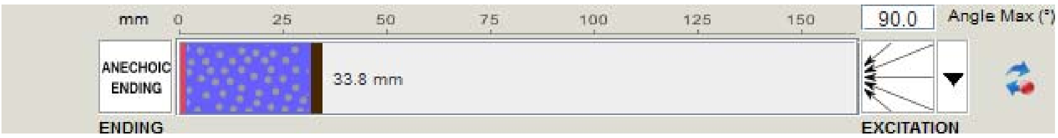
A good correspondence is observed between the simulations and the experimental data for both infinite size and spatially windowed system.

14 *TL DF : Sandwich*

3/2/2015

ValEx PT07 Fig7

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: D. Rhazi, Lx = 1.3 m, Ly = 1.3 m

Materials and Models

	Layer name	Model	Parameters
1	Steel plate PT07 Fig7-10	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 0.75 (mm) ρ = 7850 (kg.m-3) E = 200000000000 (Pa) η = 0.03 ν = 0.3
2	Mineral wool PT07 Fig7	Acoustic: Delany-Bazley-Miki Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 30.0 (mm) σ = 34000 (N.s.m-4) ρ = 90 (kg.m-3) E = 400000 (Pa) η = 0.1 ν = 0
3	Laminate PT07 Fig7	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 3.0 (mm) ρ = 1360 (kg.m-3) E = 600000000 (Pa) η = 0.15 ν = 0.15

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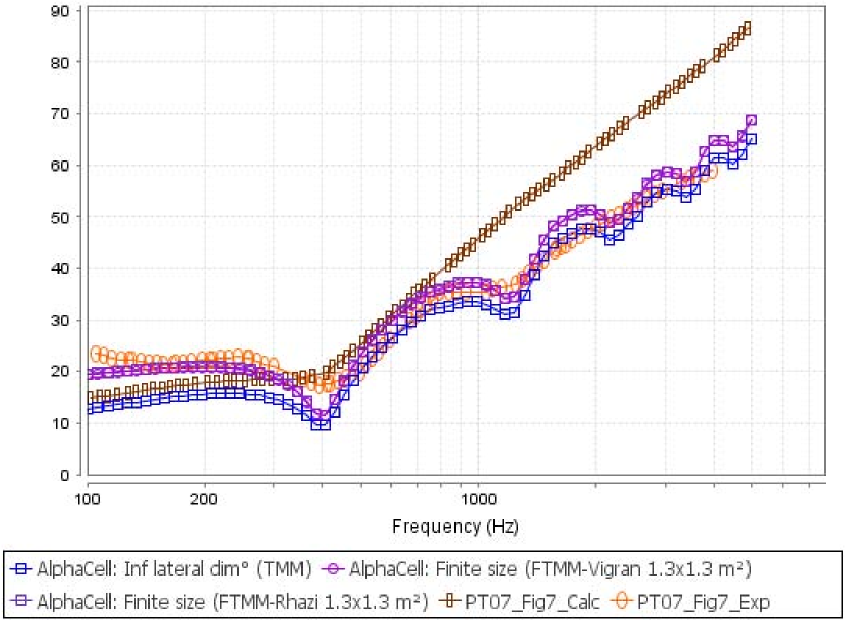
Simulation results

Transmission loss (dB)



Indicators:

Simulation	αw	Rw (C; Ctr)	Lnw	ΔLw
AlphaCell: Inf lateral dim° (TMM)		25.0 (-2.0;-5.0)	84.0	
AlphaCell: Finite size (FTMM-Vigran 1.3x1.3 m²)		29.0 (-3.0;-6.0)	79.0	
AlphaCell: Finite size (FTMM-Rhazi 1.3x1.3 m²)		29.0 (-3.0;-6.0)	79.0	
PT07_Fig7_Calc		-1.0 (-1.0;-1.0)		
PT07_Fig7_Exp		-1.0 (-1.0;-1.0)		

Comments

Ref.
[1] Pellicier, A. and Trompette, N., A review of analytical methods, based on the wave approach, to compute partitions transmission loss, Applied Ac., Vol. 68 pp. 1192-1212 (2007)
Fig 7 p.1202

A good correspondence is observed with the measurements reported in [1]. Calculations reported in [1] deviate from these two sets of results.
The levels measured at low frequency are correctly captured by applying the spatial windowing.

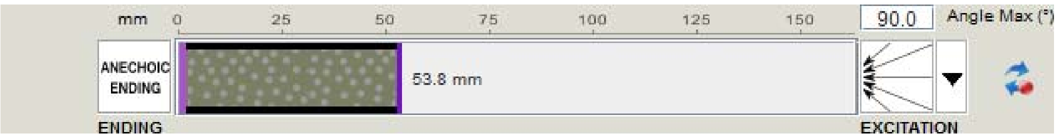
Note that a Delany-Bazley-Miki model together with poro-elastic effects has been used for the Mineral wool.

15 *TL DF Stud : Full porous filling*

3/2/2015

LA09 Stud modelling

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: T.E. Vigran, Lx = 1.22 m, Ly = 2.03 m

Materials and Models

	Layer name	Model	Parameters
1	LA09 Aluminum plate	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 2.0 (mm) ρ = 2742 (kg.m-3) E = 70000000000 (Pa) η = 0.01 ν = 0.33
2	LA09 - Stud Point	Acoustic: None Elastic: None Heterogeneous: Stud	thickness: 50.8 (mm) Connection type = Point Ks = 5E06 (N.m-1) Ms = 0E00 (Kg) ηs= 0.5 Lp = 1E-01 (m) Lh = 5.1E-01 (m) Lv = 1.22E00 (m)
3	LA09 Aluminum plate 2	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 1.0 (mm) ρ = 2742 (kg.m-3) E = 70000000000 (Pa) η = 0.01 ν = 0.33

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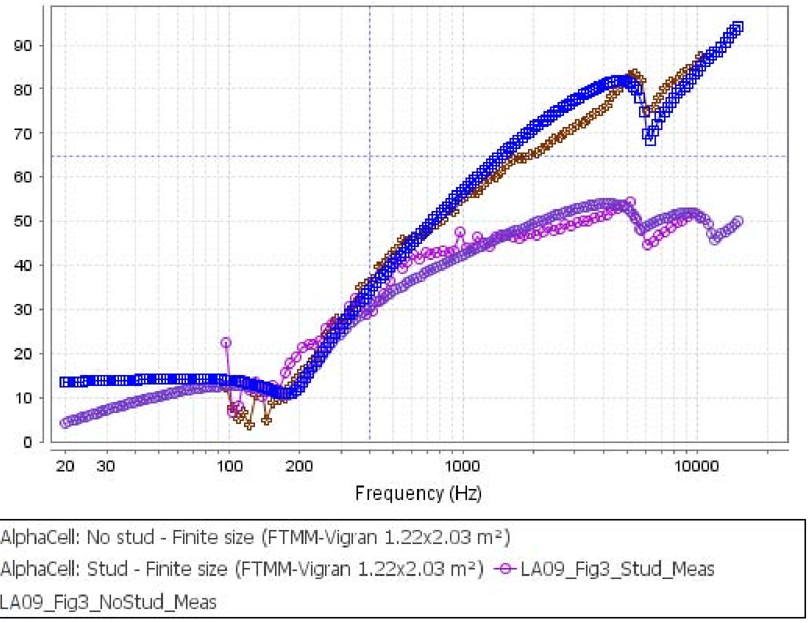
Simulation results

Transmission loss (dB)



Indicators:

Simulation	Rw (C; Ctr)	Lnw	NRC	ΔLw
AlphaCell: No stud - Finite size (FTMM-Vigran 1.22x2.03 m²)	33.0 (-4.0;-9.0)	81.0		
AlphaCell: Stud - Finite size (FTMM-Vigran 1.22x2.03 m²)	32.0 (-3.0;-8.0)	82.0		
LA09_Fig3_Stud_Meas	34.0 (-3.0;-8.0)			
LA09_Fig3_NoStud_Meas	31.0 (-3.0;-9.0)			

Comments

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Ref.
[1] Legault, J. and Atalla, N., Numerical and experimental investigation of the effect of structural links on the sound transmission of a lightweight double panel structure, J. Sound Vib., Vol. 324 pp. 712-732 (2009)

C-section stud.

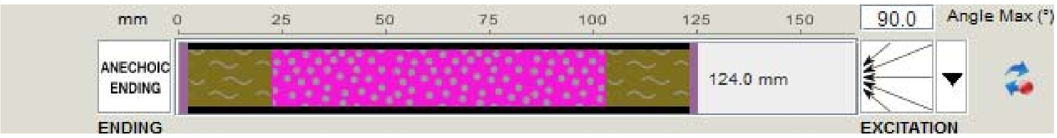
A good correspondence is observed between the simulations and the experimental data for both stud and no stud configuration.

16 TL DF Stud : Partial porous filling

3/2/2015

HLH02 Stud modelling

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: T.E. Vigran, Lx = 1.105 m, Ly = 2.25 m

Materials and Models

	Layer name	Model	Parameters
1	HLH02 Fig7b Steel plate	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 2.0 (mm) ρ = 7800 (kg.m-3) E = 200000000000 (Pa) η = 0.01 ν = 0.3
2	HLH02 Fig7b Stud with porous filling - Stud	Acoustic: None Elastic: None Heterogeneous: Stud	thickness: 120.0 (mm) Connection type = Line K's = 5E08 (N.m-1/m) M's = 0E00 (Kg/m) ηs= 0.1 Lh = 1.1E00 (m) Lv = 2.25E00 (m)
3	HLH02 Fig7b Steel plate	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 2.0 (mm) ρ = 7800 (kg.m-3) E = 200000000000 (Pa) η = 0.01 ν = 0.3

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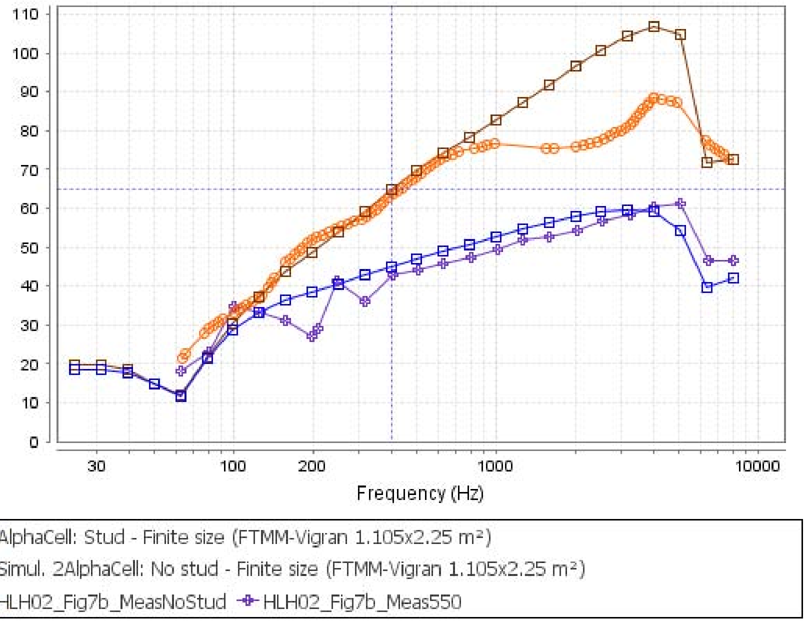
Simulation results

Transmission loss (dB)



Indicators:

Simulation	Rw (C; Ctr)	NRC	Lnw	ΔLw
AlphaCell: Stud - Finite size (FTMM-Vigran 1.105x2.25 m²)	50.0 (-1.0;-6.0)		65.0	
Simul. 2AlphaCell: No stud - Finite size (FTMM-Vigran 1.105x2.25 m²)	62.0 (-5.0;-13.0)		54.0	
HLH02_Fig7b_MeasNoStud	28.0 (-19.0;-19.0)			
HLH02_Fig7b_Meas550	47.0 (-2.0;-6.0)			

Comments

Ref.
[1] Hongisto, V. and Lindgren, M. and Helenius, R., Sound Insulation of Double Walls – An Experimental Parametric Study, Acustica united with Acta Acustica, Vol. 88 pp. 904 – 923 (2002)

A good correspondence is observed between the simulations and the experimental data for both stud or no stud configuration.

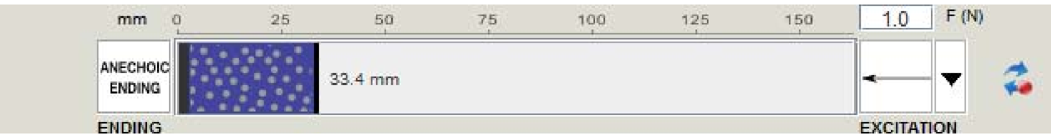
For the configuration without studs, the difference between measurements and simulation results observed between 1 000 and 5 000 Hz is probably due to difficulty in measuring such a high dynamic range.

17 *Single Force : Quad Vel (Emission), Rad Power (Reception), Insertion loss*

3/2/2015

Point force modelling

Geometry of the system



Force (F= 1 (N))

Spatial windowing: D. Rhazi, Lx = 1.0 m, Ly = 1.0 m

Materials and Models

	Layer name	Model	Parameters
1	HL	Acoustic: None Elastic: Septum Heterogeneous: None	thickness: 2.44 (mm) ρ = 1000 (kg.m-3) Bonded = true
2	foam	Acoustic: JCA Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 30.0 (mm) σ = 22000 (N.s.m-4) φ = 0.98 α_infinity = 1.9 Λ = 8.7E-05 (m) Λ' = 1.46E-04 (m) ρ = 30 (kg.m-3) E = 290000 (Pa) η = 0.18 ν = 0.2
3	acier	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 1.0 (mm) ρ = 7800 (kg.m-3) E = 210000000000 (Pa) η = 0.01 ν = 0.3

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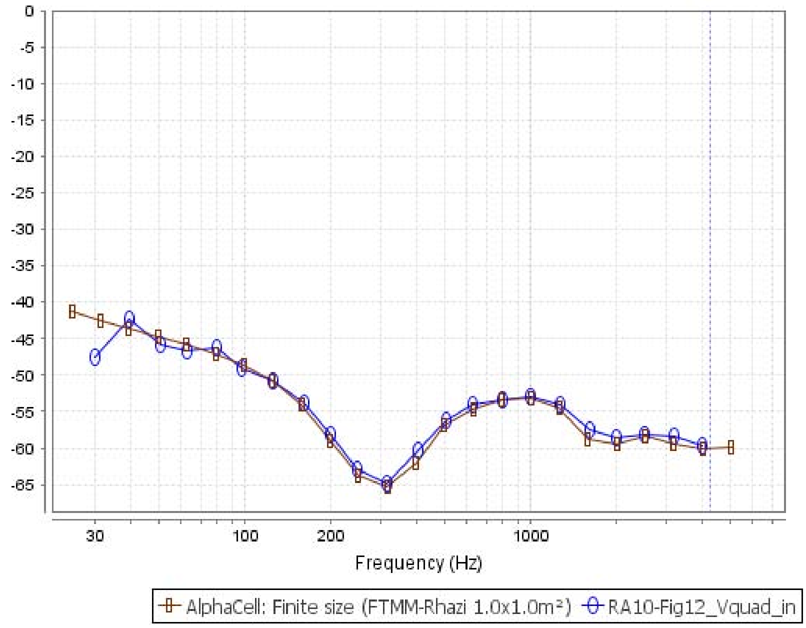
Simulation results

Quad. velocity (Emission) (dB)



Indicators:

Simulation	αw	Rw (C; Ctr)	Lnw	ΔLw
AlphaCell: Finite size (FTMM-Rhazi 1.0x1.0m²)			81.0	
RA10-Fig12_Vquad_in				

Comments

Ref.
[1] Rhazi, D. and Atalla, N., Transfer matrix modeling of the vibroacoustic response of multi-materials structures under mechanical excitation, J. Sound Vib., Vol. 329 pp. 2532-2546 (2010)
Fig. 12

The correspondence with the reference data is good.

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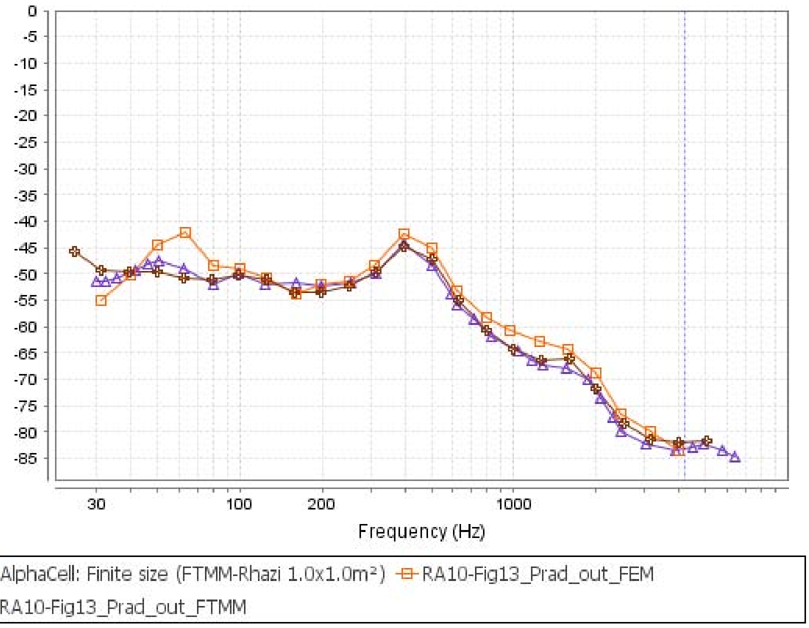
Simulation results

Radiated power (Reception) (dB)



Indicators:

Simulation	α_w	Rw (C; Ctr)	Lnw	ΔL_w
AlphaCell: Finite size (FTMM-Rhazi 1.0x1.0m²)			81.0	
RA10-Fig13_Prad_out_FEM				
RA10-Fig13_Prad_out_FTMM				

Comments

Ref.
[1] Rhazi, D. and Atalla, N., Transfer matrix modeling of the vibroacoustic response of multi-materials structures under mechanical excitation, J. Sound Vib., Vol. 329 pp. 2532-2546 (2010)
Fig. 13

The correspondence with the data obtained using FTMM (ref) and FEM (ref) is good.

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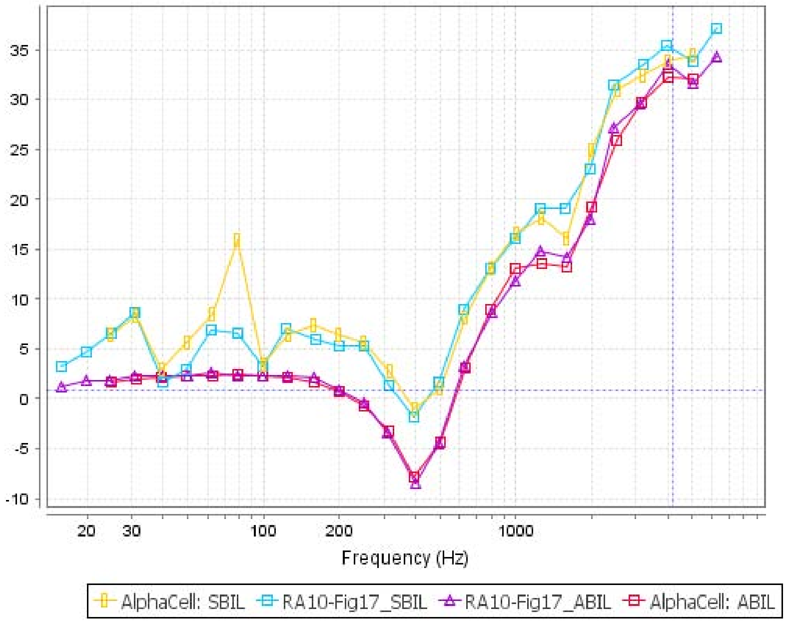
Simulation results

IL (dB)



Indicators:

Simulation	Rw (C; Ctr)	Lnw	ΔLw	NRC
AlphaCell: SBIL		81.0	17.0	
RA10-Fig17_SBIL				
RA10-Fig17_ABIL				
plate_steel_rhazi		102.0		
AlphaCell: ABIL	30.0 (-2.0;-5.0)			

Comments

Ref.
[1] Rhazi, D. and Atalla, N., Transfer matrix modeling of the vibroacoustic response of multi-materials structures under mechanical excitation, J. Sound Vib., Vol. 329 pp. 2532-2546 (2010)
Fig. 17

The correspondence with the reference data is good for both the "air-borne insertion loss" and the "structure borne insertion loss".

18 *Tapping Machine :* L_n, ΔL_w

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Tapping machine modelling

Geometry of the system

Tapping Machine
Spatial windowing: T.E. Vigran, Lx = 3.6 m, Ly = 4.2 m

Materials and Models

	Layer name	Model	Parameters
1	ConcreteCraik	Acoustic: None Elastic: Visco (isotropic) Heterogeneous: None	thickness: 140.0 (mm) ρ = 2321 (kg.m-3) E = 37000000000 (Pa) η = 0.33@10 Hz ; 0.03@10000 Hz (Pa) ν = 0.23 (Pa)
2	souscouche	Acoustic: JCAL Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 30.0 (mm) σ = 63000 (N.s.m-4) φ = 1 α_infinity = 1.3 Λ = 3.7E-05 (m) Λ' = 7.2E-05 (m) k'0 = 1.3E-09 (m-2) ρ = 103 (kg.m-3) E = 600000 (Pa) η = 0.25 ν = 0
3	chape	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 40.0 (mm) ρ = 2250 (kg.m-3) E = 20000000000 (Pa) η = 0.03 ν = 0.15

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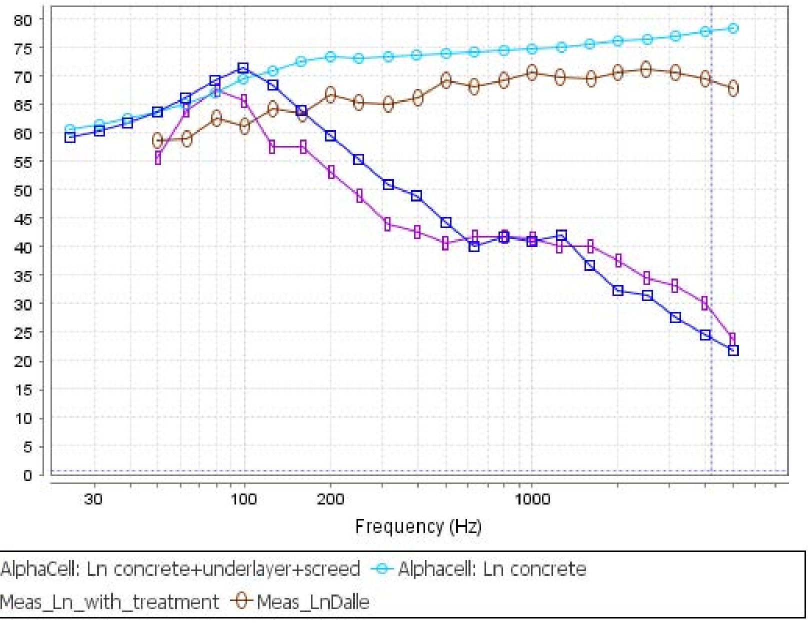
Simulation results

Ln (dB)



Indicators:

Simulation	Rw (C; Ctr)	Lnw	ΔLw	NRC
AlphaCell: Ln concrete+underlayer+screed		56.0	25.0	
Alphacell: Ln concrete		82.0		
Meas_DeltaL				
Meas_Ln_with_treatment				
Meas_LnDalle				

Comments

Ref.
internal measurements of sound pressure levels in the receiving room due to tapping machine, without and with underlayer+screed.

Correspondence is fair with measured data.

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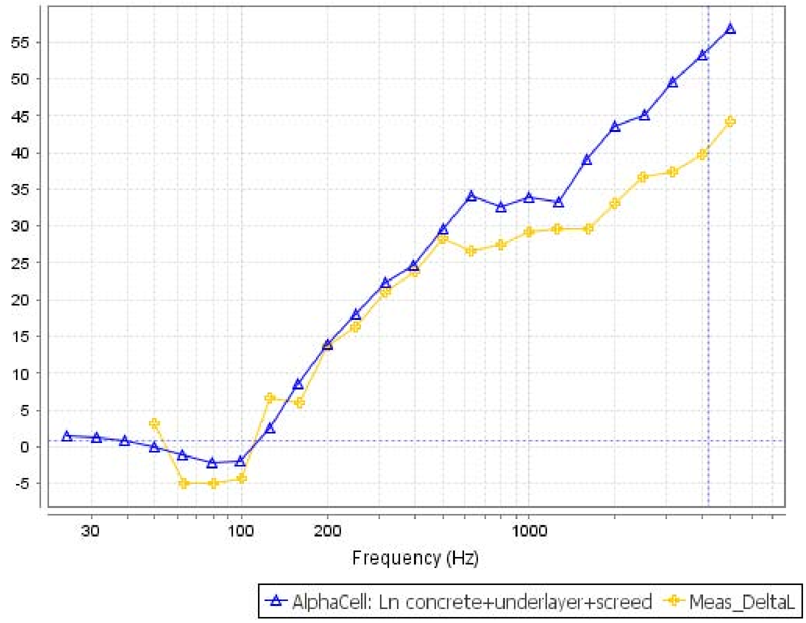
Simulation results

DeltaL (dB)



Indicators:

Simulation	Rw (C; Ctr)	Lnw	ΔLw	NRC
AlphaCell: Ln concrete+underlayer+screed		56.0	25.0	
Ln concrete		82.0		
Meas_DeltaL				

Comments

Ref.
internal measurements of impact sound attenuation due to underlayer+screed.

Correspondence is fair with measured data.

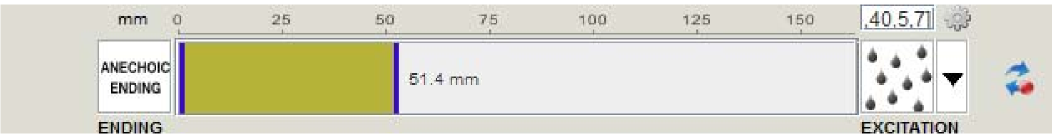
Meas: DeltaLw=25 dB
Simul: DeltaLw=25 dB

19 Rain On the Roof : Sound intensity level

3/2/2015

Rain-on-the-roof modelling

Geometry of the system



Rain on the roof (Heavy)
- Rainfall rate: 40 (mm/h)
- Drop diameter: 5 (mm)
- Fall velocity: 7 (m.s-1)

Spatial windowing: T.E. Vigran, Lx = 1.1 m, Ly = 1.4 m

Materials and Models

	Layer name	Model	Parameters
1	aluminium	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 0.7200000000000001 (mm) ρ = 2780 (kg.m-3) E = 71000000000 (Pa) η = 0.01 ν = 0.3
2	polystyrene_rain	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 50.0 (mm) ρ = 27 (kg.m-3) E = 30000000 (Pa) η = 0.08 ν = 0.2
3	aluminium	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 0.7200000000000001 (mm) ρ = 2780 (kg.m-3) E = 71000000000 (Pa) η = 0.01 ν = 0.3

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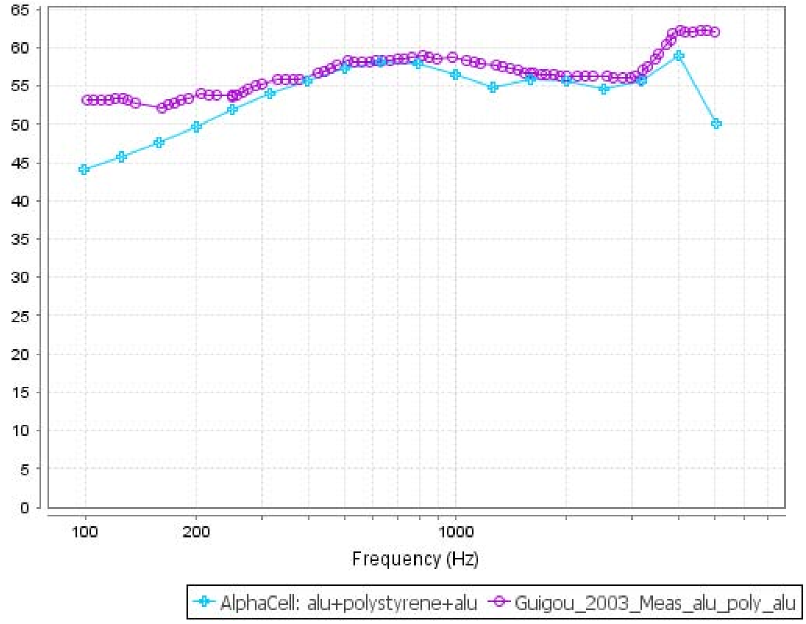
Simulation results

Li (dB)



Indicators:

Simulation	αw	LiA	Lnw	ΔLw
AlphaCell: alu+polystyrene+alu		67.0	52.0	
Guigou_2003_Meas_alu_poly_alu				

Comments

Ref.
[1] Guigou-Carter, C. and Villot, M., Study of simulated rainfall noise on multi-layered systems, In Proceedings of Euronoise 2003, Naples, Italy (2003)

The correspondence with reference data is good.
Note : in the reference paper, the authors add 6 dB to their simulated sound intensity level. This is not the case here.

20 *Turbulent Boundary Layer : TL*

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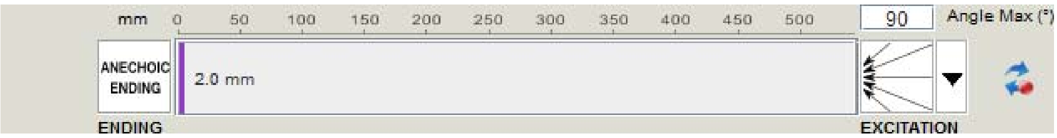
Turbulent boundary layer modelling

Geometry of the system



Diffuse field (Angle Max 90.0°)

Spatial windowing: T.E. Vigran, Lx = 1.0 m, Ly = 0.8 m

Materials and Models

	Layer name	Model	Parameters
1	duralumine	Acoustic: None Elastic: Elastic (isotropic) Heterogeneous: None	thickness: 2.0 (mm) ρ = 2790 (kg.m-3) E = 74000000000 (Pa) η = 0.01 ν = 0.3

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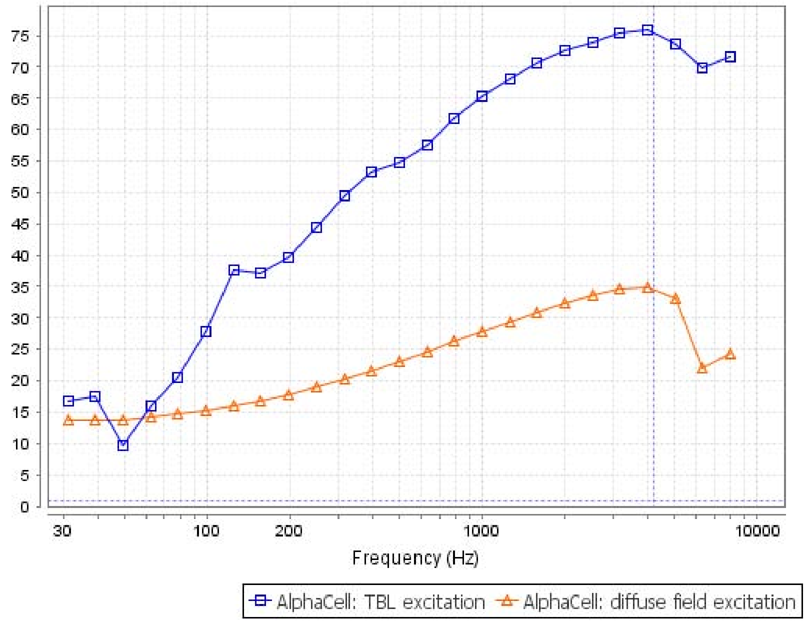
Simulation results

Transmission loss (dB)



Indicators:

Simulation	Rw (C; Ctr)	Lnw	ΔLw	NRC
AlphaCell: TBL excitation		30.0		
AlphaCell: diffuse field excitation	28.0 (-1.0;-4.0)	83.0		

Comments

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For the plate studied here :
Critical frequency : 6 040 Hz
Aeroacoustic coincidence frequency : 95 Hz

As shown on these results, for a turbulent boundary layer excitation, the aero-acoustic coincidence frequency is retrieved together with the critical frequency.

One can compare to the transmission loss obtained for diffuse sound field excitation. In this case, only the critical frequency is retrieved.
One could note that the transmission loss obtained for a TBL excitation increases more rapidly than for a diffuse field which corresponds to a purely air-borne sound excitation.
It is also noticeable that in the region of the aero-acoustic coincidence frequency, the sound transmission loss for a TBL excitation may be lower than the sound transmission loss for a diffuse field.

*Alpha*Cell is a software developped by MATELYS

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