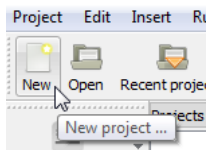# AcouSYS v4 user's manual

## QUICK PRESENTATION – ACOUSYS IN A NUTSHELL

This section presents the main steps to create a project, create a system, make a calculation and visualize the result.

1. Create a new project by clicking on "New project".

☀ Remark: this function is also available through File/New or Ctrl+N.

☀ Several projects can be simultaneously created and opened.

2. Define project's name and save it in the desired folder.
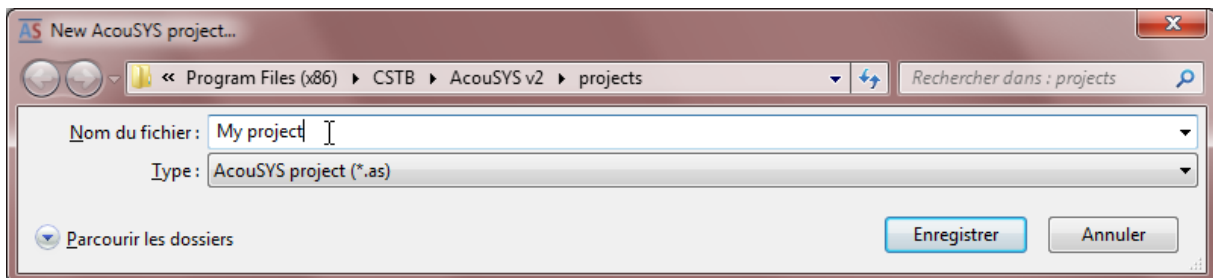
3. Create a new system by clicking on "New element" and by selecting "New system (simple multilayer)", "New system (frame partition)" or "New system (lining bonded by dabs)".
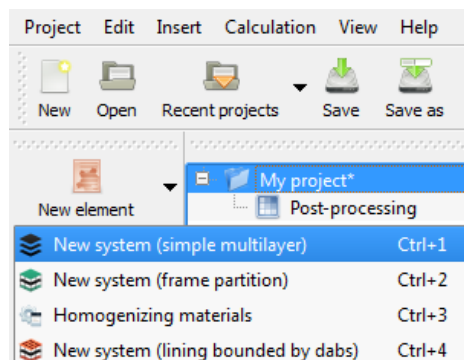
☀ Remark: this icon is only active when a "Project" object is selected

☀ Once created, a « New system » object appears in the tree project

☀ A project can contain several "Systems"

☀ In regard to the creation of a new homogenized material, please refer to the section "Homogenizing materials"

☀

4. Select a material for the multilayer and do a drag and drop in the "List of materials".
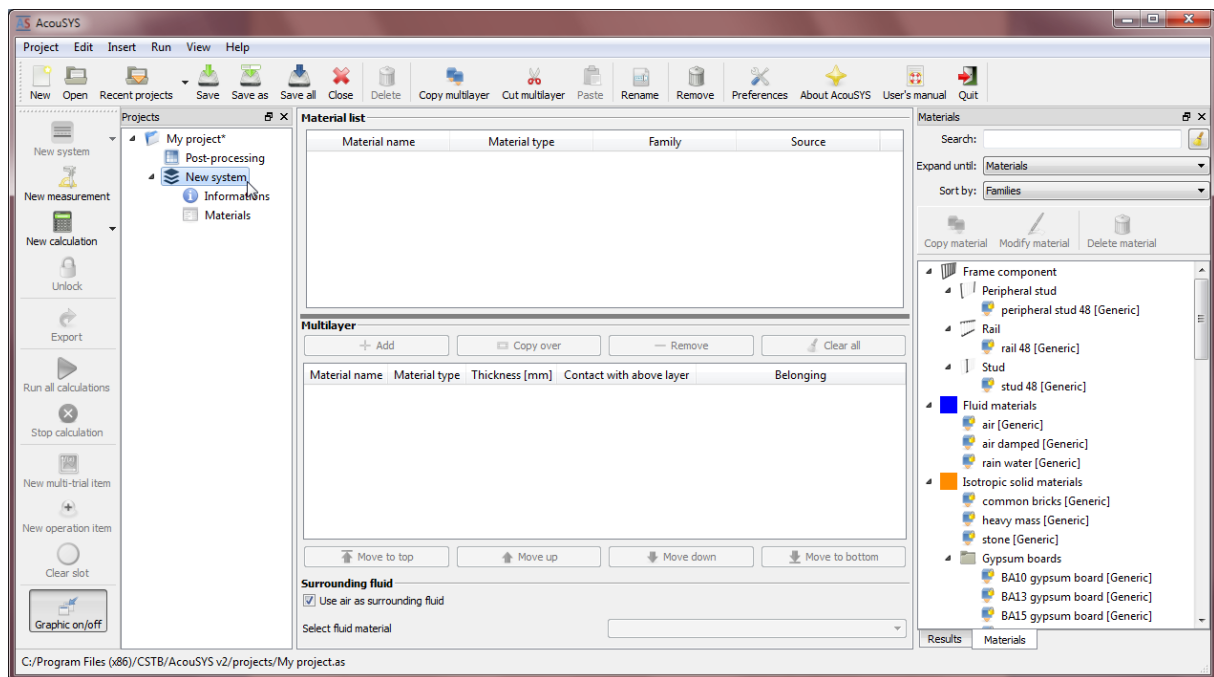

☀ Materials can also be dropped on the object "Materials" in the tree project.

☀ New materials can be created: for more information please refer to the section "Managing materials".

5. Repeat the previous action for the other materials. You created your "materials database" associated with the multilayer.
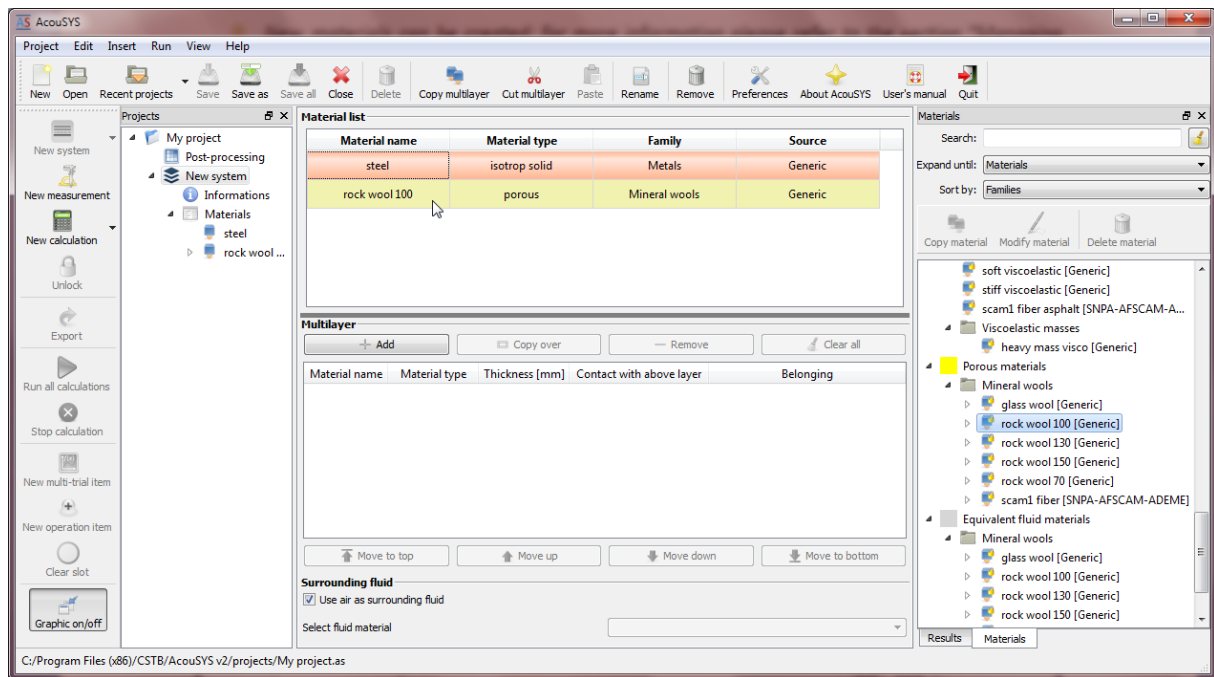
☀ Material type, family and source are also mentioned.

☀ New materials can be created: for more information please refer to the section "Managing materials".

6. Select a material in the « Material List » and click on the button « Add » to create the first layer of the multilayer. This one is added in the "Multilayer" part.
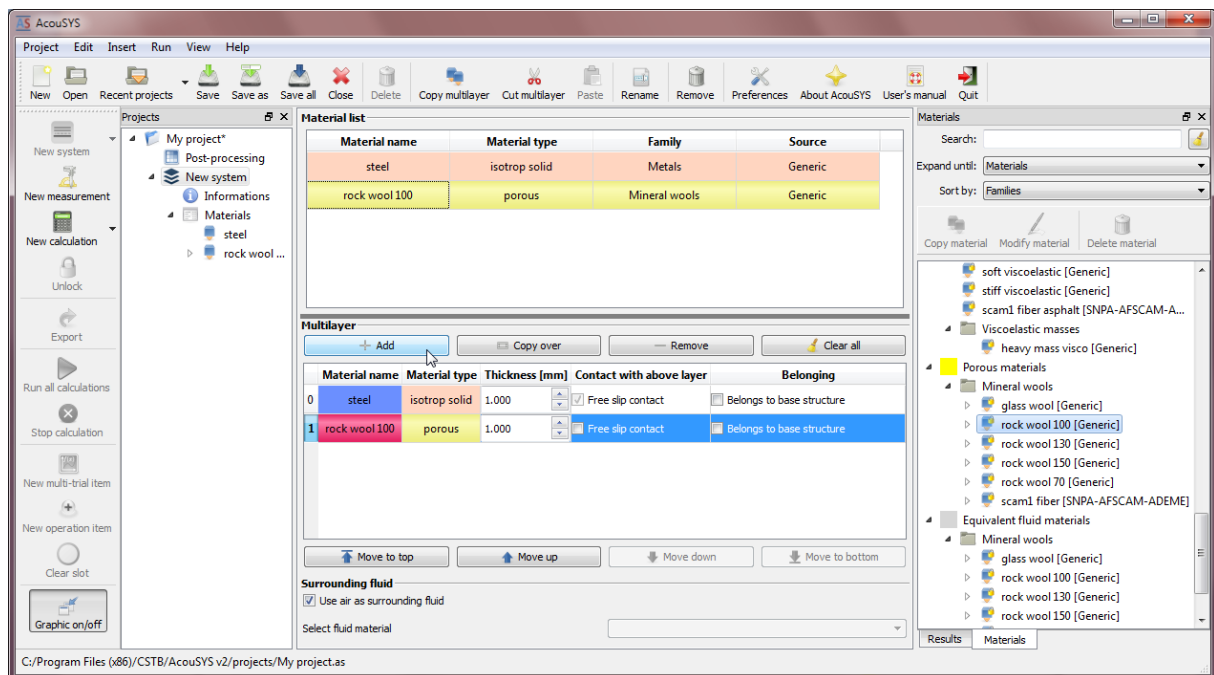
☀ This operation may also be realized by a "Drag and Drop" action.

7. Repeat the previous operation for the different layers.
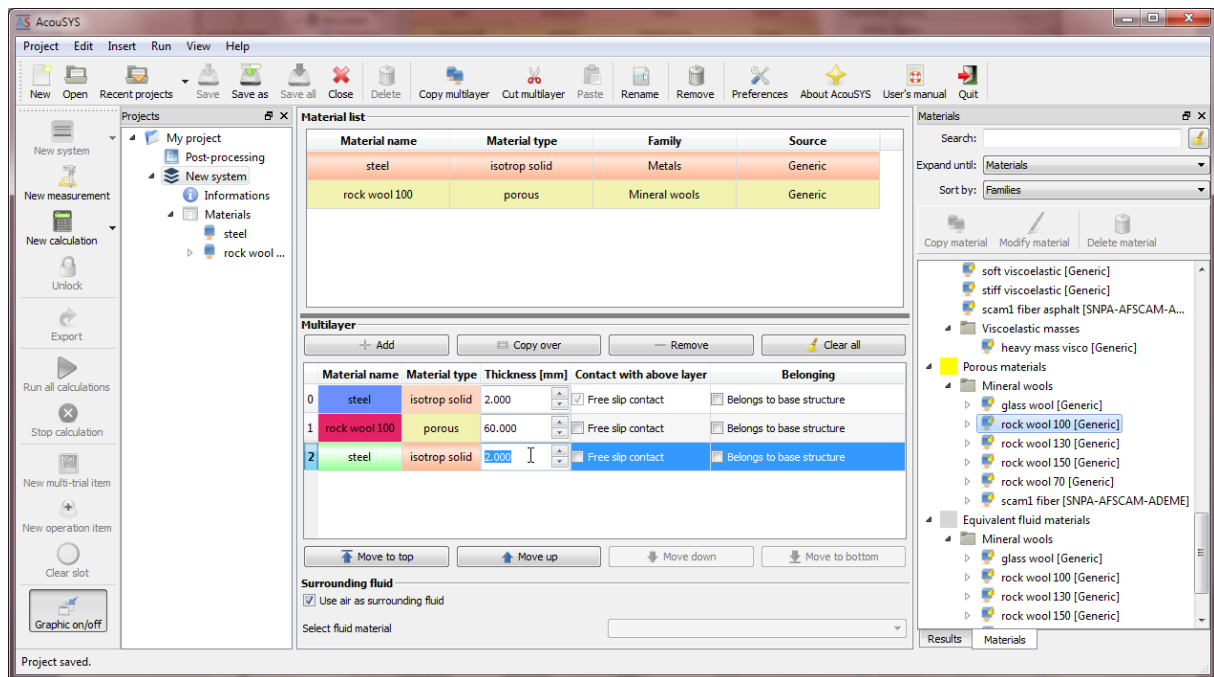
8. Define the different thickness of each layer.

9. Define the contact type between the layers (free contact or not). "Free contact" is equivalent to the addition of an infinitesimal air layer or to a sliding contact.

☀ When the box « Free contact » is unchecked it corresponds to a « bonded » contact.

☀ When the box « Belongs to base structure » is checked, it is then possible to directly calculate improvements in the sound reduction index ΔR or the reduction of impact sound pressure level ΔL. Separate calculations for the base structure and the whole multilayered system are automatically performed.

10. Click on the icon « New calculation » and select the calculation which will be carried out on the multilayer.
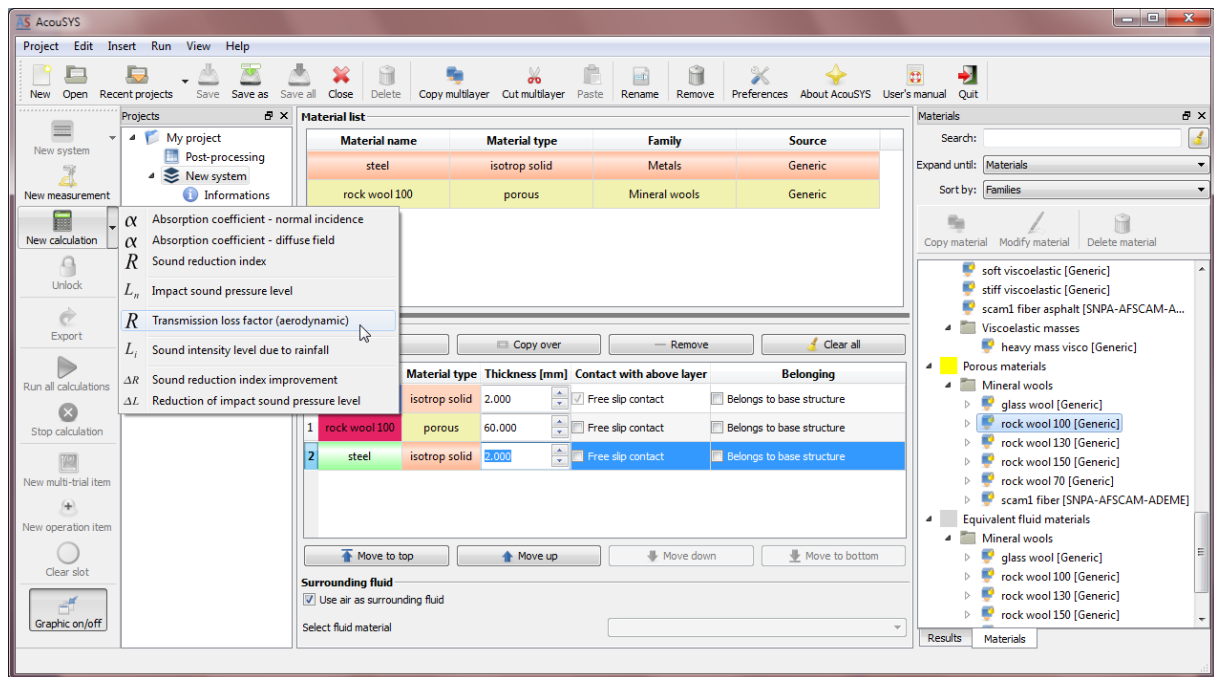
☀ One or several measurements can be associated to a system by clicking on « New measurement ». For more information, please refer to the section "Managing systems".

11. Launch a calculation by clicking on the icon "Run".
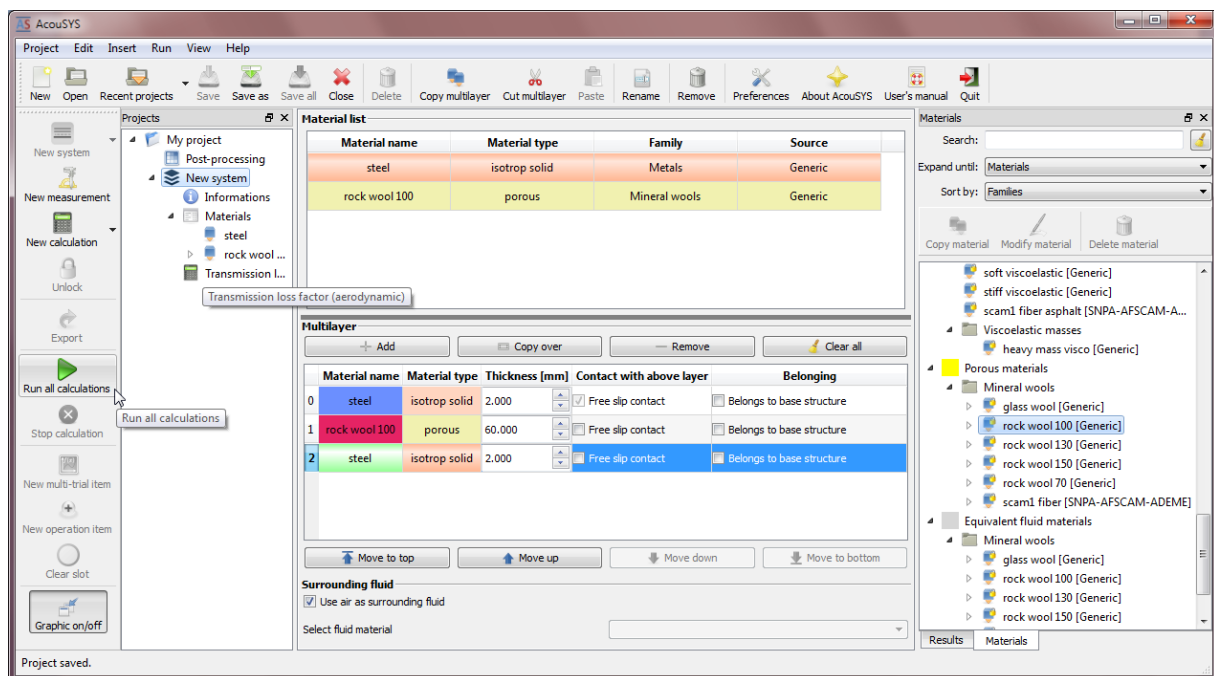
☀ When a calculation is in progress, a circular blue arrow appears on the multilayer, this one cannot be changed.

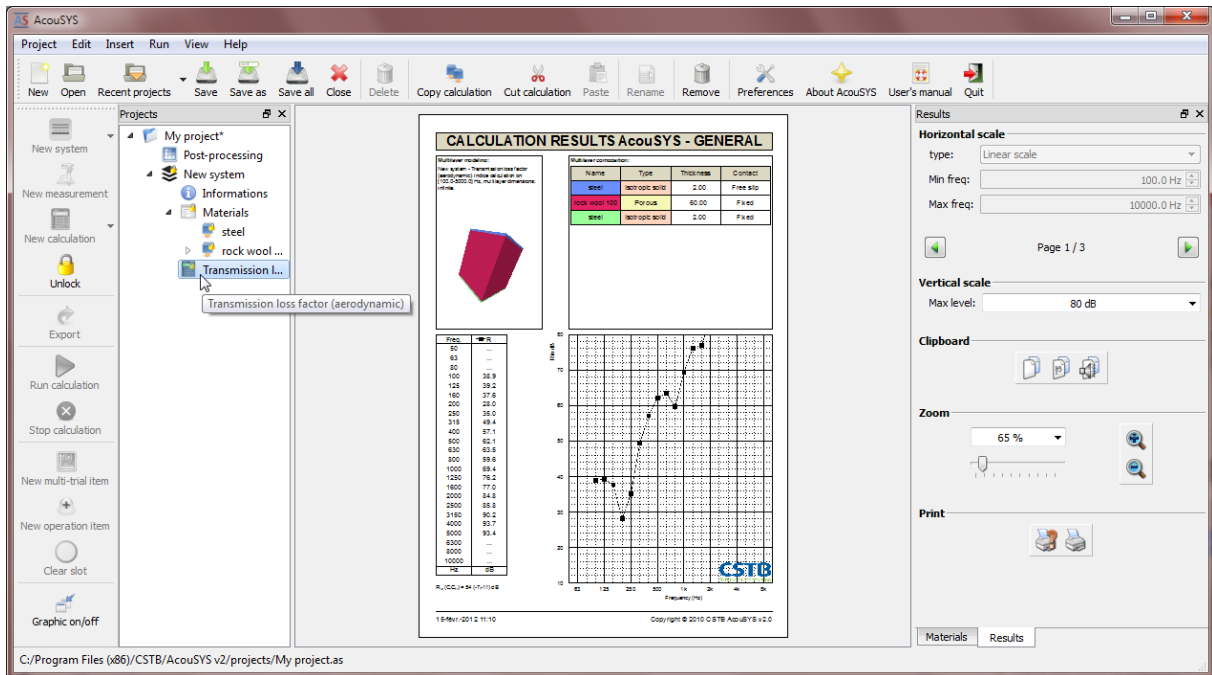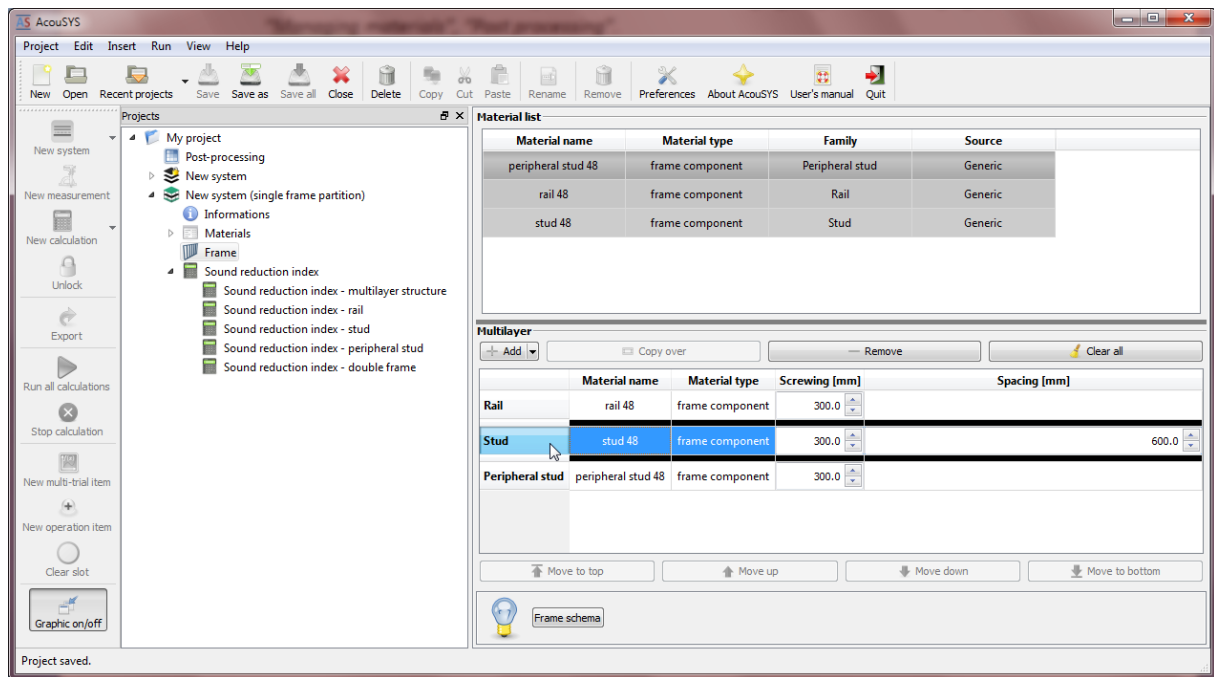☀ The progress of the calculation appears in square brackets at the right of the calculation name (e.g.: transmission loss [34.5%])

☀ Several calculations may run simultaneously.

12. The result is displayed and the system locked once the calculation is done.

☀ Several calculations may be compared thanks to the object "Multi-trial item" in "Post processing". For more information please refer to the section "Managing post processing".

☀ Operations can be carried out thanks to "Operation" in "Post processing". The results may be added or subtracted. For more information, please refer to the section "Post-processing".

☀ For more information, please refer to the sections "Managing projects", "Managing systems", "Managing materials", "Post processing".

13. To create a system "frame partition", follow steps (3-12) and add frame components. Only the evaluation of the sound reduction index is allowed in this case.

14. To create a system "lining bonded by dabs", follow steps (3-8) and specify the parameters related to the dabs. All the preconfigured layers are needed, except the "coating" layer which is optional. All layers can be isotropic solids, except the support wall which can also be 2D or 3D orthotropic. Then follow steps (10-12). Only the evaluation of the sound reduction improvement is allowed in this case, considering the supporting wall and coating as the base structure.
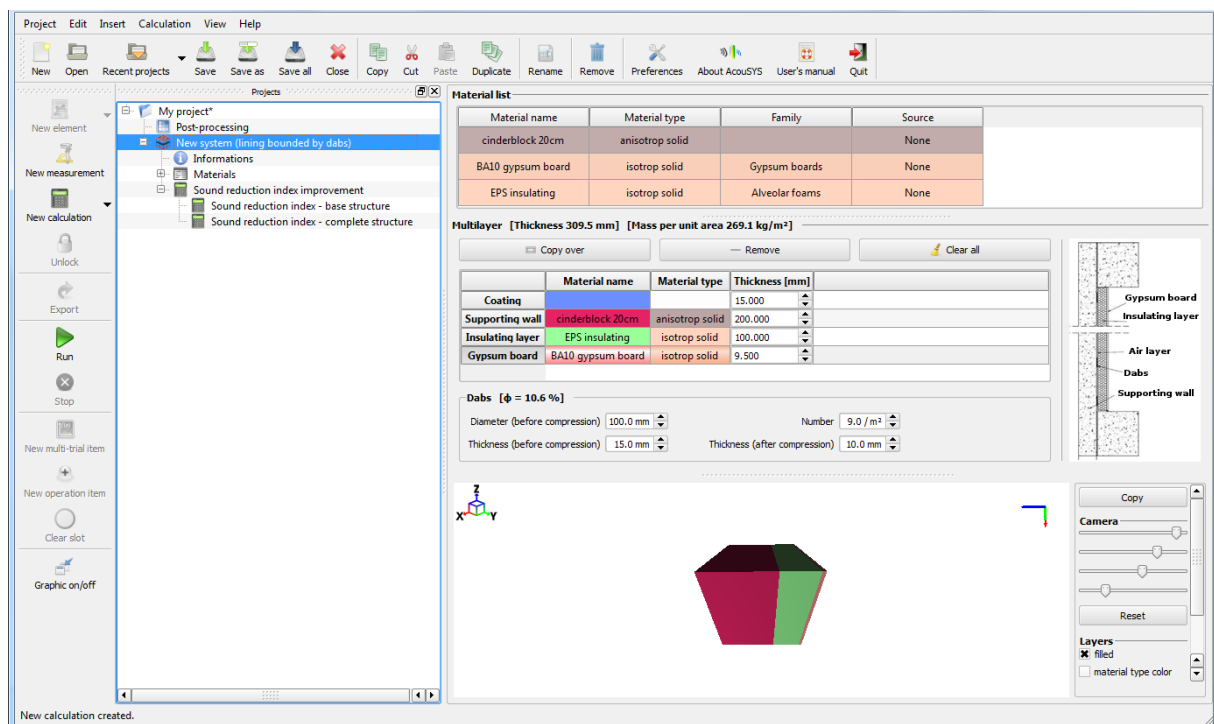
INTRODUCTION

The model for infinite multi-layered structures is based on a transfer matrix approach (see [1] for example). The different layers of constant thickness, constituting the structure can be either solid, viscoelastic, fluid, porous, perforated element or solid orthotropic materials. The modelling of porous layers (absorbing materials) follows Biot's theory [2] and includes the propagation of two coupled compressional waves and a shear wave travelling simultaneously in both phases of the porous material (elastic and fluid phase). A porous layer can also be modelled as an equivalent fluid. The solid or viscoelastic layers include the propagation of two different wave types (compressional and shear waves). Perforated elements are modelled based on work from Atalla and Sgard [3], by considering them as porous element with a rigid frame (rigid elastic frame). The orthotropic solids are modelled as thin orthotropic plates [4]. Furthermore, the layers can be bounded or unbounded with each others.

The computer program ACOUSYS based on this approach can be used to predict

- sound transmission,
- sound absorption,
- impact noise level (taping machine)
- rainfall noise level (normalized rainfall)
- transmission loss due to a turbulent boundary layer excitation (Corcos type [5]).

For sound transmission and sound absorption prediction, the system is excited by a diffuse acoustic field composed of multiple acoustic plane waves incoming in different directions. The absorption coefficient for normal incidence can also be evaluated. For sound absorption calculation, the multilayered system is assumed to rest on a rigid foundation.

A structural excitation distributed over a small area of the structure is decomposed into an infinite number of propagating normal stress waves. The velocity field, on the top and bottom interface, evaluated in the wavenumber domain allows calculating the acoustic intensity radiated on both sides of the system leading to the impact noise if tapping machine is used as structural excitation, to the rainfall noise level if rainfall is the excitation. The excitation force associated to the tapping machine can be estimated relatively well, as explained in [6-8] as a function of the mass and the impact velocity of the hammer, the input mobility of the structure studied and the impact frequency of the tapping machine. Note that the excitation force depends on the input mobility of the multilayered system and must be calculated for each system. The excitation force associated to the rainfall noise can be estimated similarly [8-10].

For the turbulent boundary excitation, the incident intensity for the evaluation of transmission loss is obtained from the integration in the wavenumber domain of the wavenumber-frequency spectrum of the fluctuating boundary layer pressures.

A technique based on a spatial windowing of plane waves presented in [11] is used in order to take into account the finite size of a planar structure in sound radiation and sound transmission calculation. This technique leads to prediction results much closer to experimental measurements than the classical wave approach applied to infinite structure. It is a very simple method in the case of sound transmission since the associated radiation efficiency depends only on the spatial window considered (i.e. the size of the structure) and can therefore be pre-calculated.

The airborne noise reduction ΔR of a wall lining or floor covering or ceiling can then be deduced from the sound transmission index of the base structure (wall or floor) calculated with and without the lining or covering [12]. In a similar way, the impact noise reduction ΔL of a floor covering can then be deduced from the impact noise level of the base floor calculated with and without the floor covering [12-13].

CSTB has developed a prediction method of sound reduction index for single frame partition [14] ; this method is based on a mixed approach : the transfer matrix approach to evaluate the sound reduction index of the partition without frame components (transmission through partition cavity only) and an SEA approach to evaluate the partition sound reduction index for transmission paths associated with the frame components only. The partition frame components are modeled as punctual springs corresponding to positions of screws fixing the boards on the frame. In the low frequency range, this method is completed by an approach considering the studs in the partition as linear periodic springs. The transition from linear connection (linear spring) to a punctual connection (punctual spring) between partition boards appear when the boards flexural half wavelength is equal to the distance between the screws.

CSTB has also developed an analytical method to account for partial contact between layers in the case of thermal linings bonded by dabs [15]. For closed-cell insulating materials (e.g. EPS), it consists in introducing a fictitious air gap between the supporting wall and the insulation layer. The thickness of this air gap is calculated from the dynamic stiffness of the insulating material, the dimensions of the mortar dabs and the number of dabs per m². The loss factor of the air gap is dependent from the nature of the supporting wall, to account for additional energy dissipation in the case of hollow masonry walls. For open-cell or fibrous insulating materials (e.g. mineral wool), the equivalent porous layer approach described in [15] is implemented.

[1] M.L. Munjal, "Response of a multilayered infinite plate to an oblique plane wave by means of transfer matrices", *Journal of Sound and Vibration* 162, 333-343 (1993)

[2] J.F. Allard, Propagation of sound in porous media: Modelling sound absorbing materials, Elsevier Applied Science, London 1993

[3] N. Atalla, F. Sgard, "Modelling of perforated plates and screens using rigid frame porous models", *Journal of Sound and Vibration* 303(1-2), 195-208 (2007).

[4] I. Bosman, P. Mees, G. Vermeir, "Strcture-borne sound transmission between thin orthotropic plates: Analytical solutions", *Journal of Sound and Vibration* 191(1), 75-90 (1996).

[5] G. M. Corcos, "The structure of the turbulent pressure field in boundary-layer flows", *Journal of Fluid Mechanics* 18(3), 353-378 (1964).

[6] C. Guigou-Carter, M. Villot, "Analytical and experimental study of wood flooring", *Proceedings of Forum Acusticum 2005*, Budapest, Hungry (2005)

[7] M. Villot, C. Guigou-Carter, "Modeling impact noise of floating floors", *Proceedings of EuroNoise 2006*, Tampere, Finland (2006)

[8] C. Guigou-Carter, M. Villot, "Predicting the acoustic performance of multi-layered structures submitted to structural excitation", DAGA 2007, Stuttgart, Germany (2007).

[9] C. Guigou-Carter, M. Villot, C. Horlaville, "Study of simulated rainfall noise of roofs and glazings", Forum Acusticum 2002, Sevilla, Spain (2002).

[10] C. Guigou-Carter, M. Villot, "Study of simulated rainfall noise on multi-layered systems", EuroNoise 2003, Naples, Italy (2003).

[11] M. Villot, C. Guigou-Carter, L. Gagliardini, "Predicting the acoustical radiation of finite size multi-layered structures by applying spatial windowing on infinite structures", *Journal of Sound and Vibration* 245, 433–455 (2001)

[12] J.-B. Chene, C. Guigou-Carter, "Prediction method for the acoustic performance of permanent form systems", Acoustics'08, Paris, France (2008).

[13] C. Guigou-Carter, J.-B. Chene, "Development of thermo-acoustic floating floors for use between parking and dwellings", Acoustics'08, Paris, France (2008).

[14] C. Guigou-Carter, M. Villot, "Analytical and experimental study of single frame double wall", Proceedings of Euronoise 2006, Finlande, 2006.

[15] C. Guigou-Carter, G. Jacqus, T. Blinet, "Acoustic performance prediction for thermal linings bounded by dabs", Proceedings of ICSV23, Greece, 2016.

MANAGING PROJECTS

CREATING A NEW PROJECT

To create a new project click on the "New project" icon (or click on File >> New Project, or hit CTRL+N). A new project comes with an empty Post-Processing item. Projects can also be created by simply copying an existing project: simply drag and drop the existing project into the project tree view and click on "Copy Project here". Note that several projects can be opened simultaneously.
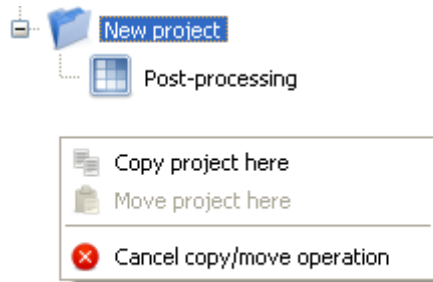
The default name for newly created projects is "New project". This can of course be changed by clicking on the "Rename" icon, or by double-clicking in the project item text.

SAVING PROJECTS

Individual projects can be saved by clicking on the "Save current project" button. When several projects are opened the "Save all projects" button allows saving all modified projects. Note that when you see a wildcard next to the project name, it means that the project contains unsaved modifications.

Closing the AcouSYS window may popup a dialog window to let you save modifications before exiting:

CLOSING AND DELETING PROJECTS

Projects can be closed by clicking on the "Close" button (or CTRL+D while selecting the project). Project files can be deleted by clicking on the "Delete current project" button. Note that the file will be **permanently deleted from disk and cannot be restored.**

MANAGING SYSTEMS

CREATION OF SYSTEMS

In order to create a system, click on the icon "New system" (the icon is active when a project is selected); another possibility is to do a right click on the project icon and select "New system (simple multilayer) Alt+M" or "New system (single frame partition)". A new multilayer is automatically created with items "Information" and "Materials" empty (and "frame"). The systems (or multilayer) may also be created by the copy of an existing system: drag and drop the system on the project and click "Copy multilayer here".
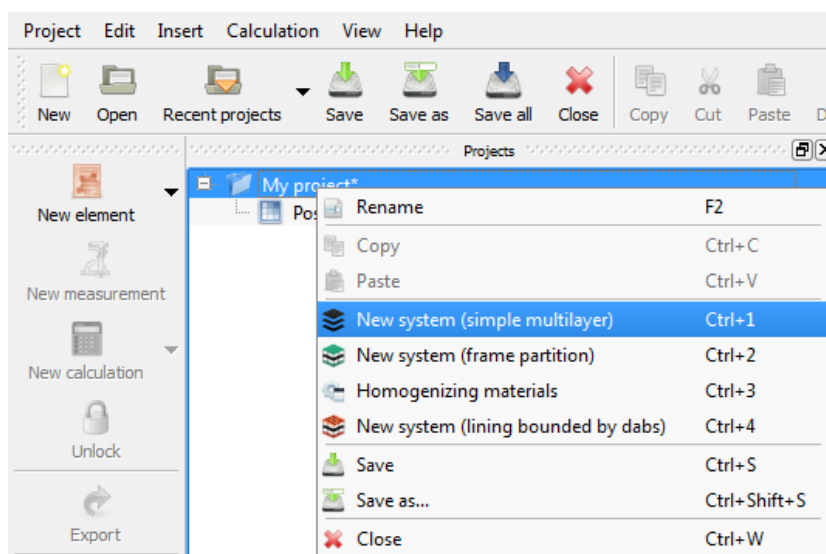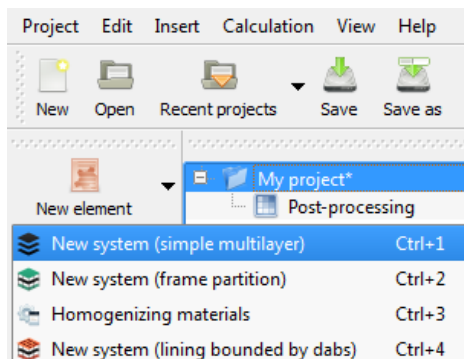
☀ The name of each multilayer may be modified. After selected the multilayer, click on the icon "Rename" or do a right click on the multilayer and select "Rename" (or press F2).

☀ A project may contain several systems.

COPY/PASTE SYSTEMS

To copy a system (or multilayer), select the system and click on the icon « Copy multilayer », or do a right click on the latter and select "Copy multilayer". This function is also available by pressing Ctrl+C on the keyboard.

To cut a system (or multilayer), select the system and click on the icon « Cut multilayer », or do a right click on the latter and select « Cut multilayer ». This function is also available by pressing Ctrl+X on the keyboard.

In order to paste a system (or multilayer) already copied or cut, select the project which is going to receive the system and click on the icon "Paste". This function is also available by pressing Ctrl+V on the keyboard. Warning: this combination allows creating a "new measure" when a system is selected. **This function is active when a project is selected.**

DELETION OF SYSTEMS

In order to delete a system (or multilayer), select a system and click on the icon "Remove", or do a right click on this latter and select "Remove". This function is also available by pressing "DEL" on the keyboard.

ITEMS ASSOCIATED TO A SYSTEM

A system (or multilayer) may contain several items or objects:

- o Object "Informations"

- o Object "Materials"

- o Object "Measurements"

- o Object "Calculations"

Management of information associated to a system

- ☀ The "Information" object is an empty text space which may be filled by the user to detail information on the system.

Management of materials associated to a system

☀ The object "Materials" allows managing materials which are used in the system. For more information please refer to the section "Managing materials".

Management of measurements associated to a system

☀ For each system, one or several measurements may be added and associated to the system. In order to add a measure, select the system and click on the icon "New measurement", or do a right click on this latter and select "New measurement". This function is also available by pressing Ctrl+V. Warning: this combination allows pasting a system when a project is selected.
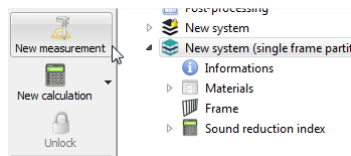
☀ A new measurement may be renamed or deleted. These functions are also available by the same icon and shortcuts than for a system.

☀ In order to add values to the measurement, double-click on a one-third octave and enter the data. Repeat the operation on other one-third octaves.

☀ In order to import values copied from another software, select one third octave band (corresponding to the start third octave band of imported values) and click on "Paste values from clipboard".

☀ In order to use these values in the post-processing, define the measurement type. The measurement will not be comparable to the calculation in the object "Multi-trial" if they are not of the same type. For more information, please refer to the section "Post-processing".

MANAGING MATERIALS

This section presents the major steps to create a material that can be used in a multilayered system.

The materials management is on the right hand side of the AcouSYS window interface.

Materials are of different types, a color is associated to each type of material:

- Frame component

- Fluid materials (Color code: blue)

- Isotropic solid materials (Color code: orange)

- 2D Orthotropic solid materials (Color code: red and orange)

- 3D Orthotropic solid materials (Color code: red, orange and yellow)

- Membranes (Color code: pink)

- Viscoelastic materials (Color code: green)

- Porous materials (Color code: yellow)

- Equivalent fluid materials (Color code: grey)

- Perforated solid materials (Color code: purple)

- Equivalent fluids for double porosity materials (Color code: red)

The list of materials can be expanded following different options: None, Families/Manufacturers, Materials and All. It can also be sorted by Family and Manufacturer. A keyword search is also possible.
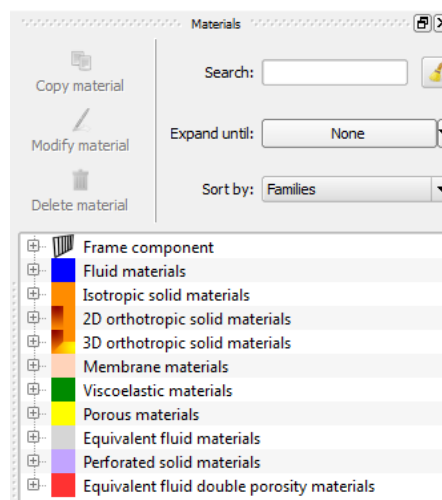
Materials in the original database are not open to be changed, they cannot be deleted either. To create a new material, the following steps can be followed:

1. Select a material of the same type as the one to be created, by clicking on it

2. Click on the button « Copy material » or in the contextual menu (mouse right click) select « Copy material »

3. Select the new material (at the end of the material type list), and click on the button « Modify material » or in the contextual menu (mouse right click) select « Modify material »
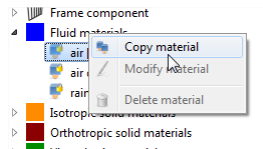
4. To delete a material, select the chosen material, and click on the button « Delete material » or in the contextual menu (mouse right click) select « Delete material ».

However, once the material has been inserted in a multilayered system, it is also possible to modify its characteristics directly in the current project. In the multilayered system, select the material (by clicking on it) to be modified in the « Materials » list, it is then possible to change the values of the different characteristics. To save these changes in the software user materials database, it is necessary to select « Export to user materials database » in the contextual menu (mouse right click).

Fluid Materials

The fluid materials are defined by:

-   a density (kg/m^3)

-   a speed of sound in that fluid (m/s)

-   a viscosity (Pa.s)

-   a loss factor

The speed of sound can vary with frequency. In that case, select « Frequency (Hz) » (see Figure below circled in red), then indicate the desired frequency (see Figure below, circled in green) and the sound speed value (see Figure below, circled in purple), finally click on « Add ». Start again to add more values. It is also possible to remove values by selecting them (selection by clicking on them), and then clicking on « Remove ». In a similar manner, the loss factor applied on the sound speed can be varied as a function of frequency. The variations of the sound speed and loss factor are linear between the selected frequencies; below the lowest frequency and above the highest frequency, values remain constant.

If no loss factor is provided (i.e. a null value) for the sound speed, the fluid viscosity is used to evaluate this effect.

Isotropic Solid Materials

The isotropic solid materials are defined by:

- a density (kg/m^3)

- a Poisson ratio

- an elastic modulus or Young modulus (MPa)

- a loss factor

The Young modulus can vary as a function of frequency. In that case, select « Frequency (Hz) » (see Figure below circled in red), then indicate the desired frequency (see Figure below, circled in green) and the Young modulus value (see Figure below, circled in purple), finally click on « Add ». Start again to add more values. It is also possible to remove values by selecting them (selection by clicking on them), and then clicking on « Remove ». In a similar manner, the loss factor applied on the young modulus can be varied as a function of frequency. The variations of the Young modulus and loss factor are linear between the selected frequencies; below the lowest frequency and above the highest frequency, values remain constant.

2D Orthotropic Solid Materials

The 2D orthotropic solid materials are defined by:

- a density (kg/m^3)

- a Poisson ration

- an elastic modulus or Young modulus in the x-direction (MPa)

- an elastic modulus or Young modulus in the y-direction (MPa)

- a shear modulus (MPa)

- a loss factor

The x- and y-directions define the orthotropic layer plane; the orthotropic layer corresponds to an orthotropic thin plate.

As described previously, the Young modulus in both x- and y- directions, the shear modulus and the loss factor can vary as a function of frequency. These variations are linear between the selected frequencies; below the lowest frequency and above the highest frequency, values remain constant.

The same loss factor is applied to the Young modulus in both x- and y- directions and the shear modulus.

3D Orthotropic Solid Materials

The 2D orthotropic solid materials are defined by:

- a density (kg/m^3)

- a Poisson ration

- elastic moduli or Young moduli in the x, y and z directions (MPa)

- shear moduli Gyz, Gzx and Gxy (MPa)

- a loss factor

As described previously stated, mechanical parameters can vary as a function of frequency.

Membranes

The membranes are defined by:

- a density (kg/m^3)

- a surface tension (N/m)

- a Poisson ratio

- an elastic modulus or Young modulus (MPa)

- a loss factor

Viscoelastic Materials

The viscoelastic materials are defined by:

- a density (kg/m^3)

- a Poisson ratio

- a elastic modulus or Young modulus (MPa)

- a shear modulus (MPa)

- a loss factor

As described previously, the Young modulus, the shear modulus and the loss factor can vary as a function of frequency. These variations are linear between the selected frequencies; below the lowest frequency and above the highest frequency, values remain constant.

The same loss factor is applied to the Young modulus and the shear modulus.

Porous Materials

Porous materials are defined by:

- an airflow resistivity (Pa s/m^2)

- a tortuosity

- a porosity

- a viscous characteristic length

- a thermal characteristic length

as well as the elastic frame characteristics, similar to those of the isotropic solid materials

- a density (kg/m^3)

- a Poisson ratio

- a elastic modulus or Young modulus (MPa)

- a loss factor

and finally the fluid part characteristics, similar to those of the fluid materials

- a density (kg/m^3)

- a speed of sound in that fluid (m/s)

- a viscosity (Pa s)

- a loss factor

The Young modulus and the loss factor describing the porous material frame can vary as a function of frequency (as for the isotropic solid materials). The loos factor is applied to the Young modulus.


Equivalent Fluid Materials

The equivalent fluid materials based on the porous materials are defined:

- an airflow resistivity (Pa s/m^2)

- a tortuosity

- a porosity

- a viscous characteristic length

- a thermal characteristic length

and finally the fluid part characteristics, similar to those of the fluid materials

- a density (kg/m^3)

- a speed of sound in that fluid (m/s)

- a viscosity (Pa s)

- a loss factor

The frame characteristics are not taken into account; the frame of the porous material is assumed to be rigid.

Perforated Solid Materials

The perforated solid materials are defined by:

- a perforation rate (%)

- a perforation diameter (mm)

and finally the fluid part characteristics, similar to those of the fluid materials

- a density (kg/m^3)

- a speed of sound in that fluid (m/s)

- a viscosity (Pa s)

- a loss factor

Equivalent Fluid Materials for double porosity materials

The equivalent fluids modelling double porosity materials are defined by:

- an airflow resistivity (Pa s/m^2)

- a tortuosity

- a porosity

- a viscous characteristic length

- a thermal characteristic length

- a perforation ratio

- perforation diameter

The frame characteristics are not taken into account; the frame of the porous material is assumed to be rigid.

HOMOGENIZATION

Since AcouSYS version 3.0 it is possible to evaluate homogenized mechanical parameters associated with complex systems such as cellular building blocks or stiffened plates. This evaluation is carried out through a mechanical calculation which is created by selecting "Homogenization of materials" in the "New Item" menu.
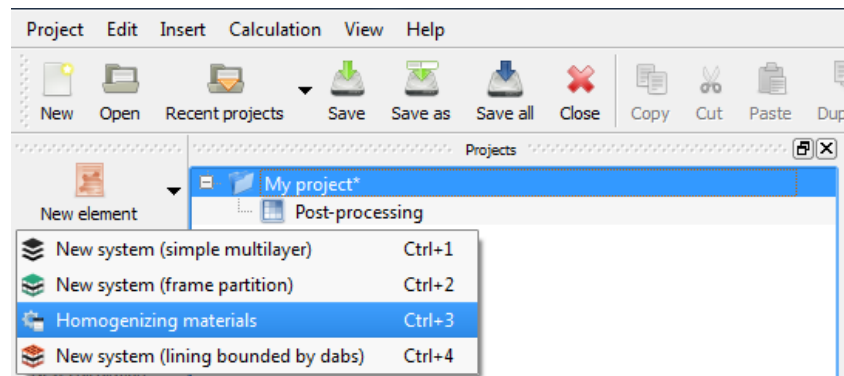

As for a conventional system, it is necessary to select and drag one or more materials from the materials database to the list of materials associated with the calculation.
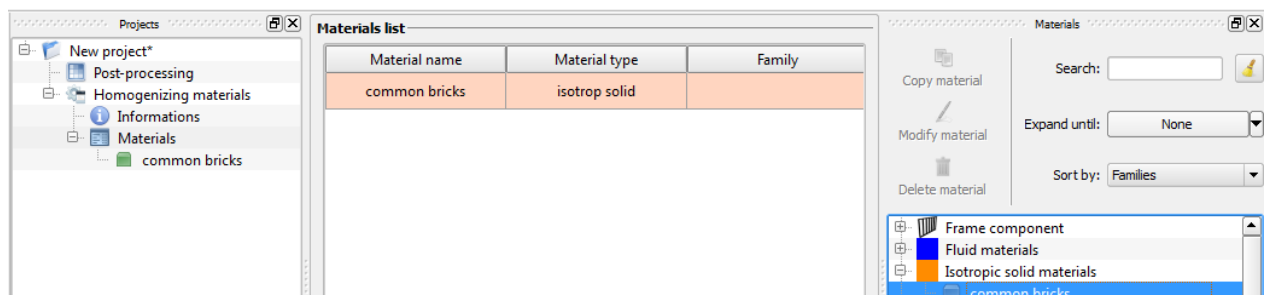
CELLULAR ELEMENTS

AcouSYS offers the opportunity to evaluate homogenized mechanical parameters of an extruded cellular elements for a 3D orthotropic solid modelling. Such a computation is initiated by selecting the "Brick" module.
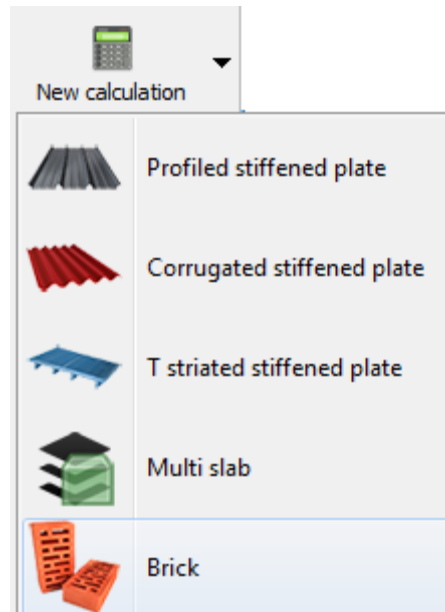
The material can then be selected from the previously created list. The "cutting" allows the definition of the extruded section through the polygon overlay "full" and "empty".

☀ A picture can be imported (.png) and scaled to assist drawing.

Extrusion depth can be defined as well as minimum element size (6 elements by depth are recommended). The calculation is performed after pressing "Run".

☀ The homogenization process is relatively resource demanding and can take more or less time depending on the hardware.
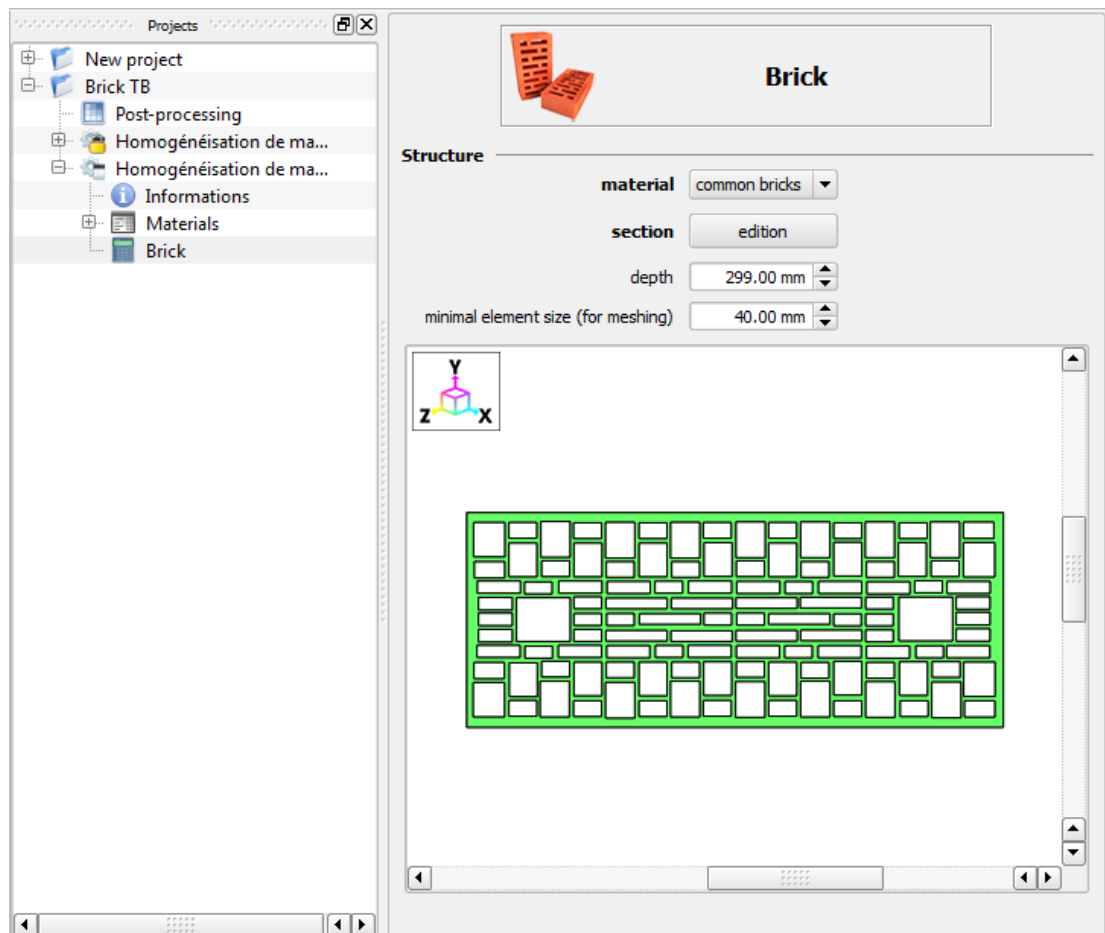
As soon as the computation ends, the function "Create the homogenized material" (located at the bottom, might need to use the scroll bar) sends the material to the materials database within the "3D Orthotropic solid materials\Homogenized equivalent" section.

☀ WARNING: The extrusion direction in AcouSYS is always the "z" direction, which also corresponds to the stacking direction for system layers. For most building applications, holes are vertical and will require to select the following orientation in the future creation of the multi-layered system:
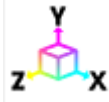
☀ The snapshot of the section is associated with the new homogenized material when created and appears in mouseover in materials database.

STIFFENED PLATES

AcouSYS offers the opportunity to evaluate homogenized mechanical parameters for various types of stiffened plates (profiled, corrugated, ribbed) resulting in a 2D orthotropic solid modeling. Setting of the different sections is based on the book: Carl Hopkins, "Sound Insulation - Theory into Practice." The process of creating and recording new material is identical to that of cellular elements. The material will then be recorded in "2D Orthotropic solid materials\ Homogenized equivalent".

MULTI-PLATES

AcouSYS finally offers the opportunity to evaluate homogenized bending properties of a multi-plate type system resulting in an isotropic thin plate modelling. The equivalent plate obtained can then be used within a single frame partition for example. The process of creating and recording new material is identical to that of cellular elements. The material will then be recorded in "Isotropic solid materials\Thin slab equivalent"

MANAGING CALCULATIONS

CREATION OF A NEW CALCULATION

In order to create a new calculation, click a "New calculation". This function is also available by a right click on the multilayer or the menu "Insert".
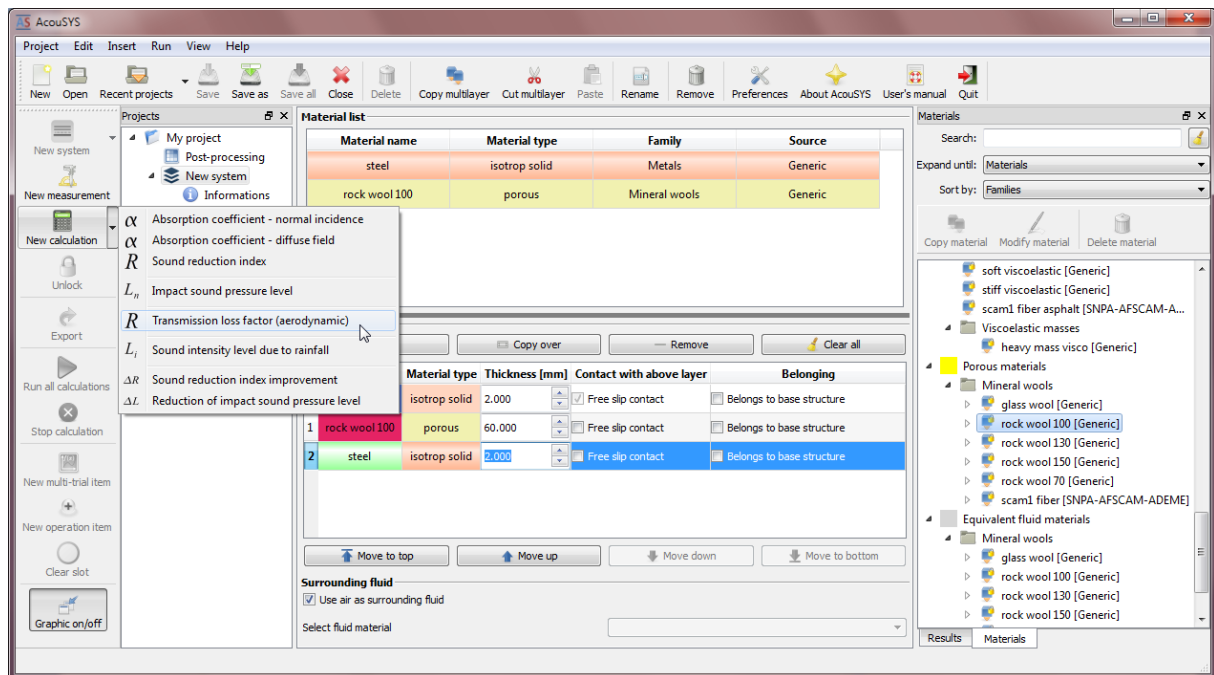
Then, select the calculation type to be carried out in the displayed list.

Once the different layers of a system defined, the calculations may be carried out on this one, the different types of calculations are the followings:

- o   α Sound absorption coefficient – normal incidence

- o   α Sound absorption coefficient – diffuse field

- o   R Sound reduction index

- o L_n Impact noise level (tapping machine)

- o   R Transmission Loss (aerodynamic)

- o L_i Sound intensity level due to rainfall

- o   ΔR Sound reduction index improvement

- o   ΔL Reduction of impact sound pressure level

☀ Several calculations may be carried out on the same multilayer.

EDITING A CALCULATION

Once a new calculation is created, this one appears in the tree project and is associated to the multilayer. The properties may be edited by clicking on this one. By default, the following window appears:
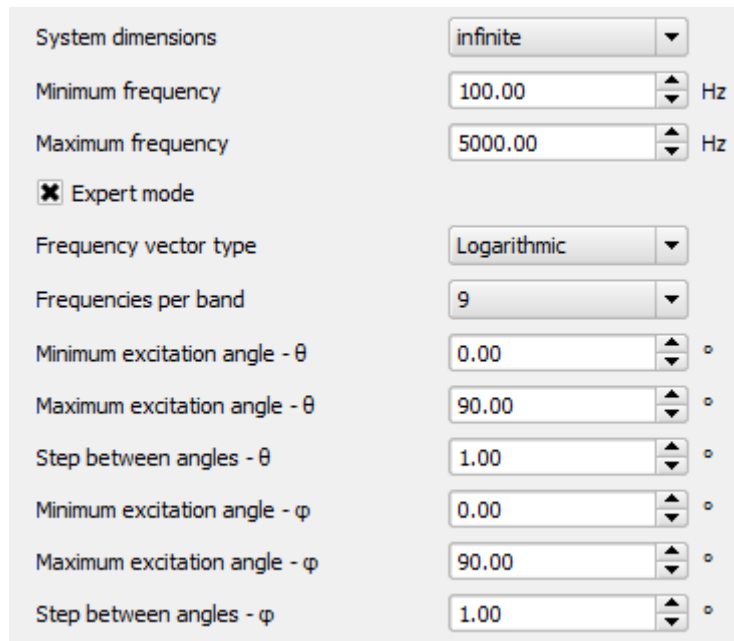
System dimensions	infinite ▼
Minimum frequency	100.00 ▲▼ Hz
Maximum frequency	5000.00 ▲▼ Hz
☐ Expert mode	

The dimensions of a system may be defined, they may be the following values:

- o « Infinite »,

- o « 1480x1230 mm », corresponding to the dimensions of the glazing unit alone for the measurement of the sound reduction index in laboratory.

- o « 3620x3000 mm », corresponding to the dimensions of the aperture CSTB test station for the measurements of the sound reduction index of light weighted façades, road barriers…

- o « 4180x2470 mm », corresponding to the dimensions of the aperture of the CSTB test station for the measurements of the sound reduction index of partition, exterior or interior insulation systems…

- o « 4220x3600 mm », corresponding to the dimensions of the aperture of the CSTB test station for the measurement of floors, floating slabs, ceilings…

- o « 642x1480 mm », corresponding to the standard dimensions of a French window.

- o « Other… », may be defined by the user.

☀ If the user defines its own system dimensions, the calculation length will be longer since the spatial windowing is computed instead of being pre-computed.

☀ The frequency bandwidth of calculation may be defined, thanks to the scrolling bars "Minimum frequency" or "Maximum frequency". The lower frequency of calculation is 20 Hz, the upper frequency is 10.000 Hz.

☀ Other parameters are available by clicking on the "Expert mode". The following window is displayed:

System dimensions	infinite
Minimum frequency	100.00	Hz
Maximum frequency	5000.00	Hz
☒ Expert mode		
Frequency vector type	Logarithmic
Frequencies per band	9
Minimum excitation angle - θ	0.00	°
Maximum excitation angle - θ	90.00	°
Step between angles - θ	1.00	°
Minimum excitation angle - φ	0.00	°
Maximum excitation angle - φ	90.00	°
Step between angles - φ	1.00	°

☀ The parameters presented below may be defined:

- o « Frequency vector type »: defines if the computations are carried out one the frequencies spaced by a logarithmic or linear step.

- o « Frequencies per band»: defines the number of frequencies per one-third octave band.

- o « Minimum excitation angle - θ » et « Maximum excitation angle - θ »: defines the incidence angle θ of different plane waves considered in the Diffuse Sound Field.

- o « Step between angles - θ »: defines the angular step between two successive plane waves.

- o « Minimum excitation angle - φ » et « Maximum excitation angle - θ »: defines the incidence angle φ of different plane waves considered in the Diffuse Sound Field.

- o « Pas entre les angles - φ »: defines the angular step between two successive plane waves.

☀ Higher is the number of frequencies per bandwidth, more accurate is the calculation. Recommended value: 9.

☀ A diffuse field is defined by the summation of plane waves in two perpendicular incident planes between 0° and 90°.

☀ Smaller is the step between angles, more accurate is the result. Recommended value: 1°.

RUN A CALCULATION

In order to run a calculation, click on the button "Run" (if this one is unlocked) or "Run calculations" in the contextual menu (available by a mouse right click on the calculation). When a multilayer is selected, all calculations associated to this multilayer will be simultaneously launched. When a calculation is selected, only the considered calculation will be launched.
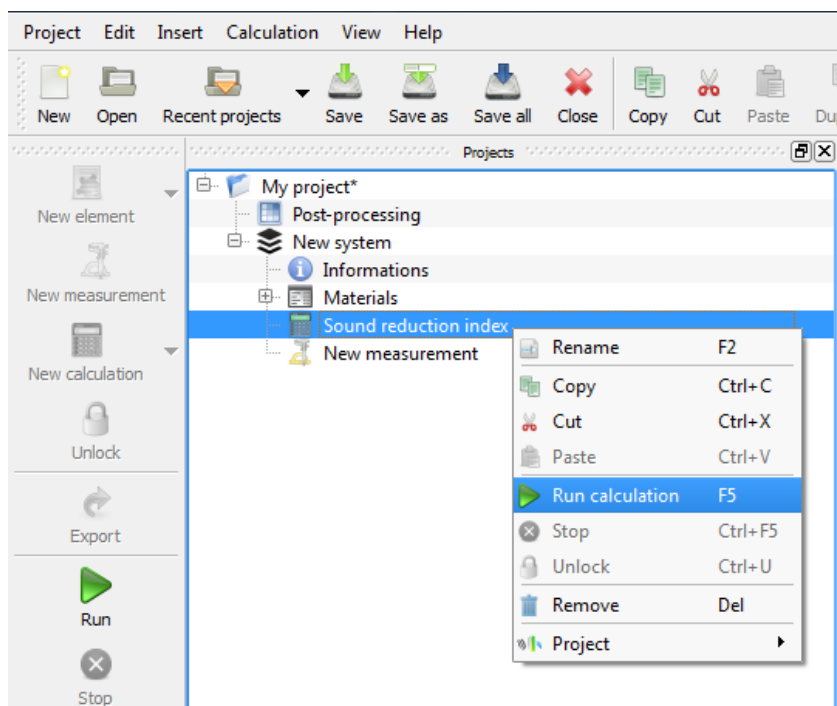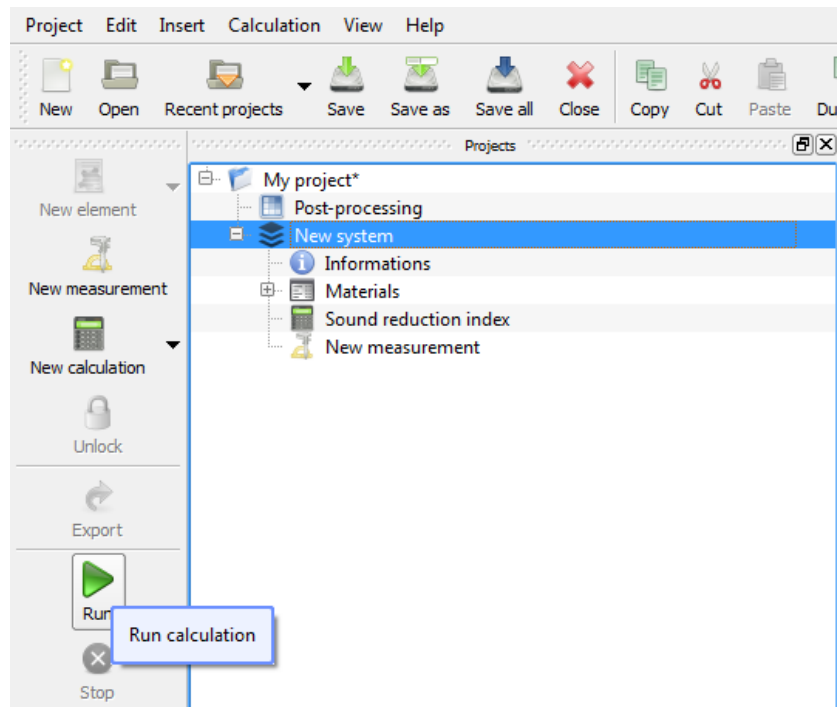
☀ When a calculation is in progress, a circular blue arrow appears on the multilayer, this one cannot be modified.

☀ The progress of the calculation appears in square brackets at the right of the calculation name (e.g.: sound reduction index [34.5%]).

☀ The calculations on systems with many layers, with porous or orthotropic materials, or with user-defined dimensions can be time consuming.

☀ When a system is locked, to re-launch one or several calculations it is necessary to unlock the system by clicking on the icon "Unlock".
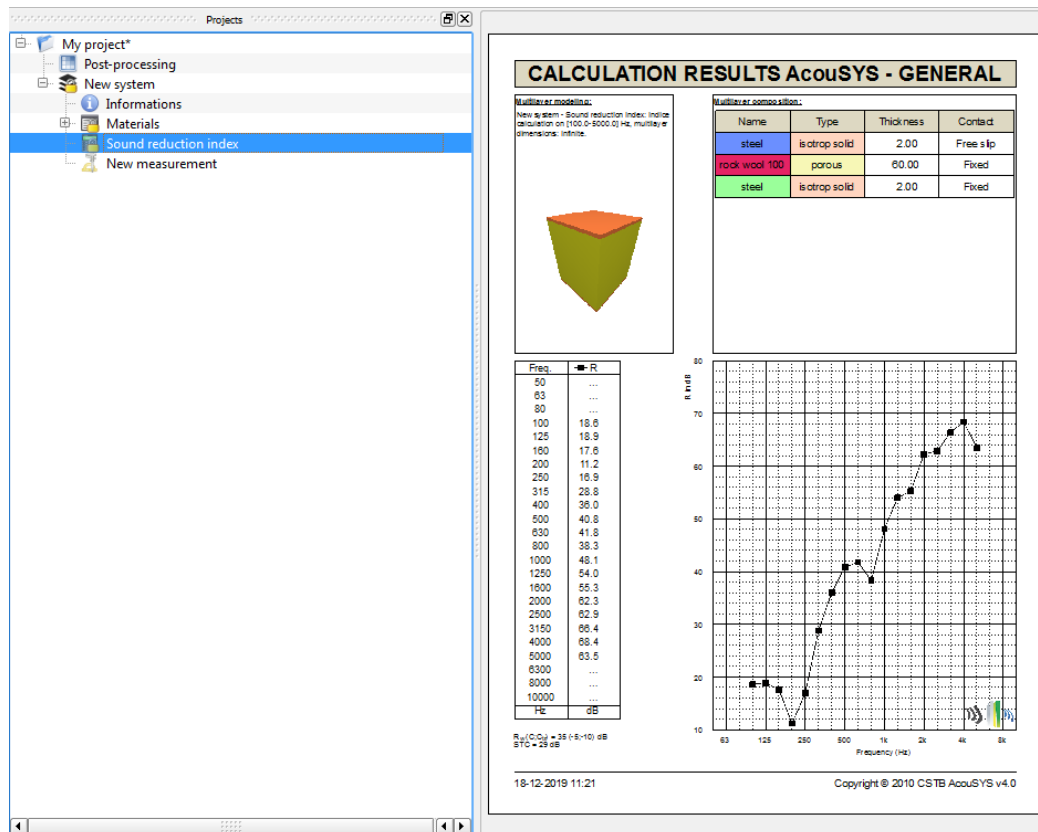

ABORT CALCULATION

When a calculation is in progress, this one may be stopped by clicking on the icon "Stop calculation" after selected it.

☀ The calculations on systems with many layers, with porous or orthotropic materials, with user-defined dimensions can be time consuming.

RESULTS VISUALIZATION

Once a calculation is achieved, this one is locked (as the multilayer) and it appears a locker . The result is displayed by clicking on the calculation.


☀ When a calculation is unlocked by clicking on "Unlock", the results are deleted and are not visible anymore.

☀ If the calculation was moved in an object of the "Post-processing" section, this one is still viewable. Nevertheless, it is not associated to a multilayer and only corresponds to the results of the calculation.

DELETE A CALCULATION

In order to delete a calculation if this one is not locked, select the calculation and click on the icon "Remove", or right click on this one and select "Remove". This function is also available by pressing "DEL" on the keyboard.

In order to delete a calculation if this one is locked, select the calculation and click on the icon "Remove" or right click on this one and select "Remove". This function is also available by pressing

"DEL" on the keyboard. A warning is displayed. Click on "YES" if you want to delete the calculation; all the results will be deleted and lost (excepted if the results were moved in the "Post-processing" object). Click on "NO" if you want to keep the results.
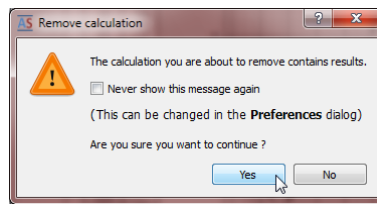

☀ *This warning may be removed in the Preferences menu (icon "Preferences" or Menu "Edit" and "Preferences").*
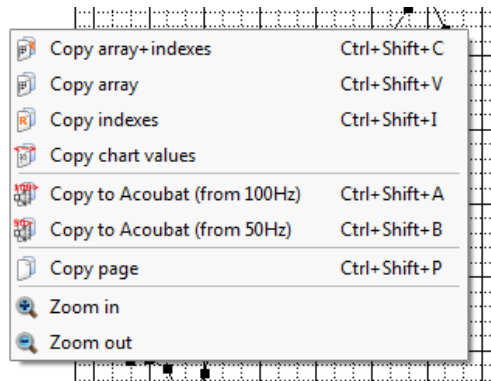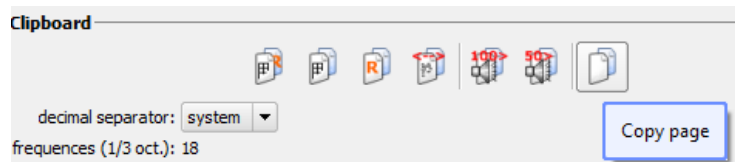
POST-PROCESSING

VIZUALIZE AND EXPORT RESULTS

To visualize calculation results simply select the calculation; the post-processing view will automatically appear. The first page shows the main calculation results. On the following pages a detailed summary of the calculation appears. It shows the all parameters used for the calculation as well as the intermediate calculation results. The dynamic range of the graph can be adjusted with the combo box "Maximum level". The zoom level can be changed with the help of controls in the zoom frame or of the mouse (CTRL+clic) on the area to zoom.
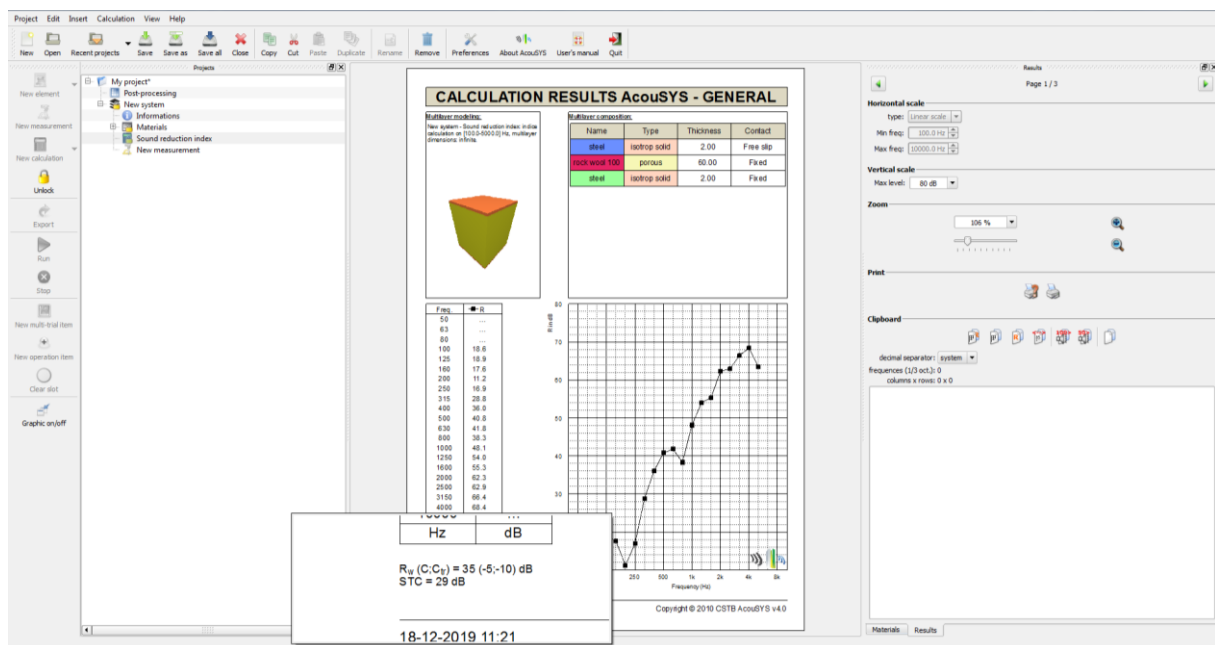

The sheet can be exported as is by clicking on the "copy page" button in the "Clipboard menu or in the contextual menu (available with mouse right click on the calculation results).

Similarly, the values can be exported to a datasheet with the help of the "copy chart values" button. The copied data will appear in the window in the "Clipboard" menu and can then be pasted into a spreadsheet. The decimal separator (dot or comma) can be selected using the list box in the "Clipboard" menu.

COMPARE SEVERAL CALCULATIONS/IMPORTED MEASUREMENTS

Several calculations or measurements can be compared on the same result sheet. To do so, select the post-processing item and click on "New multi-trial item"; a new item with five empty slots will appear. It is also possible to create a multi-trial item with 3, 5, 7 or 9 empty slots with the contextual menu (available with mouse right click on "Post-processing"). Any number of Multi-trial items can be created.
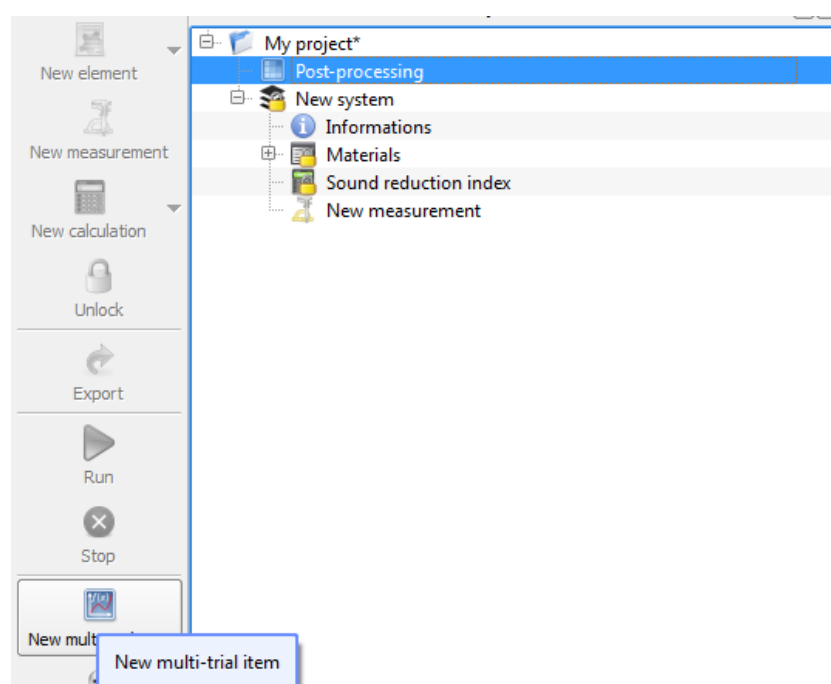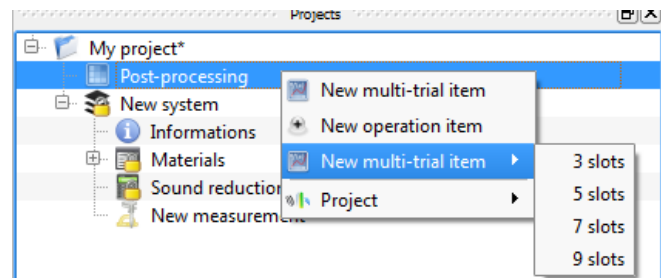
To import a new calculation (or measurement) within the multi-trial item, simply drag and drop the calculation (or measurement) to an empty slot.
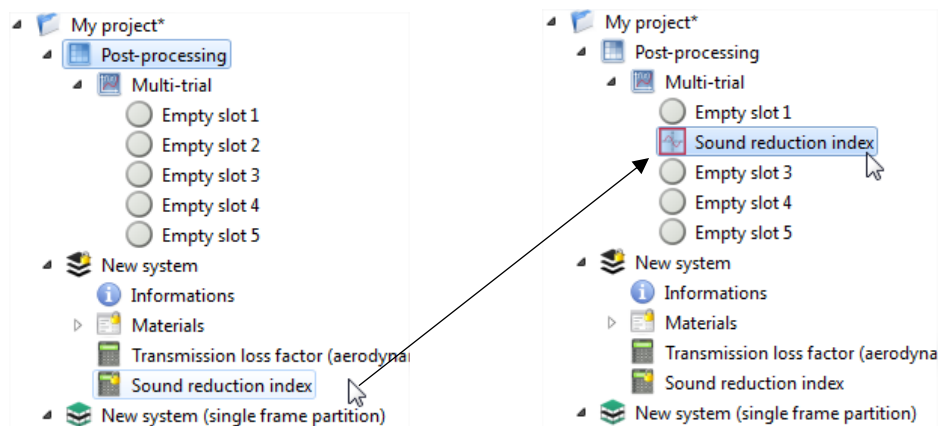
Repeat the operation until all calculations and measurements have been imported in the multi-trial item. Note that it is impossible to import items with different units within the same multi-trial item. For example, it is not possible to compare a sound reduction index with a sound absorption coefficient. To free a slot, select it and hit the Del key, or right-click on the item and select the "Clear slot" operation.
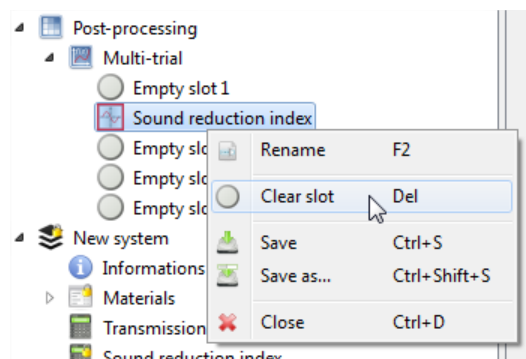
Once the multi trial item us set up as needed individual results can still be visualized by selecting the corresponding slots. To visualize all results within the same sheet simply select the multi trial item:
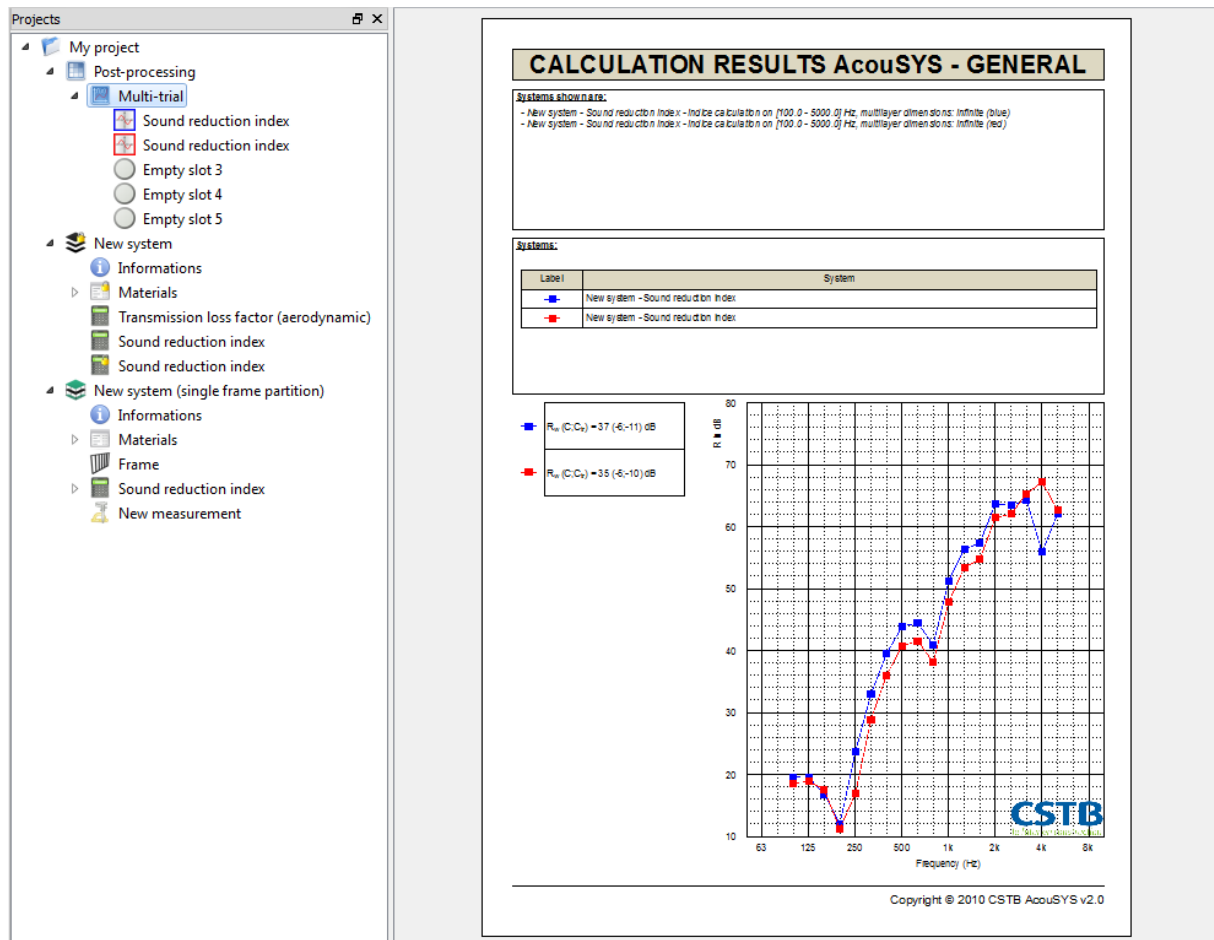

On the first page of the result sheet appears the calculation (or measurement) placed in the first slot. The second page shows a graphical comparison of all calculations and measurements in the multi-trial item.

PERFORM OPERATIONS ON CALCULATIONS/MEASUREMENTS

Simple operations (additions and subtractions) can be performed on calculations and/or measurements. Select the Post-processing item and click on "Add new operation item"; a new item with two empty slots appears.

The operation (addition or subtraction) can be set by right-clicking on the operation item and selecting the needed operation:
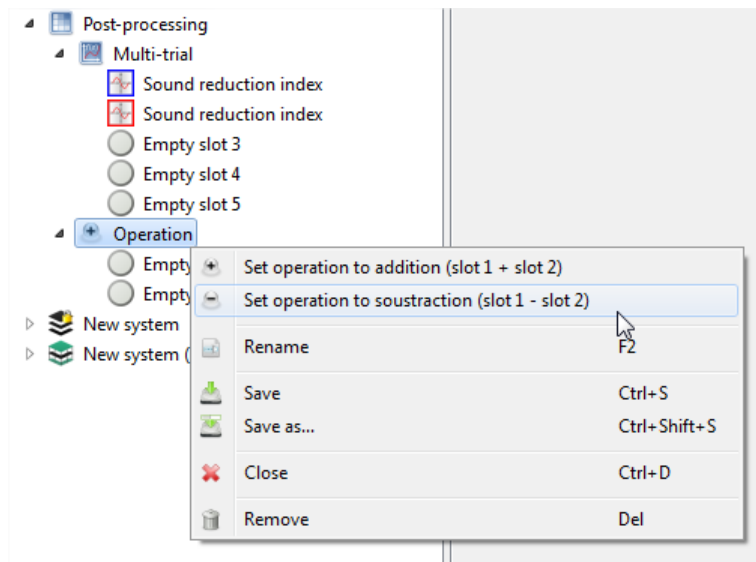
Note that in the case of a subtraction the operation performed is slot 1 – slot 2.

To import a calculation or measurement within an operation item simply drag and drop the item to an empty slot. Repeat the operation with the second slot. Note that you cannot perform operations on calculations or measurements with different units. For example, it is not possible to calculate the difference of a sound reduction index with a sound absorption coefficient. The result of the operation can be visualized by selecting the operation item.

Projects

- My project*
  - Post-processing
    - Multi-trial
      - Sound reduction index
      - Sound reduction index
      - Empty slot 3
      - Empty slot 4
      - Empty slot 5
    - Operation
      - Sound reduction index
      - Sound reduction index
  - New system
    - Informations
    - Materials
    - Transmission loss factor (aerodynamic)
    - Sound reduction index
    - Sound reduction index
  - New system (single frame partition)
    - Informations
    - Materials
    - Frame
    - Sound reduction index
    - New measurement

CALCULATION RESULTS AcouSYS - GENERAL

Multilayer modeling:

Systems shown are:
- New system - Sound reduction index – indice calculation on [100.0 - 5000.0] Hz, multilayer dimensions: Infinite (blue)
- New system - Sound reduction index – indice calculation on [100.0 - 5000.0] Hz, multilayer dimensions: Infinite (red)
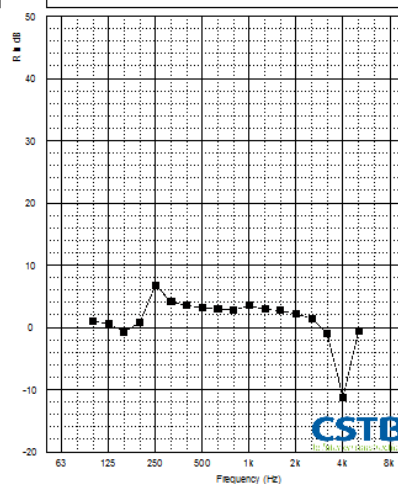
Multilayer composition:

Name	Type	Thickness	Contact
steel	Isotropic solid	2.00	Free slip
rock wool 100	Porous	60.00	Fixed
steel	Isotropic solid	2.00	Fixed
steel	Isotropic solid	1.00	Fixed

Freq.	R
50	...
63	...
80	...
100	1.0
125	0.6
160	-0.7
200	0.8
250	6.8
315	4.1
400	3.5
500	3.2
630	2.9
800	2.8
1000	3.5
1250	2.9
1600	2.7
2000	2.2
2500	1.4
3150	-1.0
4000	-11.3
5000	-0.5
6300	...
8000	...
10000	...
Hz	dB

$R_w (C;C_{tr}) = 2 (0;1)$ dB

15-févr.-2012 14:40

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