SEA-Foam & SEA-Cyl Overview

Designing Acoustic Performance

By analyzing and predicting acoustic performances (transmission and absorption) of complex multi-layered wall partitions in vehicles and buildings.

SEA-Foam is an optional module of SEA+ software based on Statistical Energy Analysis (SEA).

SEA-Foam module multiplies the capability of SEA+ by creation of acoustic trims connected to structural and/or acoustic subsystems for predicting interior or radiated noise.

SEA-Foam Library

A trim is a coating made of several kinds of layers.

SEA-Foam layer types are listed as follows:

- **Foam layer (porous biphasic foam, limped foam, limped foam with shear)**
- **Fiber layer (with or without structural shear)**
- **Thick elastic plate layer (flat plate geometry only)**
- **Fluid layer (gas or heavy fluid)**
- **Thin elastic shell (flat plate, singly-curved or doubly-curved shells)**
- **Septum layer**
- **Perforated sheet layer (equivalent porous biphasic foam, equivalent dissipative fluid)**

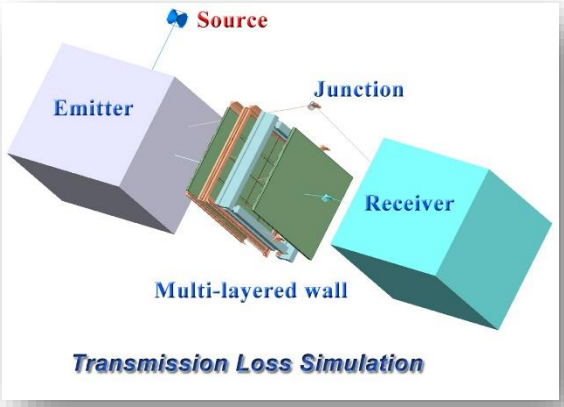
SEA-Foam Advanced Features

The prediction of trim acoustic transmission is performed using the Transfer Matrix Method (**TMM**).

Unlimited number of layers may be assembled.

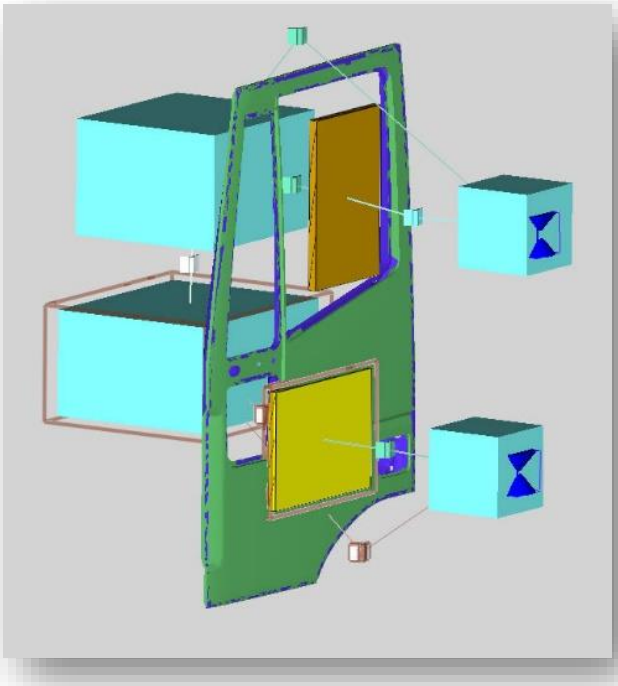
Among advanced features available in SEA-Foam:

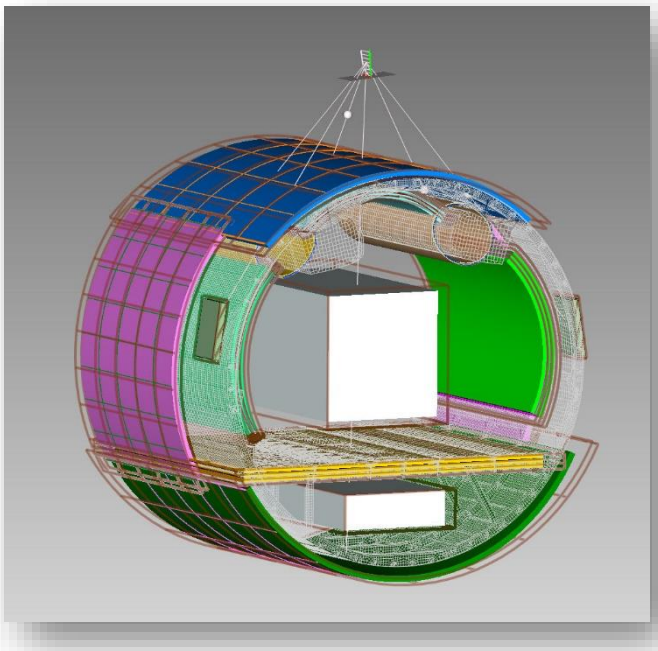
- Curvature corrections improve transmission and insertion loss prediction of curved geometry
- Properties of elastic panels covered by trims are automatically modified by added mass and added damping
- Trims properties can be computed at different temperatures
- Porous materials can be compressed
- Patch of trims may also be applied to a panel
- Prediction of acoustic transmission and absorption properties for diffuse field or grazing incidence
- Spatial windowing for finite-sized corrections



Some Applications

- Analysis of Aircraft in-flight interior noise due to turbulent boundary layer noise or incident engine sources
- Car and truck interior noise design in multi-source configuration
- Environmental noise in factories
- Insulation analysis in buildings





SEA-Foam & SEA-Cyl Specifications

SEA-Foam Library

- Porous material: Biot-Allard theory
- Limped foam
- Fiber
- Fiber with Shear
- Air Gap
- Thin panel with construction inherited for SEA+: homogeneous, sandwich, laminate with and without curvature, with and without ribs
- Thick homogeneous panel
- Perforated plate
- Septum

Spatial Windowing

- Use: correction for finite-size of the specimen
- 2D or 1D correction
- No need to limit the angle of integration to 78.5°: give correct prediction of diffuse field mass law

Interaction of Trim with Supporting Panel

- Added damping
- Added mass
- Work for heavy fluid

Power Flow Calculation

- Explicit separation of resonant (modal) transmission and non-resonant (mass) transmission
- Use: diagnosis of whether damping or mass is effective in a frequency band

Control of Transmission under Incidence

- Diffuse field transmission loss
- Customizable grazing incidence
- Acoustic transmission in a solid angle

Frequency Bandwidth

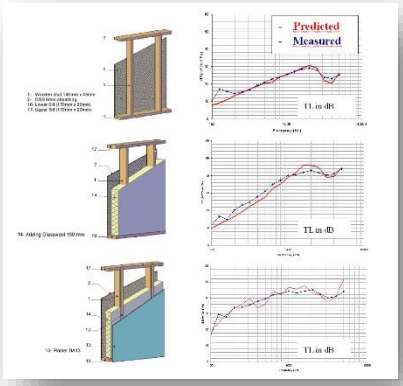
Work in 1/Nth octave band from octave down to 1/24th octave and in constant bandwidth

Outputs

- Transmission loss (**TL**)
- Insertion Loss (**IL**)
- Absorption coefficient

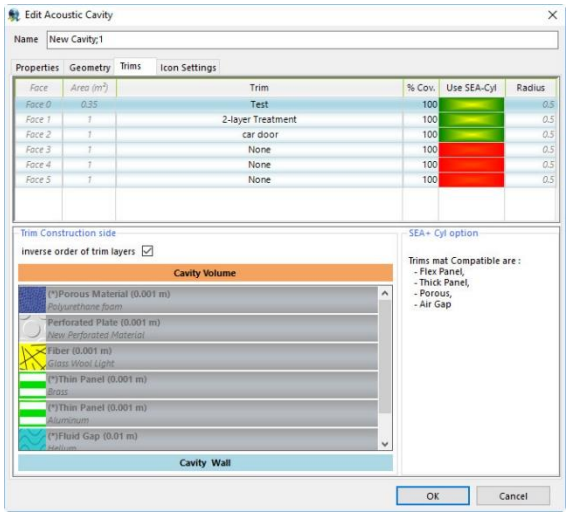
Applying Trim to SEA+ Subsystems

- All structural analytical and Virtual SEA (**VSEA**) subsystems of any type can be trimmed
- Trims can be applied to cavity for absorption prediction
- Trims can be inserted in acoustic-to-acoustic junctions
- Several trims may be applied to a subsystem or a junction
- - Trims may be individually enabled or disabled for sensitivity analysis



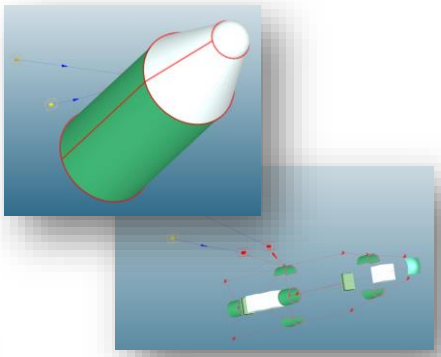
SEA-Cyl

SEA-Cyl is an optional module of SEA-Foam. SEA-Cyl (developed by CSTB) is a very efficient spectral approach of cylindrical multilayered systems improving accuracy of acoustic transfers in SEA or VSEA models in SEA+ software. It leads to refined physical behavior with quick and robust simulation of any trimmed curved element.



SEA+ / SEA-Cyl

Application to Sound Reduction



- Predicting performance of sound insulation packages, applied to curved structures in mid & high frequency ranges, is improved thanks to SEA-Cyl
- SEA-Cyl performs all TMM* computations expressing acoustic trim layers & master structure in cylindrical coordinates
- Within one click, it is possible to switch from TMM calculation in planar configuration (classical case) to full cylindrical configuration
- Curvature is known for changing radiation properties of structures but influences also the transmission properties of trims and their effect on master structure, taken into account in SEA+

Example: a single layer of porous material may considerably change the transmission behavior of an aerospace structure whether its dynamic behavior is computed in planar or curved configuration

(*) TMM (Transfer Matrix Method): classical method to compute transmission through various acoustic layers (the trim, generally modelled in planar configuration) applied to a supporting structure modelled in the SEA framework with the appropriate geometry

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