Why, product needs

Firewall grommets
- Safe routing of the harness
- Water tightness
- Acoustic performance

Cost issues
- Functions leading to expensive solutions
- Material mass contributing to the acoustic performance

Time to market issues
- Prototyping
- Acoustic testing

Challenge
- Smart solutions, acoustic design rules
- Early phase simulation
How, product development

Firewall grommets

• Concepts and solutions
• Design justification

Acoustic simulation
product design rules
Contents

• Introduction
• Experiment vs FEA
• Validation of the simulation
• Design rules
• Conclusion and perspectives
Introduction

Experiment
• Tests of prototypes in CEVAA Small Cabin

Computation
• Same model as testing

Correlation and model updating
• Validation on a reference and several prototypes

Design rules
• Validation of virtual prototypes
Introduction

Numerical Analysis

- Use of free and open-source softwares
  - FEA software Code_Aster (www.code-aster.org, developed by EDF)
  - Pre and post processing with Salome
Experiment vs FEA

Methods

• Small Cabin
  – Measurement of the acoustic performance
  – Description of the test
• 2 rooms
• Measurements up to 10 kHz
Methods

• Insertion Loss (IL)
  - Difference of Sound Pressure Level (SPL) between two configurations

**Configuration 1**: plate steel only

**Configuration 2**: Wiring grommet with soundproof materials

\[
IL (\text{dB}) = 20 \times \log_{10} \left( \frac{p_2}{p_{\text{ref}}} \right) - 20 \times \log_{10} \left( \frac{p_1}{p_{\text{ref}}} \right)
\]

• Acoustic indicator used for this study
Methods

• Computational method
  – Numerical modeling of the small cabin and the wiring grommet
    • 3D model and axisymmetric model

– Computation hypotheses
  • Fluid/Structure interface
  • Anechoic condition
  • Damping Loss factor
  • Felt in air

Components of the computation (zoom on the axisymmetric model)
Validation of the simulation

Validation with a reference

• Reference configuration

  - Configuration 1
    • Layer of steel plate

  - Configuration 2
    • Layer of steel plate
    • Layer of a felt
    • Layer of heavy mass (EPDM)

Computation of the IL for the reference.
• Facing noise emission, dash grommet admits some parameter which can improve the acoustic transparency of the grommet. These parameters admit a configuration which allow an optimal acoustic performance.

• A parametric model was built to work on several acoustic parameters. For example, these parameters were studied:
  1. Thickness of the global structure
  2. Acoustic lip thickness
  3. Second cavity length
  4. First cavity length
  5. Acoustic ring thickness
  6. Thickness of the vertical partition
  7. Thickness of the horizontal partition
1. Create quickly different meshes with the parametric model
2. Simulate each configuration and compute the insertion loss evolution
3. Compute a comparative indicator
4. Validation and diagnostic of results

1. Create quickly different meshes with the parametric model
2. Simulate each configuration and compute the insertion loss evolution
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4. Validation and diagnostic of results
• **Test diagnostic** – It can be possible to see product behavior in bench test.

• **Design rules** – Several parameters were studied during this project, and design rules were developed to allow a dash grommet design with acoustic performances without several prototypes.

• **Mechanical behavior** – Structural element can be sized and validated.

• **3D model** – In case of non-axisymmetric product, 3D model can be studied despite of important simulation cost.
Conclusions

**Computation of the Small Cabin experiment**
- 3D model and axisymmetric model computed
- Validation of the simulation with a reference
- Comparison with tests results on a study case
  - Similar trends obtained
  - Similar acoustic average
  - Good indicator of the acoustic performance of the product

**Acoustic simulation to help smart design**
- High acoustic performance level
- Weight and cost savings versus overmolding

**Design rules to support the dash grommet development**
- Optimal length of cavities
- Ratio weight / acoustic performances studied for grommet thickness and lip thickness
Improvement of the model
• Better material characterizations
  - Various material properties (temperature evolution, porous felt…)
  - Taking into account acoustic leaks
• Study of damping computation

Complete design rules with others dash grommet geometries
• Validate design rules on axisymmetric grommet close to HJD product
• Study of different geometries to develop design rules for grommet categories
Thank you for your attention

Federico CABRERA PAEZ
Component Development Manager
LEONI Wiring Systems France SA
5, avenue Newton
F-78180 Montigny-le-Bretonneux
VoIP-No. 800503067
Tél : +33 (0)1 30 85 30 67
Port : +33 (0)6 10 89 76 16
mailto : federico.cabrera@leoni.com

Quentin PELLOIE
Vibration and acoustic project manager
CEVAA
2, rue Joseph Fourier
F-76800 Saint-Etienne-du-Rouvray
Tél : +33 (0)2 32 91 73 50
mailto : q.pelloie@cevaa.com