Lumped Element Multimode Modeling of Balanced-Armature Receiver with COMSOL

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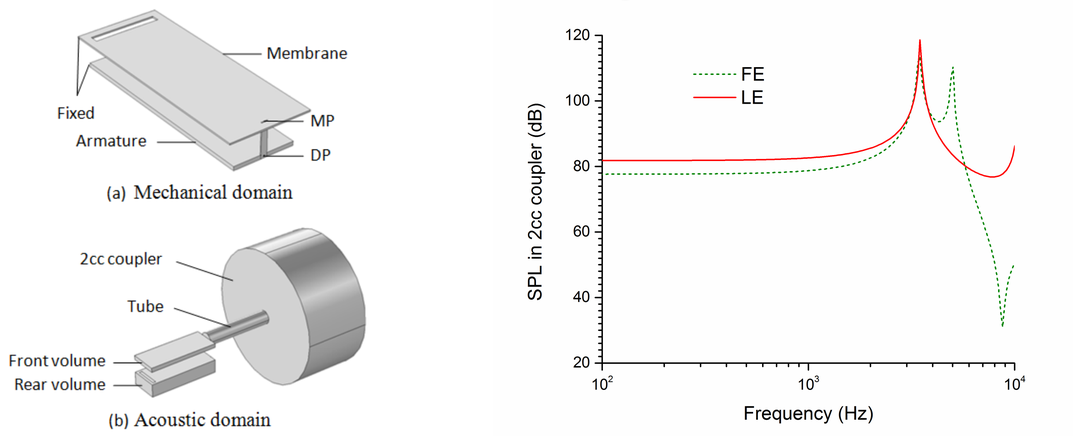
Introduction: For the lack of higher-order modes, lumped element (LE) models currently used may be insufficient to predict the system of balanced-armature receiver (BAR). The efficiency of the known combined FE-LE model is improved a little in comparison to the pure FE model. However, it is still a bit time-consuming and not applied to the engineering application because of still containing the FE part. We therefore develop a LE multimode modes to break through these hurdles.



Simplified BAR — Obvious difference Vs. FEM

Figure 1. Existing problem of the current LE model

Solution Method: The LE multimode model is developed for BAR in the frequency domain based on the techniques of mode decomposition, truncation, and selection with the aid of COMSOL Multiphysics®.

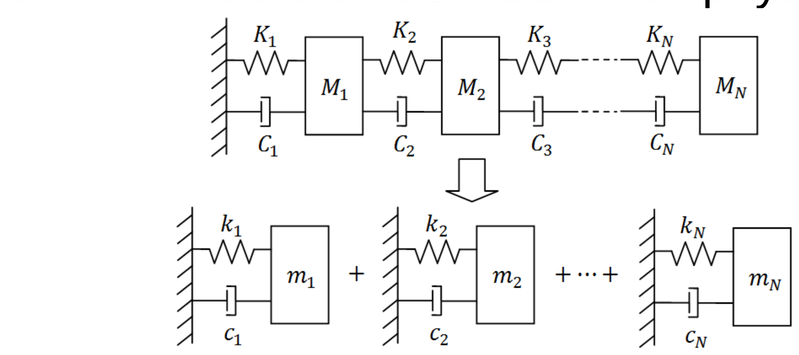


Figure 2. Decoupling the system into a set of SDOF systems

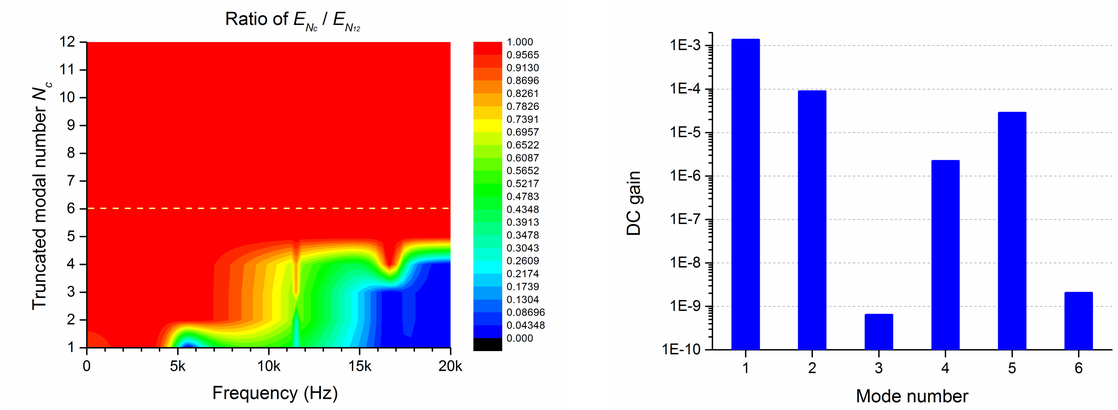


Figure 3. Mode truncation using energy norms and mode selection with DC gains for the contained vibration system

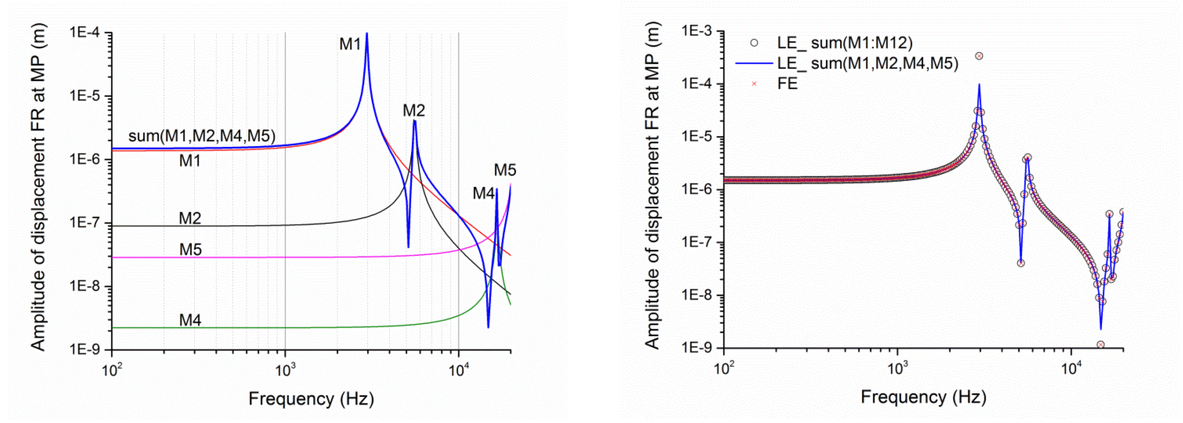


Figure 4. Validation of the determined modes in mechanical domain with displacement response at measure point

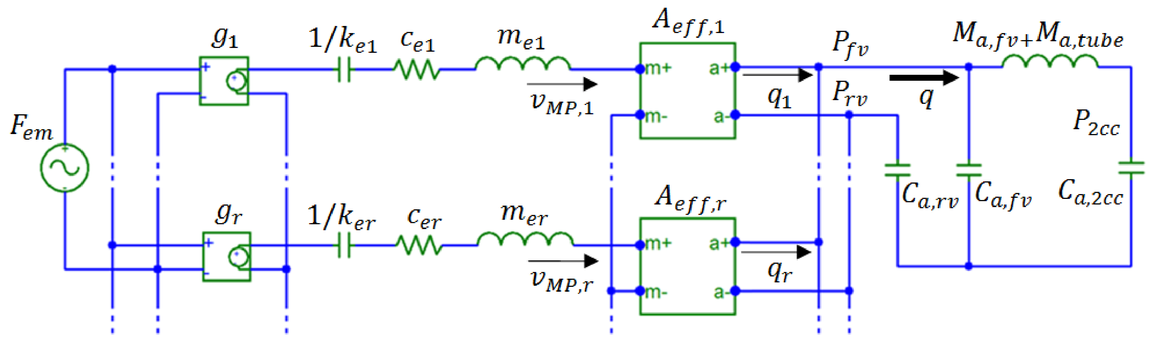


Figure 5. Developed LE multimode model for BAR

Results: The developed LE multimode model is validated by comparing with both the corresponding combined FE-LE model and the full FE model. Numerical results prove the developed model is not only as effective as the combined FE-LE model, but also much more efficient.

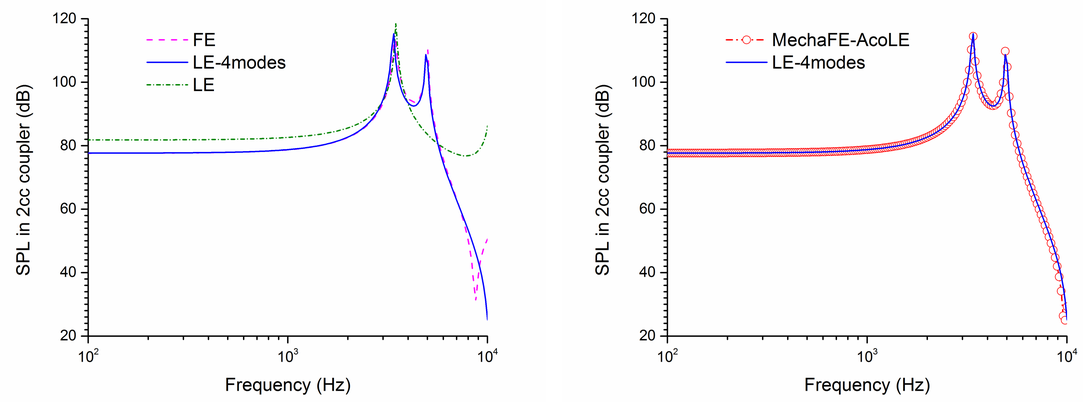


Figure 6. Developed LE multimode model Vs. the pure FE model and the current LE model

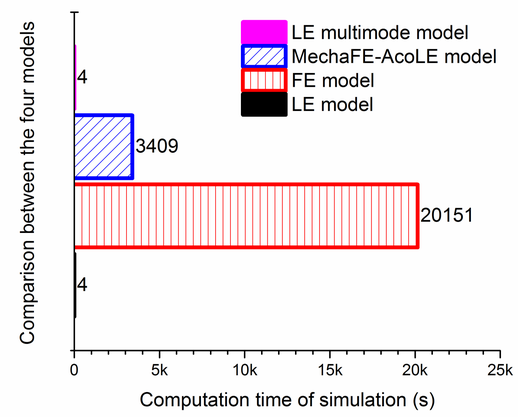


Figure 7. Comparison of the consuming time between the concerned four models

Conclusion: With the aid of COMSOL, we can conveniently extract the modal parameters for the decomposed modes. The developed LE multimode model based on the determined dominant modes is not confined to BAR. It is also applied to other types of transducers if only containing vibration structure.

Reference:

1. Wei Sun and Wenxiang Hu, Lumped Element Multimode Modeling of Balanced-Armature Receiver Using Modal Analysis, Journal of Vibration and Acoustics, **138**(6), 2016.
2. Wei Sun and Wenxiang Hu, Lumped Element Multimode Modeling for a Simplified Balanced-Armature Receiver, 23rd International Congress on Sound and Vibration, 2016.
3. Wei Sun and Wenxiang Hu, Integrated Finite-Element and Lumped-Element Modeling of Balanced-Armature Receiver, 21st International Congress on Sound and Vibration, 2014.

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