On the use of the wave based technique for three-dimensional analysis of coupled vibro-acoustic radiation problems

Jan Rejlek

Virtual Vehicle Research and Test Center, Area C NVH & Friction Inffeldgasse 21A, A-8010, Graz, Austria
jan.rejlek@v2c2.at

Joint work with: Hans-Herwig Priebsch

Over the past years the wave based technique (WBT) has been developed as an alternative deterministic method for solving vibro-acoustic problems in the mid-frequency range. The WBT adopts an indirect Trefftz approach in which it incorporates the a priori knowledge of the solved problem. The field variables are expressed in terms of globally defined basis functions which are the exact solutions of the homogeneous governing differential equation. As a result, fine element discretisation is no longer needed which yields smaller numerical models that exhibit an enhanced computational efficiency as compared to element-based methods.

Up to now, only a one-way structural-acoustic coupling strategy has been employed in the wave based formulation for the analysis of three-dimensional problems involving unbounded acoustic domains. In the real-life engineering practice, however, a considerable class of problems involves the strong coupling effects between the structure and fluid. Unlike the uncoupled structural and acoustic problems, respectively, the mutual coupling interaction is no longer negligible in the coupled vibro-acoustic systems implying that both parts of the problem have to be considered simultaneously.

This contribution discusses the basic concept and application of the WBT for the analysis of three-dimensional fully coupled structural-acoustic unbounded problems. In this type of formulation both the structural thin plate bending problem and the unbounded acoustic domain are described by means of a coupled wave based model. The validation examples demonstrate the efficiency of this novel approach by comparing the WBT results with those obtained by the state-of-the-art technologies based on the finite and boundary element method. These results also prove the applicability of WBT for real-life engineering problems in case the corresponding computational models can be built up in a time-efficient way. As the preprocessing of the wave models still involves a huge amount of man power, a further development towards a fully automated model generation process is needed.

Keywords: Vibro-acoustics, Trefftz approach, wave-based, numerical methods, boundary problem.