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An analytical model for predicting rotor broadband noise due to turbulent boundary layer ingestion

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Abstract

A semi-empirical analytical model is developed that predicts the noise produced by a rotor ingesting a boundary layer in proximity to a hard-wall. The rotor boundary layer ingestion noise source is an important source to include when a rotor is installed close to an aircraft fuselage. This is the case for a tail mounted counter rotating open rotor for example. This paper presents three extensions to Amiet's simplified rotor noise model to predict this noise source. The first extension is the method of images, which is used to model the acoustic reflections of the hard-wall. The second extension is an anisotropic velocity spectrum, which is used to model the boundary layer turbulence. The third extension is a numerical switch to account for the partial loading of the rotor as only a part of it is immersed in the boundary layer. The homogeneous anisotropic turbulence model used is a simplification of the actual turbulence the rotor encounters in the boundary layer. In reality, the turbulence in the boundary layer is not homogeneous in the wall-normal direction. Therefore, while the integral length scale in the streamwise direction can be determined from experimental or numerical data, the integral length scale in the wall-normal direction must be chosen empirically. The rotor noise model is validated by comparing its predic-

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