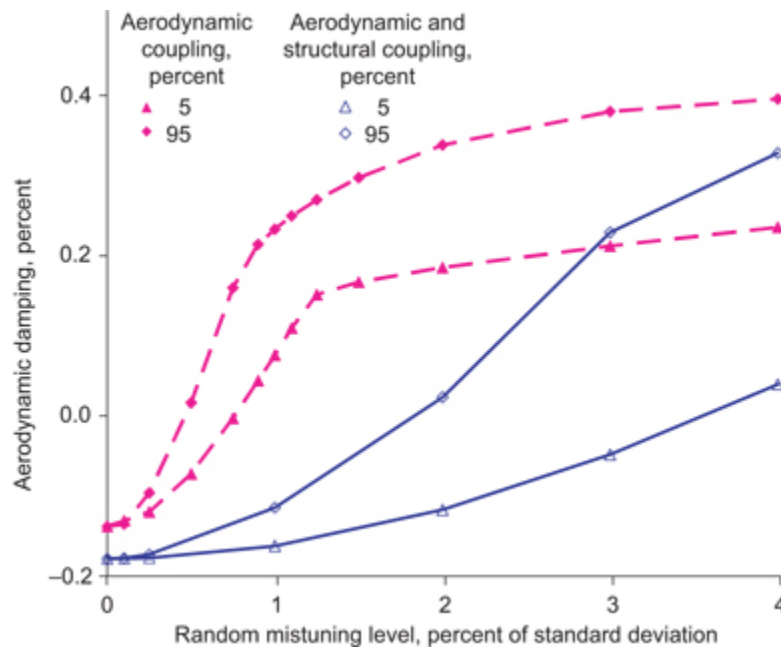


NESTEM Probabilistic Analysis Used to Study Mistuned Bladed Disks and Blisks With Aerodynamic and Structural Coupling

This document summarizes the initial results from a research effort at the NASA Glenn Research Center on blisk and bladed disk mistuning, including both structural and aerodynamic coupling. The structural coupling model is based on the Fundamental Mistuning Model (FMM, developed by Feiner and Griffin). This effort extends the FMM technique to accept aerodynamic coupling coefficients from computational fluid dynamic codes. The model was applied to a representative modern front compressor stage. Flutter stability and forced response were determined with structural coupling only, with aerodynamic coupling only, and with both structural and aerodynamic coupling. Tuned, randomly mistuned, and near alternately mistuned rotors were considered.



Effect of random mistuning on flutter.

Long description of figure. Graph of aerodynamic damping in percent versus random mistuning level in percent of standard deviation for aerodynamic coupling and aerodynamic and structural coupling of 5 and 95 percent.

The results show that, although structural coupling does not affect the stability of a tuned system significantly, it plays a key role in the stability of the mistuned system. In the test case considered, the beneficial effect of mistuning on flutter stability was greatly inhibited by the addition of structural coupling. The graph presents Monte-Carlo

simulation results of a randomly mistuned bladed disk. The system is unstable in the tuned state. The figure shows the 5th and 95th percentile aerodynamic damping values as a function of the standard deviation in blade frequency. As is well known, mistuning is stabilizing. However, the mistuning level required to stabilize the system with structural and aerodynamic coupling is approximately 4 times larger than when aerodynamic coupling is used alone. In addition, the mode shapes were found to differ significantly. For the forced-response case, the inclusion of aerodynamic coupling had a relatively small effect on the global and local response levels. Additional studies are needed to generalize these conclusions for other blade types and cases. In addition, future studies are planned to develop a model that considers multiple, interacting families of modes. This work was performed under NASA Grant NAG3-2928.

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