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Final Technical Report

for

Aeroelastic Stability & Response of Rotating Structures

NASA Grant Number
NCC3-446

Grant Duration
January 8, 1996 to November 30, 1997

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December 1998

Aeroelastic Stability and Response of Rotating Structures

Summary

A summary of the work performed from 1996 to 1997 is presented. More details can be found in the cited references. This grant led to the development of aeroelastic analyses methods for predicting flutter and forced response in fans, compressors, and turbines using computational fluid dynamic (CFD) methods.

(A) Analysis of Multi Blade Row Fans, Compressors, and Turbines

During this grant period, the multistage aeroelastic code MSAP2D, which was updated with a new algorithm in the previous period, Ref. 1, was exercised for validation, of the new algorithm. Several examples were run and the results were compared with those obtained previously. It was noted that the new algorithm produced the previous results with a 30% saving in computational time.

MSAP2D was also used to study the viscous effects on oscillating loaded blades with the new version. The code reproduced the results published in the literature. Some examples were run for flows in which flow separation was present. However, it could not predict separation for an airfoil where separation was supposed to occur. Some time was also spent on assessing the validity of the code for unsteady aerodynamic load prediction for cascades in supersonic flow with subsonic axial flow. It was decided that for both separated flow and for flows with subsonic axial flow further improvements are required to the MSAP2D code.

(B) Three Dimensional Aeroelastic Analysis Method for fans

Previously several analysis methods were developed to study the flutter behavior of fans. During this period a comparative study was undertaken to study these different methods, and their advantages and disadvantages. The findings of this study were presented in Ref. 2.

(C) Development of FREPS-E a Linearized Aeroelastic Solver.

A new activity was initiated to combine linearized unsteady Euler aerodynamic solvers to structural solvers. Euler solvers can predict the effect of strong shocks accurately compared to linearized solvers based on the potential equation. Clearly, the linearized Euler solver will be faster than the solver based on nonlinear Euler equations. During this period, a linearized unsteady Euler solver developed for NASA was acquired and implemented on a local workstation. The unsteady solver was run for several examples to get familiarity and check its validity for unsteady aerodynamic calculations. A framework for developing an aeroelastic response prediction code using linearized Euler equations was formulated

(D) Submission to COSMIC

During this research period, the ASTROP2 code was submitted to COSMIC. ASTROP2 is an aeroelastic code based on two-dimensional linear unsteady aerodynamic equations, and three-dimensional structural dynamic equations. An abstract was prepared for publication in the NASA Tech Briefs magazine. COSMIC implemented the ASTROP2 code on several workstations (LEW 16407).

Bibliography

1. Reddy, T.S.R. and Srivastava, R., User's Guide for MSAP2D: A Program for Unsteady Aerodynamic and Aeroelastic (Flutter and Forced Response) Analysis of Multistage Compressors and Turbines, Version 1.0, NASA CR 198521, August 1996.

2. R. Srivastava and Reddy, T.S.R., Application of Three Flutter Analysis Methods to a Ducted-Fan Configuration, AIAA-97-3287, 33rd Joint Propulsion Conf., July 6-9, 1997, Seattle, WA.