STRUCTURAL ANALYSIS

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Hot section components of aircraft gas turbine engines are subjected to severe thermal-structural loading conditions, especially during the start-up and take-off portions of the engine cycle. The most severe and damaging stresses and strains are those induced by the steep thermal gradients induced during the start-up transient. These transient stresses and strains are also the most difficult to predict, in part because the temperature gradients and distributions are not well known or predictable, and also because the cyclic elastic-viscoplastic behavior of the materials at these extremes of temperature and strain are not well known or predictable.

A broad spectrum of structures-related technology programs is either underway or will be in the near future to address the deficiencies previously mentioned. The problems are being addressed at the basic as well as the applied level, including participation by industry and universities as well as in-house at NASA Lewis. In addition to the HOST program, some elements are being supported through our Base R&T program.

One element of the structures program will develop improved time-varying thermal-mechanical load models for the entire engine mission cycle from start-up to shutdown. The thermal model refinements will be consistent with those required by the structural code including considerations of mesh-point density, strain concentrations, and thermal gradients. Models will be developed for the burner liner, turbine vane and turbine blade. One aspect of this part of the program is a thermal data transfer module currently under development which will automate the transfer of temperatures from available heat transfer codes or experimental data sets to the structural analysis code. Another part of the program which will soon be initiated is an automated component-specific geometric modeling capability which will produce 3-D finite element models of the components. Self-adaptive solution strategies will be developed and included to facilitate selection of appropriate elements, mesh sizes, etc.

Another major part of the program is the development of new and improved nonlinear 3-D finite elements and associated structural analysis programs, including the development of temporal elements with time-dependent properties to account for creep effects in the materials and components. Improved constitutive models to facilitate improved prediction of cyclic thermomechanical viscoplastic material behavior are also under development. Experimental facilities to aid in developing and verifying theories and models are currently being established in-house at Lewis.

Further explanation and some details about the various aspects of the structures program mentioned above will be given in the following write-ups.

HOST

STRUCTURAL ANALYSIS

OBJECTIVE:

TO DEVELOP AND VALIDATE INTEGRATED, TIME-VARYING THERMAL/MECHANICAL LOAD MODELS FOR IMPROVED STRESS/STRAIN/DEFORMATION PREDICTIONS IN GAS TURBINE ENGINE BURNER LINERS, TURBINE BLADES AND VANES. ALSO TO DEVELOP COMPONENT-SPECIFIC AUTOMATED GEOMETRIC MODELING AND SOLUTION STRATEGY CAPABILITIES AND ADVANCED INELASTIC ANALYSIS METHODS, INCLUDING PLASTICITY AND CREEP EFFECTS, FOR NONLINEAR, ANISOTROPIC, FINITE ELEMENT STRUCTURAL ANALYSIS AND DESIGN COMPUTER CODES.

STRUCTURAL ANALYSIS

PROGRAM ELEMENT	FISCAL YEAR 81	82	83	84	85	86	87	EXPECTED RESULT
THERMAL DATA TRANSFER								COMPUTER MODULE LINKING THERMAL AND STRUCTURAL ANALYSES
COMPONENT SPECIFIC MODELING								COMPONENT-RELATED, TIME VARYING, THERMAL-MECHANICAL LOAD HISTORY & GEOMETRIC MODELS
3-D INELASTIC ANALYSES								ADVANCED 3-D INELASTIC STRUCTURAL/STRESS ANALYSIS METHODS AND SOLUTION STRATEGIES
LINER CYCLIC RIG		(IH)						BURNER STRUCTURAL/LIFE EXPERIMENTS
HIGH-TEMPERATURE STRUCTURES LAB	(IH)							INTEGRATED EXPERIMENTAL /ANALYSIS RESEARCH
MATERIAL BEHAVIOR TECHNOLOGY		(IH)						MATERIAL CONSTITUTIVE MODELS

CD 82-13387

STRUCTURES

THERMAL/STRUCTURAL DATA MODULE	DR. R. J. MAFFEO, G. E.
COMPONENT-SPECIFIC MODELING	DR. M. HIRSCHBEIN, NASA
INELASTIC ANALYSIS METHODS	DR. C. CHAMIS, NASA
BURNER LINER CYCLIC RIG	DR. R. THOMPSON, NASA