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Structural analysis of aero-engine rotor

K. Kumar, S.L. AjitPrasad, K. Ramachandra

1 Research scholar, PES College of Engineering, Mandya, India.
2 Professor Department Mechanical Engineering, PES CE, Mandya, India.
3 Former Director, GTRE Bangalore, India.

Abstract

This paper describes the possible development process of upgrading a general purpose linear program, an analysis tool for linear optimization, to a dedicated 'Design-Tool' for gas-turbine compressor rotor drums and blades, as well as turbine components, such as discs This design-optimization tool developed exploits the quick convergence ability of a linear system for handling large iterations and overcomes the limitation imposed by material non-linearity, by embedding 'Neuberization' algorithm, for all decision points based on stress, strain and displacement, in the design-flow process. The design tool also incorporates ability to specify variable design-constraints such as radial & axial growth, over-speed and burst-speed margins etc.The design-optimization tool has been used successfully to reduce the weight of a compressor drum. Without violating the geometrical constraints imposed and meeting all the design goals. Cases where nearly 10 percent weight reductions have been achieved in discs and drums, through axi-symmetric analyses, with considerable saving in computer time, are presented in this paper. Multi-stage compressor drum is the optimization case presented and discussed. In addition to utilizing the standard powerful features available in the analysis code for sizing and shape optimization, it is possible to extend the capabilities of the program by customizing and incorporating user requirements like averaging the elemental stresses in rotor (area weighted average hoop stress (AWAHS)) in to the code, by using the available hooks to interface and linking user written subroutines.

***Key words**: Design optimization, Linear optimization tool, Neuberization*

1. Introduction

With the demand for the thrust-to-weight ratio of current generation aero-engines continuously increasing & going beyond 10, steadily advancing towards the ambitious goal of 20, the need for pushing advanced engine-materials to operate even in the non-linear regime satisfactorily, becomes almost mandatory. Critical engine-components need to meet the conflicting requirements of stiffness, strength, fatigue, creep and impact to operate in high speed, pressure and temperature environments, with minimum component weight and reliability associated with aero-engines.

The design process of assuring the structural performance of critical components, especially that of rotating parts, is highly iterative and demands delicate balance between the geometrical constraints dictated by

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