# Hover Performance Analysis of Advanced Rotor Blades

**C. Tung**
Research Scientist
U.S. Army Aeroflightdynamics Directorate, AVSCOM
NASA Ames Research Center
Moffett Field, California
and
**K. Ramachandran**
Research Scientist
Flow Analysis Inc.
NASA Ames Research Center
Moffett Field, California

## Abstract

This is an effort aimed at validating recent hover prediction methods. The experimental basis for this validation work is an extensive set of loads, wake and performance data, which were obtained from a pressure instrumented model UH-60 rotor tested at the Sikorsky hover test facility and at Duits-Nederlandse Windtunnel (DNW). This model was equipped with replaceable tips - including a tapered and a BERP-type tip - which permitted studies of the effects of rotor geometry. The central prediction method studied is a free-wake, vortex embedded, full-potential CFD method - called "HELIX-I". It is found that the HELIX-I code produces very good comparisons with the data including wake, surface pressure and performance. Comparisons with the measured radial load distributions have permitted an improved understanding of the wake resolution modelling requirements of CFD methods. Since HELIX-I is a combined Eulerian/Lagrangian method, limited comparisons are also made with a Lagrangian boundary element code (called "EHPIC") and an Eulerian Navier-Stokes code (called "TURNS"). In most cases all methods produce good comparisons with the data. It is found that the HELIX-I code provides a good compromise between the speed of boundary integral methods and the comprehensive nature of Navier-Stokes methods.

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## List of Symbols

| | |
|---|---|
| $a$ | = distance denoting region of variable vorticity |
| $C_t/\sigma$ | = ratio of rotor thrust coefficient to solidity |
| $C_q/\sigma$ | = ratio of rotor torque coefficient to solidity |
| $FM$ | = figure of merit |
| $FMI$ | = ideal figure of merit |
| $M_\infty$ | = free stream Mach number |
| $q^v$ | = rotational velocity field |
| $r$ | = spanwise distance along the rotor blade |
| $R$ | = radial distance to rotor tip |
| $V$ | = velocity |
| $V_{ave}$ | = local average velocity |
| $\gamma$ | = specific heat ratio |
| $\Gamma$ | = circulation |
| $\lambda$ | = normal distribution function |
| $\rho$ | = density |
| $\phi$ | = potential function |
| $\omega$ | = vorticity |

## Introduction

The most recent generation of helicopter rotors are marked by significant departures from the usual