شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأفلام قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأفلام بعيدا عن الغبار

في درجة حرارة من ١٥-٢٥ مئوية ورطوبة نسبية من ٢٠-٤٠%

To be Kept away from Dust in Dry Cool place of 15-25- c and relative humidity 20-40%

بعض الوثائـــــــق الاصليـــــة تالفـــة

بالرسالة صفحات لم ترد بالاصل

Mansoura University
Faculty of Engineering
Mechanical Power Engineering

Experimental Investigation of Single Wing Stall Flutter

A Thesis Submitted in Partial Fulfillment for The Requirements of The
Master Degree
in Mechanical Power Engineering

By
Eng. Salah Aly Dafee
B.Sc. Mechanical Engineering

Supervisors

Prof. Dr. Hassan M. El-Saadany
Faculty of Engineering
Mansoura University

Dr. Abdel-Rahim A-B Dohina
Faculty of Engineering
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1995

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بسم الله الرحمن الرحيم

" قالوا سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم"

صدق الله العظيم

الآية ٣٢ من سورة البقرة"

Mansoura University
Faculty of Engineering
Mechanical Power Department

Supervission Committee

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Thesis Title:

Experimental Investigation of Single Wing Stall Flutter

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Examination Date: 18/12/1995

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ABSTRACT

Flutter of aircraft wings or turbomachinary bladings occurs when the flow is separated from the suction surface of the profile during all or part of the cycle of oscillation. Due to the adverse pressure gradient, the separation of the boundary layer that is confined to a thin layer causes the so called airfoil stall. The unsteady nature of the flow separation from the airfoil surface causes the unsteadiness of the stall phenomenon. This stall in turns causes the aerodynamic forces, such as the lift and the moment, to change with certain frequency. This dynamic behavior of the aerodynamic forces tends to vibrate the structure of the airfoil element. The entrainment of the natural frequency with the aerodynamic frequency makes the airfoil to experience self vibratory motion which is called *flutter*.

The present study is for a two-dimensional characteristic airfoil section with a two degrees of freedom in bending and torsion. The airfoil freely moving inside the test section which is mounted on a subsonic air speed wind tunnel. Two sides special mechanisms are designed to

maintain freely motion in the two degrees of freedom, bending and torsion. These mechanisms are being mounted on the two vertical side walls of the test section.

The objective of the present study is to investigate experimentally the effect of blade natural frequency on the stall frequency. A practical values of the blade natural frequency has been chosen in the range of $k = 0.22$ to 0.55.

A strain gauge technique has been used to measure vibrations of airfoil in the two degrees of freedom. The strain gauge signals are fed to a data acquisition system in which the signals has been digitized and recorded. The data is then post processed on the laporatory personal computer employing the Fourier analysis technique.

The present study has indicated clearly that the flexibility of the blade structure in practice, affects the aerodynamic response for stall flutter. The increase of the airfoil natural frequency increases the stall frequency. This proves that the airfoil vibrations affect the boundary layer structure and, in turns, the stall frequency.

It is concluded, from the results, that the aerodynamic forces adjust itself to maintain a response of a nearly constant amplitude even the natural frequency of the airfoil is changed. This emphasis that, the unsteadiness of the aerodynamic force due to stall is more pronounced.

It has been also found that the increase of angle of attack increases both blade vibrating frequency and amplitude.

Only, the chaotic response with no dominant frequency has been observed in the case of bending vibrations. This result agrees with that obtained by Hauenstein and Laurenson [9].

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