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THE SELF-EXCITED VIBRATION OF THE NACA0015 PROFILE

V. Vlček, I. Zolotarev, J. Kozánek*

Abstract: *The two-dimensional flow pattern around the vibrating profile NACA0015 with his self-excitation mode was measured in the wind tunnel by optical methods. The used profile with two-degree-of-freedom moved in the vertical direction to the flow direction and rotated around the elastic axis in 1/3 of the profile chord. The Mach numbers for the self-excitated profile vibrations was in the interval 0.2-0.45. Some results of the interferometric measurements and the profile kinematic movements during the self-excitations are presented.*

Keywords: ***self-excited vibrations, aeroelastic experiment, wind tunnel, flutter .***

1. Introduction

Aeroelastic experiments were realized in the aerodynamic tunnel of the Institute of Thermomechanics AS CR in Nový Knín with modified NACA0015 profile. The range of Mach numbers M corresponding to the self-excited vibrations was in the rang M = 0.2 – 0.45 and the Reynolds number range was $(0.25 – 0.54)\cdot 10^6$. The detail description of the experimental setup is in the paper Vlček et al. (2009), schematic arrangement is in Fig.1. The flow field was measured by interferometric and pneumatic methods, the profile position was indicated by mechanical sensor.

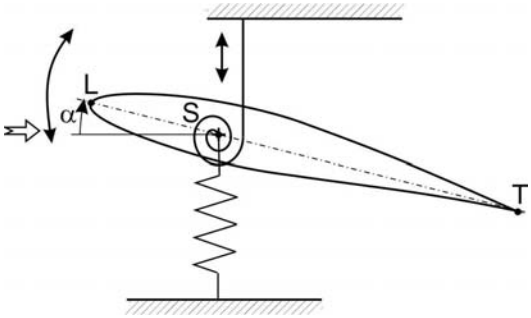

Fig.1 Schematic arrangement of the experiment

Eigenfrequencies for M = 0 were 19.0 Hz with 9.3 % damping in translation mode and 21.5 Hz with 11.9 % damping in rotation mode.

2. Experimental results

The new arrangement of the system with closer values of eigenfrequencies (corresponding to the translation and rotation motion of the profile) influenced the properties of the flow-field and mechanical structure interaction. As it is depicted in Fig. 2 by increasing the inflow velocity, already at M = 0.26 an area-wide separation occurs and the frequency of the vibration arises above the both eigenfrequencies identified for M = 0. The increase of the vibration level was so high that at M = 0.45 the experiment had to be finished due to the danger of system destruction. The flutter frequency of the vibration in this process increased 1.6 times and the optical measurements showed that the area-wide separation during 25% to 50% of the vibration period appeared. The evaluation of interferograms is described in Šafařík, Vlček (1985).

* Ing. Václav Vlček, CSc., Ing. Igor Zolotarev, CSc., Ing. Jan Kozánek, CSc.: Institute of Thermomechanics AS CR, v.v.i., Dolejškova 1402/5, 182 00 Praha 8, Czech Republic; e-mail: vlcek@it.cas.cz, igor@it.cas.cz, kozanek@it.cas.cz .

The kinematics of the airfoil motion during one period of the self-excited vibrations in the case of aera-wide separation for M = 0.45 is depicted in Fig. 3. There is interesting that the zero angle of attack was achieved about 15 – 20% of the maximal amplitude of the rotation center motion only.

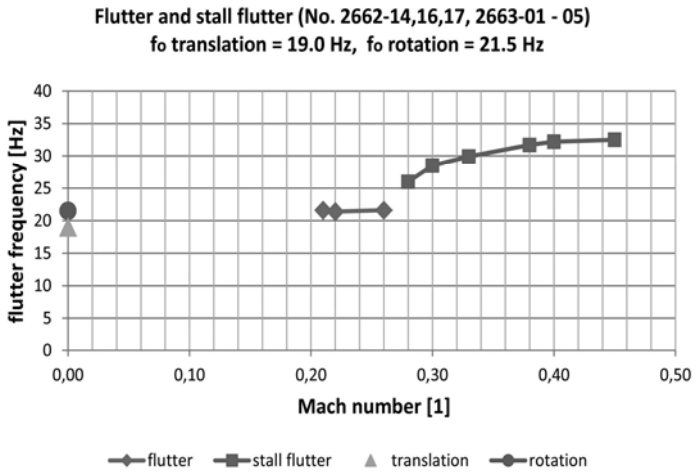

Fig. 2 The flutter frequency changes of the self-excited vibration as a function of the Mach number

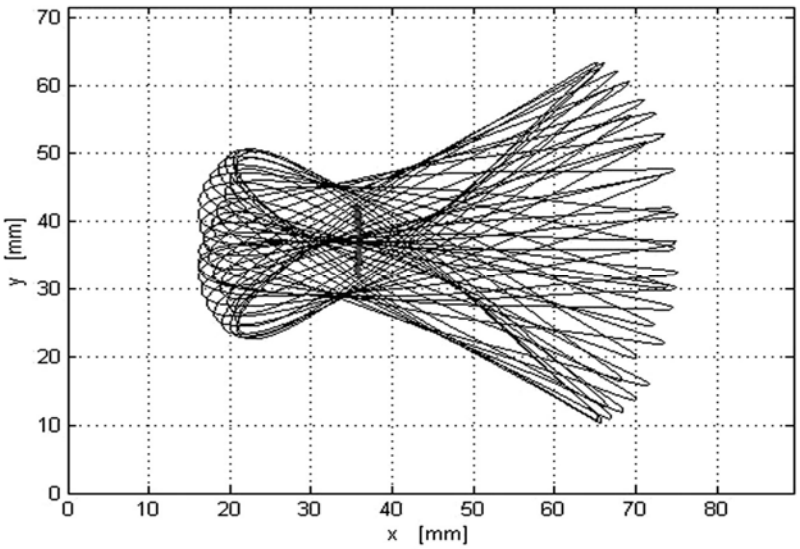

Fig. 3 The kinematics of the profile corresponding to the interferograms 2663-05, M=0.45.

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