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# Experimental Investigation of the Flutter Incidence Range for Subsonic Flow Mach Numbers

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**Abstract:** For the grant of the Grant Agency of the Czech Republic „Subsonic flutter analysis of elastically supported airfoils using interferometry and CFD“ new airfoil model NACA0015 was constructed and manufactured. Profile is divided in five parts and inside is the replaceable elastic element, which enable the pitch angle changes. Inside the body there is also pitch angle sensor and four semiconductor pressure sensors. The second degree of freedom is allowed by the plunge of the structure with the airfoil and centered its position by two feathers with position detected with the magnetic sensor. The whole arrangement of the experiment was described with all details in [2].

## Introduction

The experimental device was constructed with idea to generate self-excited motion of the airfoil in subsonic air flow with possibility to change the elasticity of both degrees of freedom and simultaneously enable the optic, mainly interferometric measurements. As a result experiments were made, which verify that the arrangement as a whole is suitable for flutter experiments in subsonic Mach number range. During the experiments, the diapason of both support elasticity parameters was determined, where flutter occurs. The total scheme of the experiment arrangements presented in [2], the view of the test section with an older airfoil model is in [3].

## Experimental set-up

The airfoil model with a chord length of 59 mm, thickness 8.85 mm and width of 76.6 mm was divided into five parts, as we can see in Fig.1. The reason of such solution was easy to arrange the relatively complicated system of elastic element and set of sensors, which must be supported on roll bearings, because the lowest damping of the rotational degree of freedom was required. The negligible attenuation of the translational motion was achieved by fixation of the frame with the airfoil on the thin blades.

The photography of the profile taken apart is in Fig. 1. There are two variations of tested springs; one use more elastic winding spring, the other is a torsion spring. The part devoted to the non-contact method of the pitch-angle is described in detail in [1]. It was used the sensor RM08, which is located in a case 3 mm long and with diameter 8 mm. For the pressure measurement on the profile surface four semiconductor absolute pressure sensors MPXH6115A6U - FREESCALE SEMICONDUCTOR with size 7x7x3 mm were used. Sensors are situated on the back-side of airfoil parts always in couples, as we can see in Fig. 1. These sensors will serve for correction of interferometric measurements, which evaluation assumes isentropic flow. For the registration of the plunge of the rotation center of the profile, the contactless magnetic linear sensor LM13TCD40CB10A05 was used; the accuracy of the measurement is 5μ, the length of the plunge detection is not limited

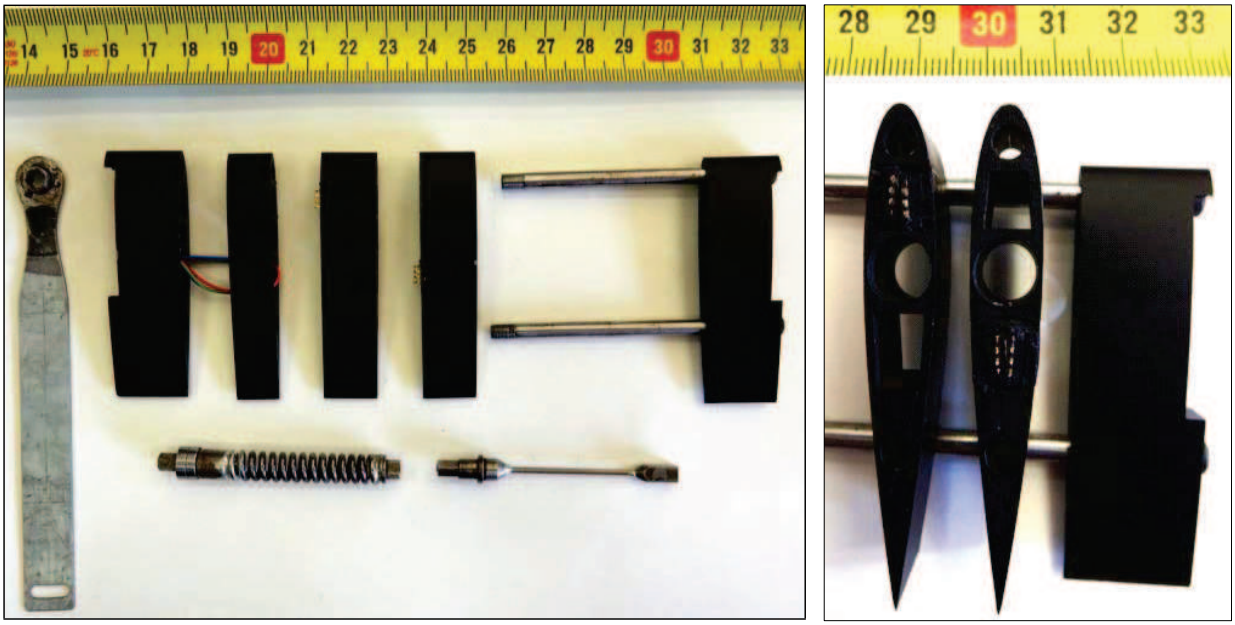


Fig. 1: Details and components of the measured profile: profile weight = 40.5/34 g (with the different axis); the axis of profile rotation is situated in 1/3 of the chord, measured from the leading edge; the instrument situated in the left part of the picture is used for zero position setting of the angle of attack.

**Summary**

After some corrections realized in the experimental setup construction a study verified, where the aim of the grant was achieved and enhanced stand has main properties suitable for detailed research of the flutter with profile which has pitch and plug degrees of freedom. The main interval of Mach numbers, where flutter occurs, was M = 0.2 – 0.4.

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