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THE EXPERIMENTAL EQUIPMENT FOR WIND TUNNEL TAD - 2 NAU

Experimental equipment, which consists of six-component combined weights of strain-gauge sting balance type, calibration device, information collecting and processing system, coordinate device for determination of air stream parameters, additional equipment for study of propellers.

A lot of attention recently is given to unsteady characteristics of objects of research and for that purpose new measurement tools are needed. This is due to an increase in flight speed, reduction of drag and introduction of new methods, which would allow to create and increase the lift force.

The majority of modern aircrafts create lift force due to steady flow around the lifting surfaces and due to depression, which occurs as a result of a flow around lifting surfaces. But the air flow around vehicles, which have propeller or windmilling propeller as lifting surface and objects with complex geometric shape is unsteady and with separation. That is why the necessity of special experimental equipment usage for studies of such phenomena occurs. In wind tunnels for such purposes multi-strain balances are used.

To date, multi-component system for measuring aerodynamic loads is created, which gives possibility to carry out independent measurements of six components of the total aerodynamic force during aerodynamic experiment. These strain-gauge balances will allow to carry out experimental studies not only of static but also dynamic loads, which act on the object of study. This approach will make it possible to investigate aerodynamic characteristics of such objects as lifting system of windmilling propeller type, propeller of helicopter and vortex structures around objects of complex geometric form or behind parts of the aircraft.

Fig. 1 shows the general view of multicomponent system for measuring aerodynamic loads of strain-gauge sting balance type.

Fig. 2 shows elastic elements of this balance. Fig. 3 shows adopted coordinate system with respect to strain-gauge balance, and provides limits of measured loads for each component of the total aerodynamic force.

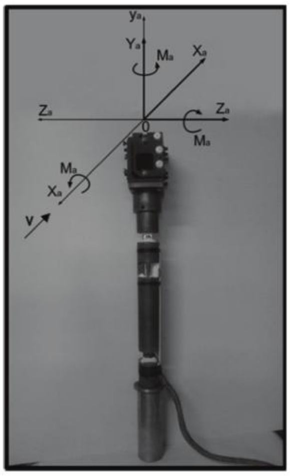
One of the main tasks, for obtaining high accuracy of aerodynamic research results, is metrological certification of measuring instrument – strain gauge balance.

For this purpose the calibration test rig for six-component strain-gauge balance was developed. This rig is designed to assess metrological characteristics of aerodynamic strain-gauge type balance.

The construction of this rig requires maximum accuracy and also must meet the following requirements: while applying partial forces at the origin the moments, calculated by calibrating formulas must be equal to zero; a rig and calibrating equipment should be rigid; the calibrating equipment should allow simultaneous application of all forces and moments at one point, which is the origin of balance, for initial position before calibration.

Fig.1 General view of six-component combined strain-gauge balance.

Fig. 2 Elastic devices of strain-gauge balance.



Forces and the moments which act on scales	Limiting value
Ya	±1000 H
Xa	± 730 H
Za	± 325 H
Mx	± 25 H·м
My	± 60 H·м
Mz	± 240 H·м

Fig. 3 Accepted axes of strain-gauge balances and the limiting values of measured loads for each balance component.

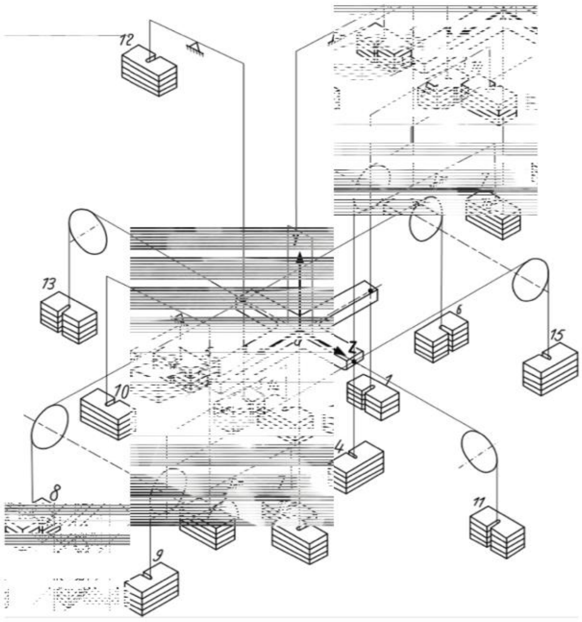
Calibration is the process of determining metrological characteristics of measuring equipment complex from balance to equipment, which records random and systematic errors.

Fig. 4 shows the kinematic scheme of calibration rig and positions for creation of necessary loads by components.

By means of a designed calibration test rig the assessment of metrological characteristics of this strain-gauge balance, as well as in the future of balance of other type will be carried out. Fig. 5 shows the general view of the calibration test rig.

Also a coordinate device for air flow parameters research was developed. It allows assessment of vortex structures characteristics, namely to investigate unsteady and vortex characteristics of the flow. The construction is based on Cartesian coordinate system with two degrees of freedom: 0.5m vertically and 1m horizontally.

As the flow parameters measurement sensor the Pitot tube with six components is used



Forces and moments which necessary to create	№ load position
X+	8;9
X-	6;15
Y+	5
Y-	16
Z+	11
Z-	13
Mx+	3;7
Mx-	4;12
My+	8;15
My-	9;6
Mz+	2;14
Mz-	10;1

Fig. 4 The kinematic scheme of calibration test rig.

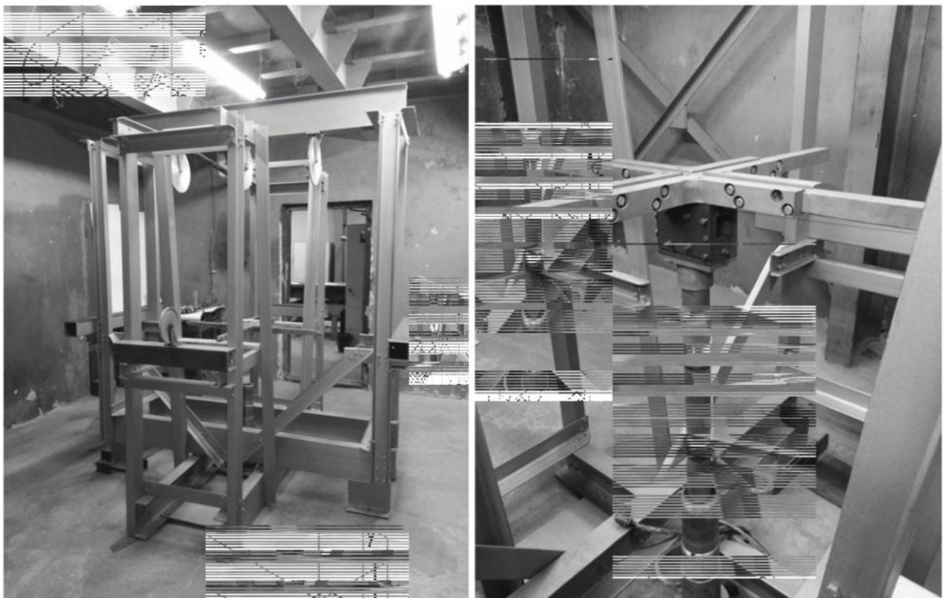


Fig. 5 General view of calibration test rig.

Sensor design provides an opportunity to get the velocity vector angle position in horizontal and vertical planes and the velocity vector itself. Thus, it is possible to investigate vortex structures in the flow. Fig. 6 shows general view of coordinate device elements: moving components, information and measurement equipment, Pitot tube.

Fig. 6 General view of coordinate device components.

Conclusions

Six-component combined balance of strain-gauge sting balance type, which would extend researches in the field of experimental aerodynamics with the possibility to evaluate unsteady characteristics of research objects. Calibration test rig, which design allows conducting both static and dynamic calibration of balance, was developed for determination of metrological characteristics In addition, it is possible to calibrate other devices in this rig. Coordinate device will allow to measure vortex structure parameters during experiment with possibility to evaluate velocity vector taking into account angular position with respect to set plane and initial point. Also system for collection and processing data was developed. As auxiliary equipment for studying of lifting propellers the special mounting system was designed, propeller hub with sensor to determine rotor speed and set angle.

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