METHOD FOR DETERMINING THE FAILURE OF FLAPS MECHANISM

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Abstract: *Starting from design stage cinematic scheme of any mechanism, at this stage we must consider possible construction errors, errors due to the technology adopted and errors that may occur during the operation of the mechanism. On the basis of the representative kinematics scheme of a flap actuator we can establish the constructive element errors and kinematics couplings components.*

Keywords: *constructive and technological errors, flaps, kinematics scheme*

1. INTRODUCTION

High lift flap is a device usually placed at the trailing edge of the wing (aerodynamic surface) that operates on the voucher. The role of the flap is to increase the lift coefficient by changing the local geometry. Flap actuation leads to a change in curvature of the wing that will produce an increase in lift at the same speed or a reduction in the incidence rate, see Fig. 1.

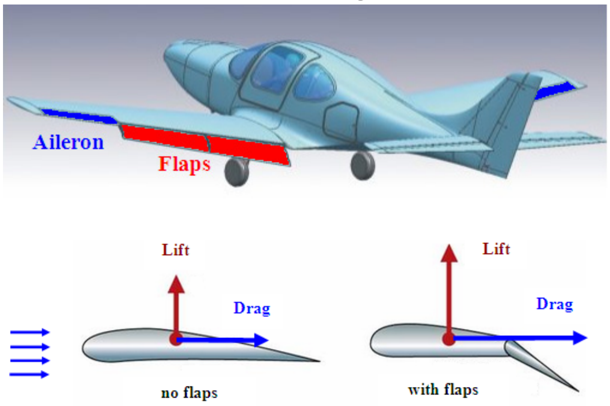

Fig. 1 Landing configuration

The kinematics of the control mechanisms in the structure of the transmission flap, may be considered complex and requires a dimensionally study in order to avoid the occurrence of the phenomenon of buckling of the articulated rod, to minimize friction and the phenomenon of reduction of construction and assembling of game kinematics parameterization rods, and bearings used in rods (Luculescu, 2013).

The most common embodiment of the flaps are shown in Fig. 2.

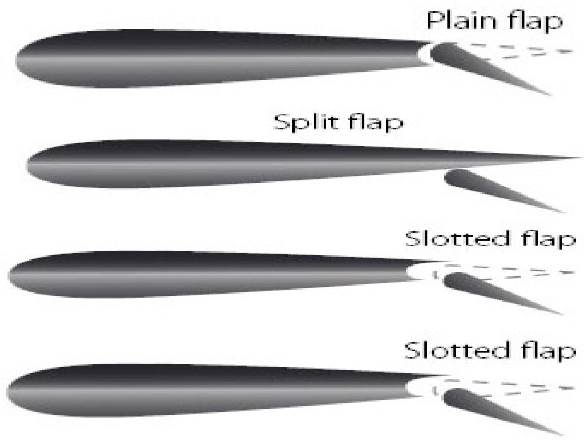

Fig. 2 Usual constructive two flaps (***, 2013)

Flap command is shown in Fig. 3.

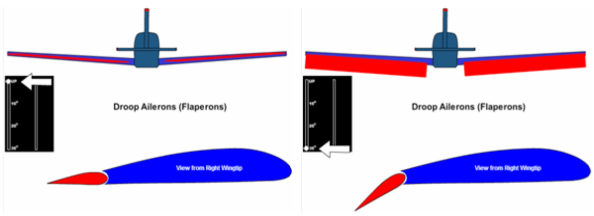

Fig. 3 Flap command (Preston, 2013)

Flap actuator transmits force and motion in the driveline, it includes scenes, sticks and kinematics coupling elements and with varying degrees of freedom. Actuator flaps must fulfill the conditions relating to the accuracy of transmission and reception of kinematics parameters.

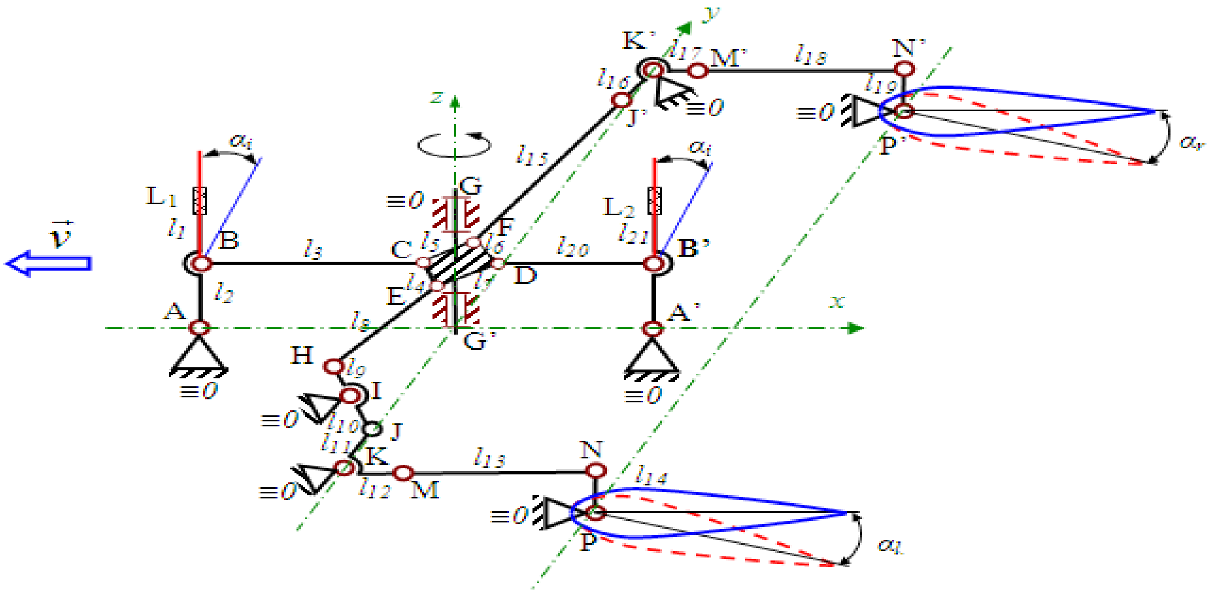

Fig. 3 The control of the aircraft with dual flaps

So it is important to identify and calculate error propagation which exists in the flow signals arranged function and their influence on the position of the mechanism.

Aircraft movements around the center of gravity are possible by steering control surfaces and the curvature drive voucher (flaps).

Roller drive levers work simultaneously being placed two pilot position, and act directly by its driveline on voucher curvature turn at different angles depending on the evolution of the aircraft (ex. 45^0/landing, take-off/25^0). Shutters of curvature (flaps) have coated metal structure and fabric impregnated and has at least two joints flat mounting of the wing trailing edge.

2. DETERMINING THE DESIGN ERROR MECHANISM

For the control mechanism of the flaps articulated bars , see Fig. 3 , (Crețu, 2010; Luculescu, Lazar , 2008) equations of the two flaps position according to the angle of rotation of the two levers are :

for first seat L_1:

$$\alpha_{f\ left} = \alpha_{l\ left}(\alpha_i, l_1, l_2, l_3, l_4, l_8, l_9, l_{11}, l_{12}, l_{13}, l_{14}) \tag{1}$$

for second seat L_2:

$$\alpha_{f\ left} = \alpha_{l\ left}(\alpha_i, l_{21}, l_{20}, l_7, l_8, l_9, l_{10}, l_{11}, l_{12}, l_{13}, l_{14})$$

for first seat L_1:

$$\alpha_{f\ right} = \alpha_{l\ right}(\alpha_i, l_1, l_2, l_3, l_5, l_{15}, l_{16}, l_{17}, l_{18}, l_{19}) \tag{1'}$$

for second seat L_2:

$$\alpha_{f\ right} = \alpha_{l\ right}(\alpha_i, l_{21}, l_{20}, l_6, l_{15}, l_{16}, l_{17}, l_{18}, l_{19})$$

Admitting that there are theoretical and formal errors , angular displacement of the lever α_f is influenced by manufacturing tolerances Δl_1, Δl_2, Δl_3, ..., Δl_{19}, the nominal dimensions of cinematic elements of the composition mechanism $l_{1.0}$, $l_{2.0}$, $l_{3.0}$, ..., $l_{19.0}$. It follows that the flap control mechanism can reproduce the functions of position (1), (1 ') only roughly for each value of the angle α_f driving element . These errors appear called constructive errors are random it can be determined in the manner as follows. The functions performed by the actual position of the mechanism kinematics elements analyzed is determined by the equations :

$$\alpha_{f\ right.} = \alpha_{e\ dr.}(\alpha_1, l_{1.0} + \Delta l_1, l_{2.0} + \Delta l_1, l_{3.0} + \Delta l_3, \ldots, l_{19.0} + \Delta l_{18}) \tag{2}$$

$$\alpha_{f\ left.} = \alpha_{e\ dr.}(\alpha_1, l_{1.0} + \Delta l_1, l_{2.0} + \Delta l_1, l_{3.0} + \Delta l_3, \ldots, l_{14\ 0} + \Delta l_{13}) \tag{2'}$$

The error introduced into the control mechanism of the flaps is determined by the equations:

➯ For right flap: (3)

$$\Delta\alpha_{f\,dr.} = \alpha_{f\,dr.} - \alpha_{f\,dr.0}$$

➯ For left flap: (3')

$$\Delta\alpha_{f\,stg.} = \alpha_{f\,stg.} - \alpha_{f\,stg.0}$$

In calculating these errors constructive develops, functions given by equations (2) and (2 ') , Taylor series , considered turn the actual dimensions of the cinematic elements of the mechanism components l_1 , l_2 , l_3 , ..., l_{19} , the size variables:

$$\alpha_{e_{right}} = \alpha_{e_{right\text{-}0}} + \left(\frac{\partial f}{\partial l_1}\right)\cdot \Delta l_1 + \left(\frac{\partial f}{\partial l_2}\right)\cdot \Delta l_2 + \ldots + \left(\frac{\partial f}{\partial l_{19}}\right)\cdot \Delta l_9 + \left(\frac{\partial^2 f}{\partial l_1^2}\right)\cdot \Delta l_1^2 + . + \left(\frac{\partial^2 f}{\partial l_{19}^2}\right)\cdot \Delta l_{19}^2 + \ldots \quad (4)$$

$$\alpha_{e_{left}} = \varphi_{e_{left\text{-}0}} + \left(\frac{\partial f}{\partial l_1}\right)\cdot \Delta l_1 + \left(\frac{\partial f}{\partial l_2}\right)\cdot \Delta l_2 + \ldots + \left(\frac{\partial f}{\partial l_{14}}\right)\cdot \Delta l_{14} + \left(\frac{\partial^2 f}{\partial l_1^2}\right)\cdot \Delta l_1^2 + . + \left(\frac{\partial^2 f}{\partial l_{14}^2}\right)\cdot \Delta l_{14}^2 + \ldots \quad (4')$$

Assuming that the manufacturing tolerances is infinite Δ is small compared to the nominal dimensions of cinematic elements , the terms of second order and their superiors in the Taylor series expansion can be neglected. Errors constructive global movement kinematics chains of the two flaps can be calculated with the following relations:

$$\Delta\alpha_{f\,right} = \left(\frac{\partial f}{\partial l_1}\right)\cdot \Delta l_1 + \left(\frac{\partial f}{\partial l_2}\right)\cdot \Delta l_2 + \left(\frac{\partial f}{\partial l_3}\right)\cdot \Delta l_3 \ldots + \left(\frac{\partial f}{\partial l_{19}}\right)\cdot \Delta l_{19} \quad (5)$$

$$\Delta\alpha_{f\,left} = \left(\frac{\partial f}{\partial l_1'}\right)\cdot \Delta l_1 + \left(\frac{\partial f}{\partial l_2}\right)\cdot \Delta l_2 + \left(\frac{\partial f}{\partial l_3}\right)\cdot \Delta l_3 \ldots + \left(\frac{\partial f}{\partial l_{14}}\right)\cdot \Delta l_{14}' \quad (5')$$

The relations (5) , (5 ') parameters Δl_1, Δl_2 , Δl_3, ..., Δl_{19} are random sizes that vary between two sizes but known limits upper and lower deviation tolerances fields.

Constructive errors are determined considering that the dimensions of all cinematic elements are affected only limit errors . The probability of error in practical limit , however, is relatively small. The kinematics analysis of the mechanism studied the flow of signals from element to element leader - led leg flaps can have constant sensitivity S = ct. , Namely: $s_{e_0} = S \cdot s_i$

Considering that the sensitivity of the flow signal is
for right flap:

$$S_{right} = \frac{l_2}{l_1}\cdot\frac{l_5}{l_3}\cdot\frac{l_{16}}{l_{15}}\cdot\frac{l_{18}}{l_{17}} \quad (6)$$

for left flap:

$$S_{left} = \frac{l_2}{l_1}\cdot\frac{l_4}{l_3}\cdot\frac{l_9}{l_8}\cdot\frac{l_{12}}{l_{11}}\cdot\frac{l_{14}}{l_{13}} \quad (6')$$

CONCLUSIONS

The method presented in this paper enables the identification and calculation errors that occur in the construction constructive linkages of the mechanisms used in aviation technology.

Depending on the size of these errors can take a number of variants and technology from design stage to compensate for their size and that they are affected by random errors Δ are errors introduced in the mechanism studied are: for right flap

$$\Delta s_{right} = s_f^r - s_{f_0}^r = \sum_{i=1}^{10}\left(\frac{\partial s_f^r}{\partial l_i^r}\right)_0 \cdot \Delta l_{i_{right}} \quad (7)$$

for left flap:

$$\Delta s_{left} = s_f^l - s_{f_0}^l = \sum_{i=1}^{10}\left(\frac{\partial s_f^l}{\partial l_i^l}\right)_0 \cdot \Delta l_{i_{left}} \quad (7')$$

or expressed as:

$$\Delta s_{right} = \frac{l_2}{l_1}\cdot\frac{l_5}{l_3}\cdot\frac{l_{16}}{l_{15}}\cdot\frac{l_{18}}{l_{17}}\cdot s_i^r \sum_{i=1}^{9}\frac{\Delta l_i^r}{l_i} \quad (8)$$

$$\Delta s_{left} = \frac{l_2}{l_1}\cdot\frac{l_4}{l_3}\cdot\frac{l_9}{l_8}\cdot\frac{l_{12}}{l_{11}}\cdot\frac{l_{14}}{l_{13}}\cdot s_i^l \sum_{i=1}^{10}\frac{\Delta l_i^l}{l_i'} \quad (8')$$

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