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OFICINA CENTRAL - APARTADO 5599
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ESTIMATION OF LOADS OF RETRACTING CABLE

FOR INVERTING FLAP INSTALLATION ON A BEECH C-45 AIRCRAFT

A COURTESY TRANSLATION BASED ON A

FANASA REPORT ACC-3 ENTITLED

"ESTIMADO DE CARGAS DEL CABLE DE RETRACCION

DE UNA ALETA INVERTIBLE INSTALADA EN UN AVION BEECH C-45"

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Annal	ACS	ACE 1

ESTIMATION OF LOADS OF RETRACTING CABLE FOR INVERTING FLAP INSTALLATION ON A BEECH C-45 AIRCRAFT

Introduction

In this report, there will be estimated the magnitude of tensions which the single cable actuator system of each flap must resist in steady flap positions.

For the purposes of this report the flap loads of the FANASA report ACS-1 will be used. Flap loads for other flap deflections are estimated from NACA TR 620; these are not critical.

A single retracting cable is used on the inverting flap installation as sketched on Fig. 1. The entire flap load is distributed to the three flap hinges and to the single cable having an approximately central location on the flap panel.

The tension on the cable can be determined from the estimated loads by a moment equation about the flap hinge axis.

2. Method and approximations

The moment-system for the cable loads is shown in Fig. 2. The perpendicular distance L_c between the cable and the flap's hinge axis is the moment arm of the cable's tension force T_c. The flap load F is assumed perpendicular to the flap according to report ACS-1. In that report, the chordwise locations assumed for the resultant flap force are further back than in fact. Therefore the results of the present study are conservative in that the cable tension in the aircraft should be smaller than predicted by the arm distances used herein. In Fig. 2 the perpendicular distance between the flap force F and the hinge axis is L_f.

3. Flap structural speed

For the purpose of this report, a flap speed of 120MPH will be used. It is not the purpose of this study to investigate the simulated dive-bombing conditions of 160MPH.

4. Determination of flap loads

From Fig. 2 the moment equation about the hinge axis is

$$T_c L_c - F L_f = 0$$

hence

$$T_c = F\left(\frac{L_f}{L_c}\right)$$

Full size drawings of the flap not included with this report have been used to determine the distances L_f and L_c, (the units shown in this report for length ratios are in centimeters)

The cable tension T_c, according to the assumption of this report is evaluated as follows:

at 30° flap:
$$T_c = (F)_{30°}\left(\frac{L_F}{L_c}\right)_{30°}$$
$$= 1105 \left(\frac{20.4}{21.6}\right)$$
8.05" 8.5"
$$= 1040 \text{ pounds at 120MPH}$$

at 90° flap:
$$T_c = (F)_{90°}\left(\frac{L_F}{L_c}\right)_{90°}$$
$$= 731 \left(\frac{31}{32}\right)$$
$$= 708 \text{ pounds at 120MPH}$$

For flap deflections smaller than 30°, both F and L_c drop rapidly. It is of interest to estimate loads at 20° flap. From NACA TR 620, at 20° flap, F can be estimated at 730 pounds. L_c, however, at 19.7cm. has not decreased greatly and the cable load is

at 20° flap:
$$T_c = (F)_{20°}\left(\frac{L_F}{L_c}\right)_{20°}$$
$$= 730 \left(\frac{20.4}{19.7}\right)$$
$$= 756 \text{ pounds at 120MPH}$$

5. Special conditions:

For the separated flow regime of $\delta_f \approx 90°$ a small varying load component may exist which the cable must resist to prevent flap buffet. The magnitude and frequency of this varying load is not known. The magnitude of the variation cannot be large in reference to the total load, and the total load is known not to change in direction. It is noted that with $\delta_f = 90°$, T_c is well below $T_{c\ max}$ at 30° flap, hence the cable must resist the varying load component at an average tension well below its maximum design tension.

The type of support shown in Fig. 2 prevents the development of flap buffet for any flap position; this has been shown in test flights

as reported in the FANASA flight test report ACF-5.

In the design of the flap provisions should be made for adequate closure of the flap to its cruise position.

In the test flight of the aircraft, it is possible to measure the cable's tension with a strain gage in the cable or in a turnbuckle, as a function of flap deflection and flight speed. Such a method would also serve as an indirect measurement of flap loads estimated in report ACS-1 for the inverting flap. The possibility also exists of instrumenting the flap's cable system to detect fluctuating flap loads which could exist in the separated flow regime on the flap, as well as any short-time peack loads which could exist due to inertia of the flap during flap motion or detention.

Note: The cable [illegible] [illegible] static tests [illegible] of 3500 [illegible]

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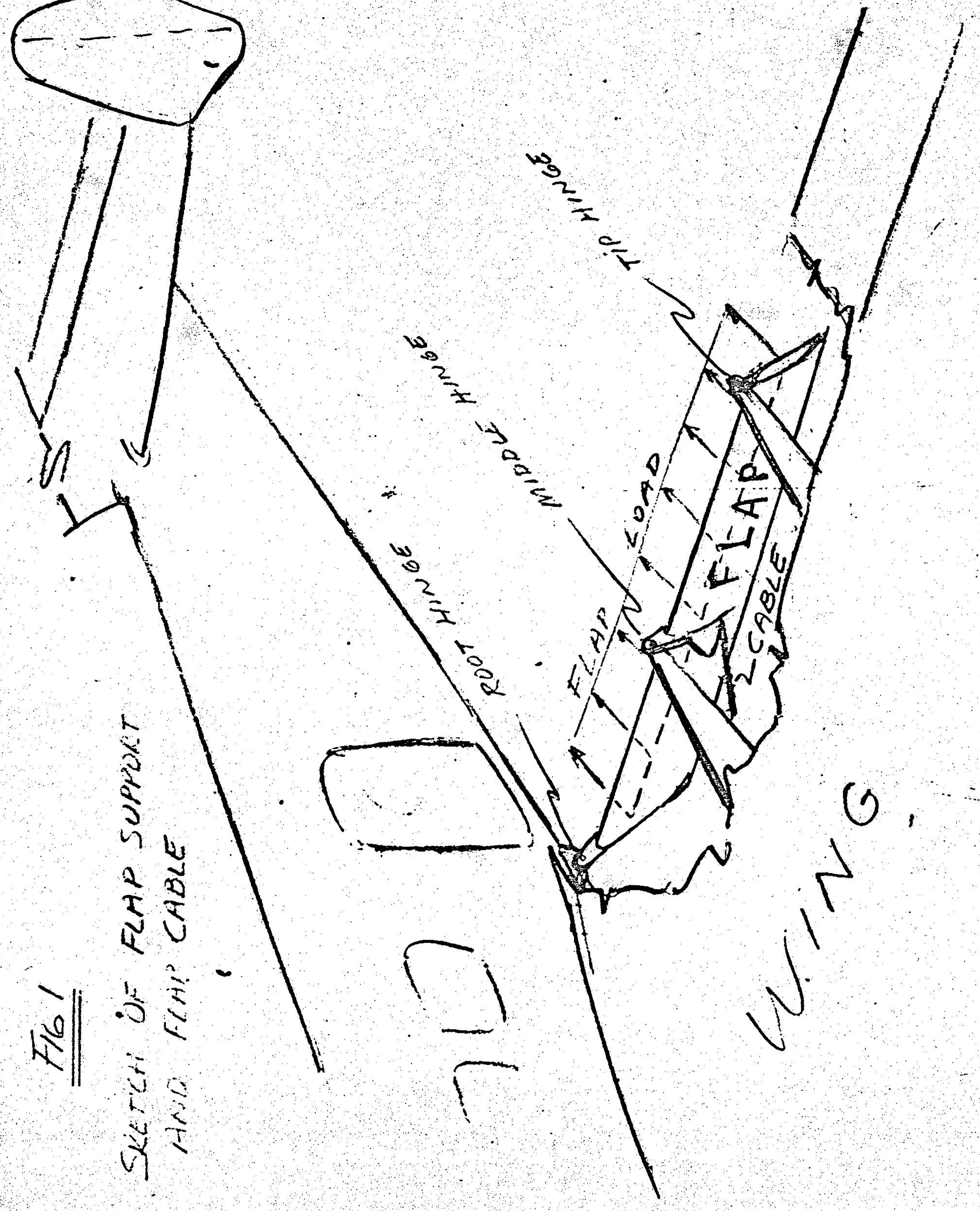
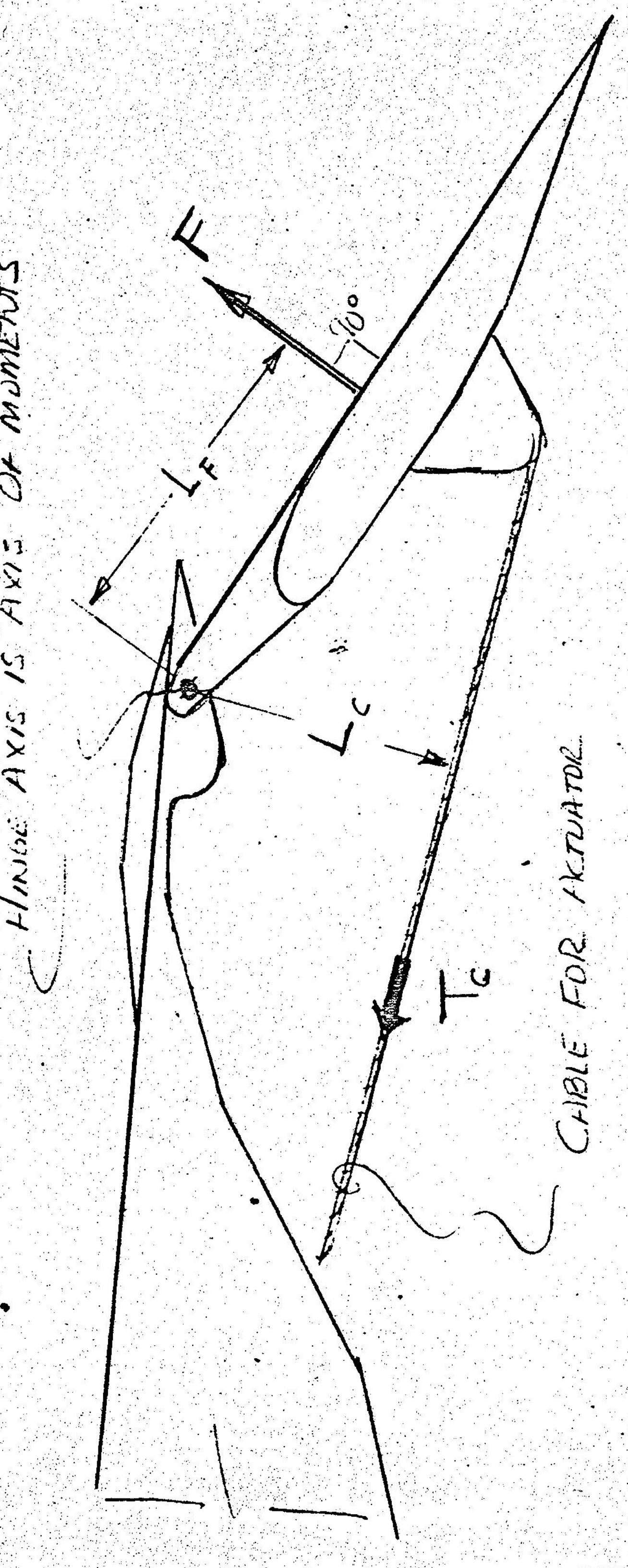


FIG 1

SKETCH OF FLAP SUPPORT AND FLAP CABLE



$$T_c = F \frac{L_F}{L_c}$$

FIG 2

SKETCH OF MOMENT SYSTEM TO DETERMINE CABLE TENSION T_c