MEMORANDUM REPORT
for
Army Air Corps, Materiel Division
and
Bureau of Air Commerce

RESULTS OF LANDING TESTS OF KELLETT YG-1
AUTOGIRO (A. C. R. 35-275)

By R. R. GILRUTH

NOT EDITED

FILE COPY
To be returned to
the files of the National
Advisory Committee
for Aeronautics
Washington, D. C.

November 15, 1937
RESULTS OF LANDING TESTS OF KELLETT YG-1 AUTOGIRO (A. C. R. 35-278)

By R. R. GILRUTH

SUMMARY

Flight tests were made with a Kellett YG-1 autogiro to determine the relationship between the ground reaction and the vertical velocity at contact for landings of the flared and gliding three-point types. The data obtained are presented in the form of time histories of the linear accelerations at the center of gravity resulting from the initial landing impact. In addition, the attitude angle and velocity of the autogiro at contact were measured. The landings were all mild as compared to those representative of airplanes tested in this manner, the maximum vertical velocity being 4.4 feet per second with a corresponding normal acceleration of 2.35 g.

INTRODUCTION

At the suggestion of the Army Air Corps, Materiel Division (reference 2) and the Bureau of Air Commerce (reference 1) the National Advisory Committee for Aeronautics
is conducting a series of tests to measure the magnitude and direction of the loads developed and also the flight path and attitude of airplanes at contact for various types of landings. The present tests, which are fifth in a series of similar tests of airplanes, were made with a Kellett XG-1 autogiro made available by the Army Air Corps. Tests have previously been made with a Consolidated B-2 airplane (reference 3), a North American BT-9 airplane (reference 4), a Boeing X-26 airplane (reference 5), and a Curtiss XP130-3 airplane (reference 6).

APPARATUS AND TESTS

The XG-1 autogiro used in this investigation (figs. 1 and 2) is a direct-control, wingless type of the following specifications:

- Gross weight as flown: 2,060 lb.
- Rotor diameter: 40 ft.
- Brake horsepower: 225 hp.

A series of 15 filtered and glide-type landings were made, out of which usable records were obtained from 9. An accelerometer was installed at the center of gravity of the autogiro and was oriented to record accelerations parallel to the X and Z axes. An attempt was made to measure pitching accelerations with a turnmeter; however, none of the records were usable. The attitude angle and
the velocity of the autogiro at contact were obtained with a recording phototheodolite.

RESULTS AND DISCUSSION

The landing data are presented in the form of time histories (figs. 3 to 7, inclusive). The linear accelerations in these figures are the accelerations recorded at the center of gravity of the autogiro, the normal and longitudinal components being perpendicular and parallel to the thrust axis, respectively. The maximum accelerations and the results obtained from the phototheodolite are summarized in table I. Figure 5 shows the variation of the maximum recorded vertical accelerations at the center of gravity with the vertical velocity of the autogiro at the instant of contact.

The resultant forces acting on the autogiro are indicated by the recorded accelerations and are made up of aerodynamic forces as well as ground reactions. The vertical accelerations experienced immediately prior to contact varied from 1 g to 0.3 g which shows the range of the vertical component of the aerodynamic forces existent at contact. An indication of the variance of this component throughout the period of impact was obtained by noting the rotor coning angle as recorded by the theodolite camera. In all the landings of this investigation the coning angles
showed no appreciable change during that time, indicating that the accelerations representative of ground reactions were from 1 to 0.8 g less than the recorded values. This may not be generally true as shown by a case observed in landings of reference 3, where a coning angle of 6° was noted following a severe landing. A further analysis of the present data to determine the division of ground loads between the main wheel and tail wheel units was not possible due to the lack of pitching acceleration data. In addition, the longitudinal moment of inertia of the autorotor, also necessary for such division, was not known.

As a point of interest it is well to note in the calculation of chassis loads from the acceleration data that the effective mass of the rotor is a function of the weight distribution along the blades. For a uniform distribution the effective mass is one-fourth the total mass of the rotor. It should be further noted that all the landings presented are mild, and it is probable that they do not represent as severe conditions as would be experienced in routine service.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., November 15, 1937.

R. R. Gilruth
R. R. Gilruth, 
Senior Aeronautical Engineer.

Approved: Elton W. Miller,
Principal Mechanical Engineer.
REFERENCES

1. N. A. C. A. Let. Apr. 30, 1936, CWMW.

2. N. A. C. A. Let. May 28, 1936, CWMW.


