NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE

No. 1898

EFFECT OF A 90° CROSS WIND ON THE TAKE-OFF DISTANCE OF A LIGHT AIRPLANE EQUIPPED WITH A CROSS-WIND LANDING GEAR

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SUMMARY

Flight tests were conducted with a light airplane equipped with a cross-wind landing gear to determine the relative take-off distances required in calm air and in a 90° cross wind. These tests showed that approximately 24 percent less ground run was required to attain take-off speeds of 40 to 50 miles per hour in a 16-mile-per-hour 90° cross wind compared to calm-air conditions.

INTRODUCTION

The introduction of the latest type of cross-wind landing gear to enhance the safety and utility of both private and commercial flying has aroused considerable interest. The purpose of a gear of this type is to enable safer operation of an airplane under cross-wind conditions at airports having but a single runway. Some question has arisen, however, regarding the length of runway necessary for a cross-wind take-off compared to the length required in calm air. At the request of the Civil Aeronautics Administration, tests were conducted on a light airplane equipped with a cross-wind landing gear to compare the take-off distances required in calm air and with a 90° cross wind.

DESCRIPTION OF THE AIRPLANE AND INSTRUMENTATION

The test airplane was a high-wing strut-braced monoplane supplied with a cross-wind landing gear. The main wheels of this gear were free to caster through an angular range of ± 25°, thus

enabling the airplane to maintain a heading other than the direction of the ground run. Figure 1 shows the airplane with the wheels in a turned position. A detailed description of the landing gear is given in reference 1.

The measurements of airspeed were made by means of a free-swiveling airspeed head and a standard NACA recording airspeed instrument. The airspeed head was mounted approximately one chord length ahead of the wing leading edge near the left wing tip. A photograph of the airplane as instrumented for flight tests is shown in figure 2. Measurements of the length of ground run were made by means of an NACA photographically recording theodolite. Standard NACA timers were incorporated in both the airspeed and theodolite systems and were synchronized by discharging a flash bulb located within the airplane cabin.

The wind speeds at ground level, prevailing during the tests, were measured by means of an anemometer.

METHOD

In order to minimize the effect of pilot take-off technique on the test results, no actual take-offs of the airplane were performed. Instead, measurements were made of the distance covered in accelerating to a given indicated airspeed using a consistent starting procedure. The tests were made at full throttle setting and the brakes were used to hold the airplane until the records were started. All runs were started with the fuselage and wheels alined with the runway. During the cross-wind runs, the airplane was operated so that the main wheels straddled a straight line on the runway throughout the entire run. This required heading the airplane into the relative wind at progressively increasing angles with respect to the runway as the speed of the airplane was increased. For all runs, the tail of the airplane was raised immediately after starting until the airplane thrust line was approximately level.

TESTS, RESULTS, AND DISCUSSION

The tests were conducted with the airplane having a gross weight of approximately 1135 pounds, and a center-of-gravity location at 0.251 mean aerodynamic chord. All the cross-wind tests were conducted with the wind blowing 90° to the take-off path of the airplane. The intensity of the cross winds ranged from 11.4 to 19.3 miles per

hour. It was not possible to obtain a completely calm-air test condition; head winds were encountered ranging in value from 0.6 to 2.3 miles per hour. Standard sea-level conditions prevailed during the test periods.

The results of the tests presented in tables I and II for the calm-air and 90° cross-wind conditions, respectively, show the actual distances measured and also the distances corrected to zero wind conditions and to an average cross-wind value of 16.4 miles per hour.

The data presented in figure 3 show the corrected ground distances required to accelerate to various indicated airspeeds for several wind conditions. These data show that approximately 24 percent less ground run was required to accelerate to indicated airspeeds of 40 to 50 miles per hour in a 16.4-mile-per-hour 90° cross wind compared to calm-air conditions. As an added point of interest, the effect of a head wind on take-off distance has also been included in figure 3. With a value of head wind of 16.4 miles per hour, the take-off run would be reduced approximately 65 percent from the calm-air condition at a 40 mile-per-hour take-off speed (calculated from reference 2).

CONCLUDING REMARKS

The results of flight tests of a light airplane equipped with a cross-wind landing gear showed that approximately 24 percent less ground run was required to attain take-off speeds of 40 to 50 miles per hour in a 16 mile-per-hour 90° cross wind compared to calm-air conditions.

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REFERENCES

1. Geisse, John H., and Child, Lloyd: Summary Report on Cross-Wind Landing Gears. C.A.A., Dept. of Commerce, Washington, D. C., May, 1948.

2. Diehl, Walter Stuart: Engineering Aerodynamics. (Rev. Ed. N.Y.) The Ronald Press Co., 1936.

TABLE I.- GROUND DISTANCE VALUES

OBTAINED IN CALM AIR

Run	Head wind (mph)	Measured ground run (to 40 mph) (ft)	Ground run (to 40 mph) corrected to zero wind[1] (ft)	Measured ground run (to 50 mph) (ft)	Ground run (to 50 mph) corrected to zero wind[1] (ft)
1	2.3	285	317	533	573
2	0.6	305	311	524	529
3	1.7	292	314	553	582
4	2.3	322	358	514	553
5	1.7	280	301	522	550
Average	1.7	--	320	--	557

[1]Corrections made by method of reference 2.

TABLE II.- GROUND DISTANCE VALUES

OBTAINED IN 90° CROSS WINDS

Run	90° Cross wind (mph)	Measured ground run (to 40 mph) (ft)	Ground run (to 40 mph) corrected to 16.4 mph cross wind[1] (ft)	Measured ground run (to 50 mph) (ft)	Ground run (to 50 mph) corrected to 16.4 mph cross wind[1] (ft)
1	14.8	263	258	472	469
2	17.0	234	236	474	479
3	11.4	211	200	458	447
4	14.8	234	229	427	424
5	17.0	241	243	432	436
6	19.3	235	244	403	415
7	17.0	242	244	386	390
Average	16.4	--	236	--	437

[1]Correction factor = $\dfrac{\cos(\sin^{-1}) \dfrac{16.4}{V_{take-off}}}{\cos(\sin^{-1}) \dfrac{V_{wind}}{V_{take-off}}}$

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Figure 1.- Front view of the test airplane with the main wheels in a turned position.

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Figure 2.- Three-quarter front view of the test airplane as instrumented for the flight tests.

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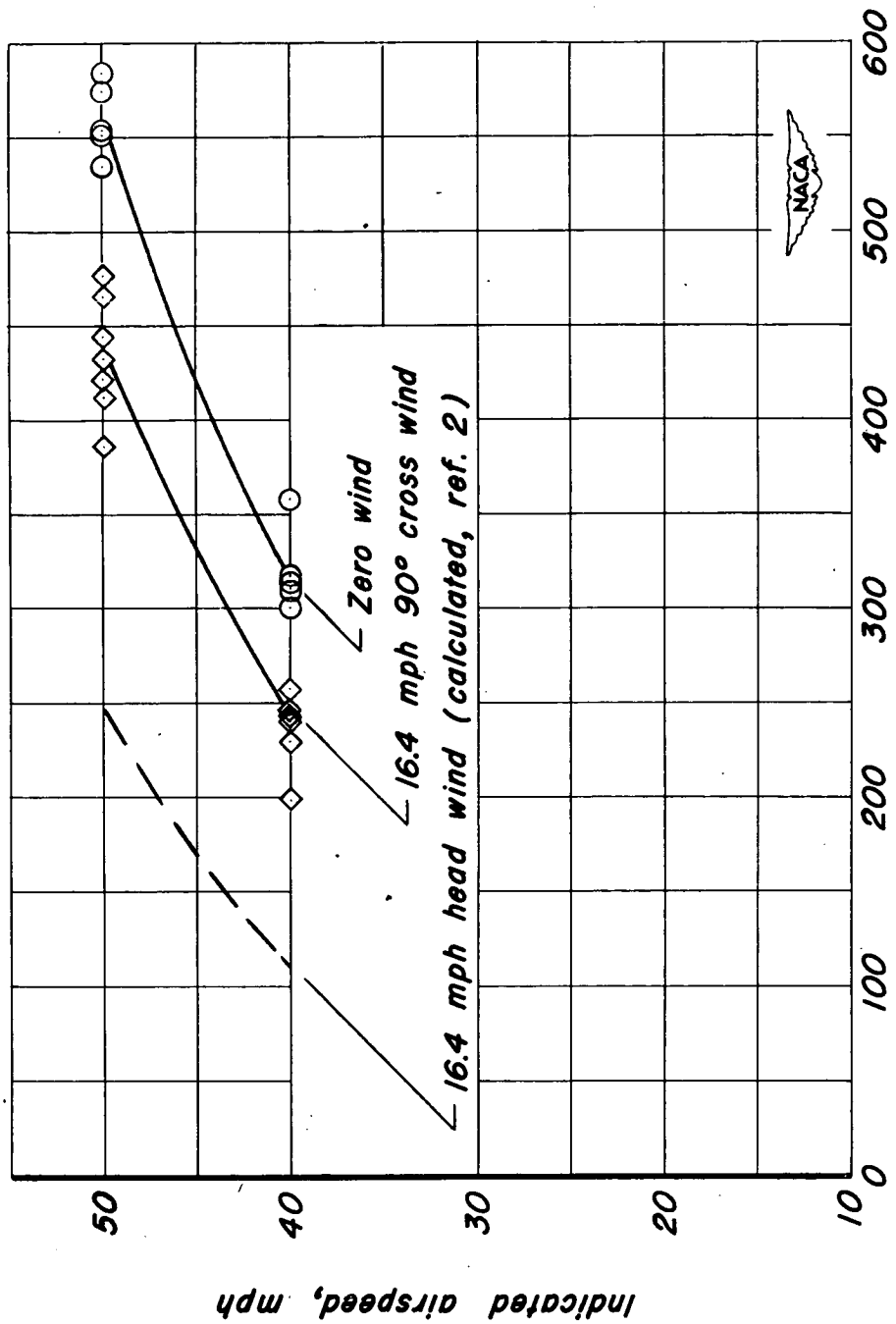

Figure 3.- Effect of wind on ground distance required to accelerate to various airspeeds. Take-off condition.