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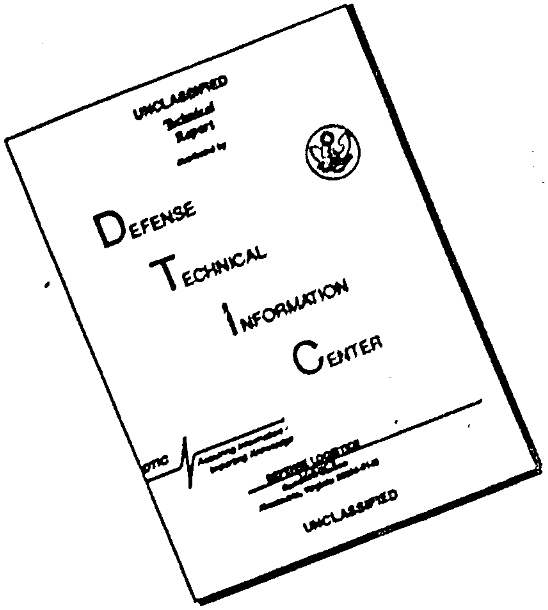

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U. S. ARMY
TRANSPORTATION RESEARCH COMMAND
FORT EUSTIS, VIRGINIA

TCREC TECHNICAL REPORT 62-1

EFFECTS OF VARIOUS LANDING GEAR CONFIGURATIONS ON PERFORMANCE OF H-13G HELICOPTER

Report of Test
Under
Task 9R-38-13-014-01

March 1962

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DEPARTMENT OF THE ARMY

TRANSPORTATION CORPS

EFFECTS OF VARIOUS LANDING GEAR CONFIGURATIONS ON PERFORMANCE OF H-13G HELICOPTER

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Under

Task 9R-38-13-014-01

(High Performance Helicopter Research)

Paul R. Curry, Project Engineer

U. S. ARMY TRANSPORTATION RESEARCH COMMAND

Fort Eustis, Virginia

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SUMMARY

This report covers the results of tests conducted during February and March of 1961 by the U. S. Army Transportation Research Command (USATRECOM) at Fort Eustis, Virginia, to determine the feasibility of reduction in drag on operational observation helicopters. Three types of landing gear (the standard H-13G, the H-13H, and the modified H-13H) were tested on the airframe of an H-13G. The H-13H skid-type landing gear whose crossmembers had been faired to symmetrical airfoils was the most successful in obtaining drag reduction.

CONCLUSIONS

1. The addition of a device, such as an airfoil, to the landing gear of a skid-type helicopter to reduce drag offers an inexpensive modification for improvement of helicopter performance.

2. There are no adverse effects introduced in the aircraft stability or control by the installation of the landing-gear airfoil.

BACKGROUND

Personnel in the aviation field have long believed that a lessening of drag would increase the performance and the stability and control of skid-type helicopters.

To investigate this possibility, USATRECOM requested permission of the Office of the Chief of Transportation to conduct comparative drag tests on three ski configurations, each to be used on the airframe of an H-13G aircraft. Approval was granted in February 1961 to modify the H-13G helicopter so that H-13H landing gear could be installed. Tests were performed under In-House Task 9R-38-13-014-01. The objectives of the test were (1) to investigate the possible gains in drag reduction by using a low-drag device on the landing gear and (2) to determine the presence of adverse operational characteristics inherent in the aircraft modification.

DESCRIPTION OF EQUIPMENT

The three landing gear configurations installed on the airframe of the H-13G aircraft were tested in the following order:

1. H-13G Standard Gear. The first series of tests were run with the aircraft in its standard configuration except for the instrumentation. Figure 1 shows the details of the "G" gear as well as the total pressure pickup mounted on the tip of the skid.

2. H-13H Modified Gear. A symmetrical airfoil made of balsa wood and Fiberglas was bonded to the crossmembers of an H-13H landing gear. The faired gear is identified as B in Figure 1. The skid itself was of standard design except for the pressure pickup devices.

3. H-13H Standard Gear. The airfoil was stripped from the crossbars, and the crossmembers were left in standard configuration.

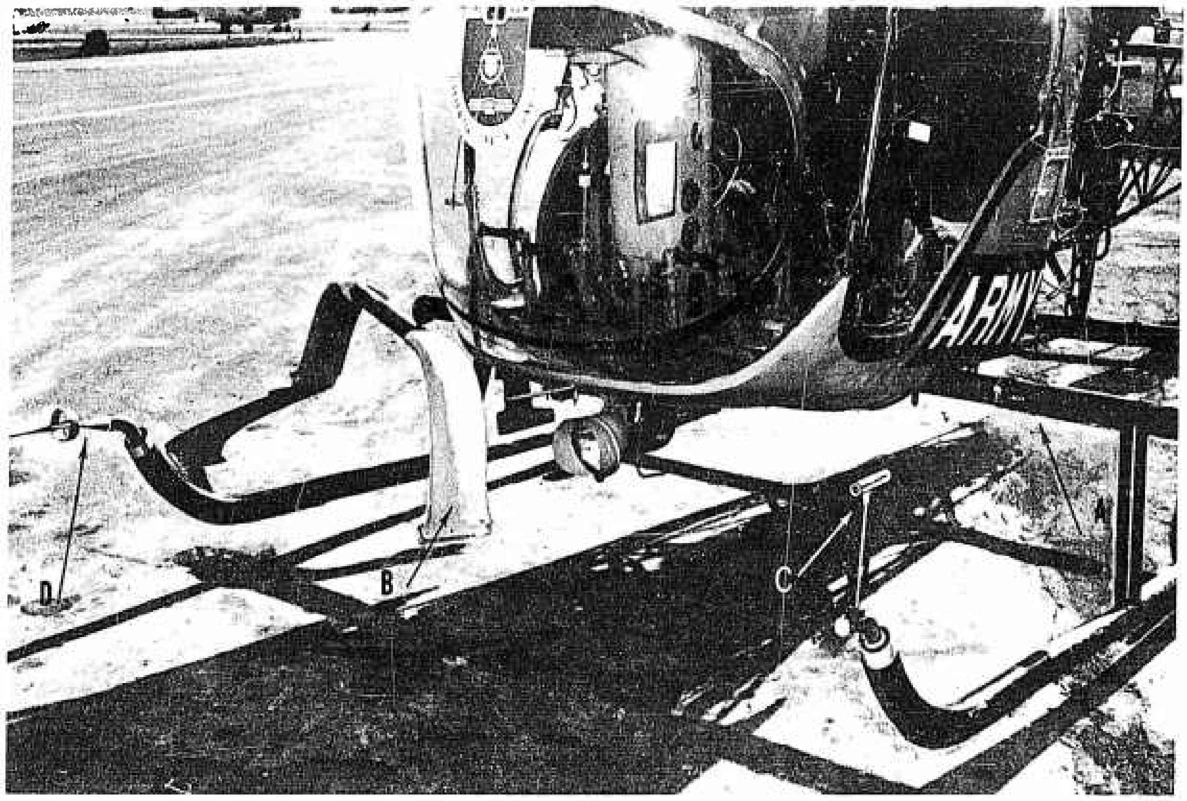

Figure 1. Operational Helicopter Equipped With Skis. A - H-13G standard gear; B - H-13H modified gear, with airfoil added; C - total pressure sensor mounted on left ski; D swivel-type, static pressure sensor mounted on right ski.

The following instrumentation was added to the helicopter:

1. A device showing the total pressure pickup, designed to read independently of angle of attack, was mounted on the left skid (see C of Figure 1).

2. A swivel-type, static-pressure sensor was mounted on the right skid (see D of Figure 1).

3. An attitude indicator was mounted in the cockpit. An inverter was mounted on the floor to power the attitude indicator (Figure 2).

4. The standard airspeed indicator was replaced by an indicator that is sensitive in the low-speed regime.

The inputs from the pressure pickups were carried to the airspeed indicator by means of 1/4-inch instrument hose taped to the skids and crossbars.

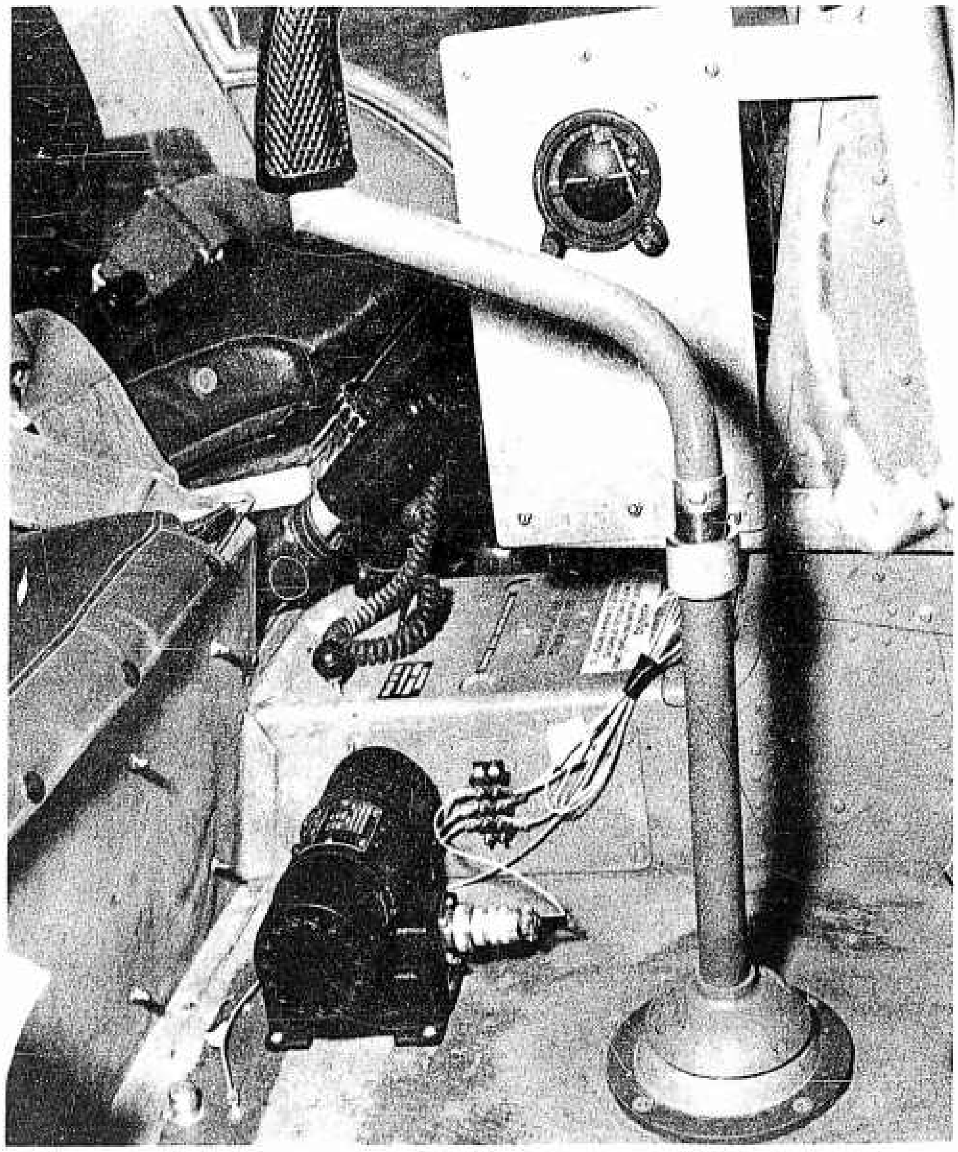

Figure 2. Attitude Indicator Mounted in Cockpit.

TEST PROCEDURES AND RESULTS

The following tests were conducted with each of the three landing gear configurations installed, in turn, on the frame of the H-13G helicopter:

DETERMINATION ONE. Straight-and-Level Test Runs

Procedure

The H-13G helicopter was flown at a pressure altitude of 1,000 feet and at an engine r.p.m. of 3,100 and was stabilized at airspeeds of from 20 to 70 miles per hour. The speeds were varied at increments of 10 miles per hour. At each stabilized speed, the manifold pressure and attitude were recorded. The procedure was repeated twice for each speed.

Results

The parameters measured in the straight-and-level test runs were manifold pressures versus airspeeds. The manifold pressures were converted to rate of fuel consumption from available engine charts. The manifold pressure is also a direct measure of engine brake horsepower. The resultant curves plotted in Figure 3 show a general improvement of the "H"-type gear, both with and without the airfoil, over the "G" gear of the standard configuration. Below 50 knots, the airfoil gear showed a reduction in fuel consumption over the standard "H" gear, but above 50 knots, the airfoil gear was inferior to the standard "H" gear.

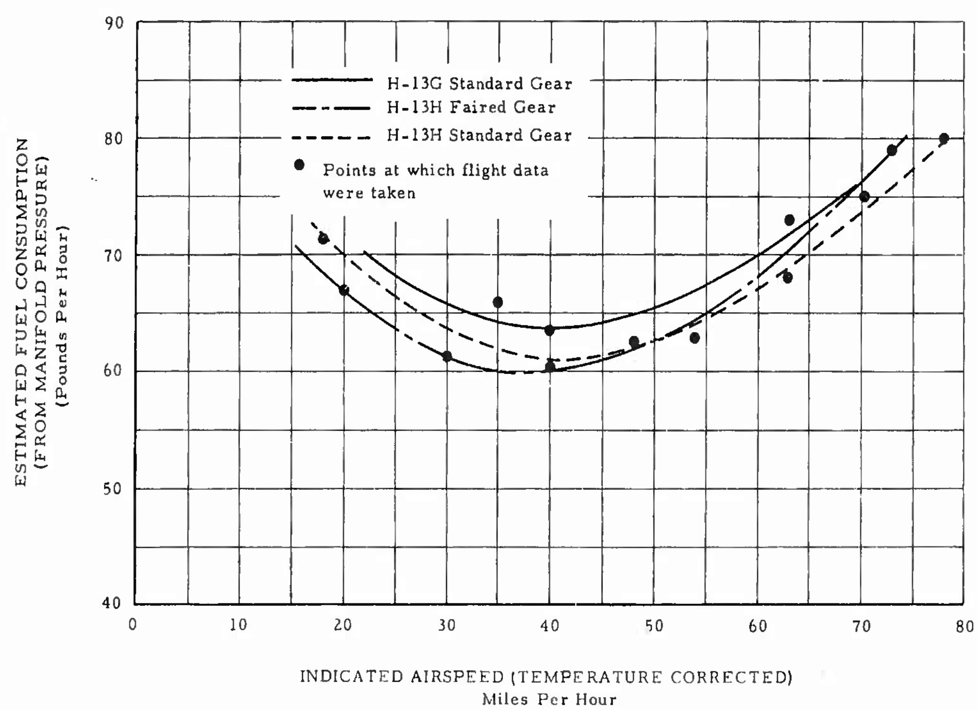

Figure 3. Airspeed Versus Fuel Consumption.

Observation

The explanation of this phenomenon must be tied in with a flow breakup over the airfoil as the helicopter is nosed down at the higher speeds. The airfoil was designed with a +6-degree angle of incidence in order to remove the effects of a negative angle of attack when the helicopter was nosed down. Apparently, the +6 degrees should have been raised to +10 degrees to eliminate this negative angle of attack. The down loads on the airfoil at the high speeds lessen the advantage of the reduced profile drag; thus, use of the standard cylindrical configuration is more satisfactory at higher speeds. The reduction in power required at lower speeds indicates an improvement in the speed-power curve. This feature increases the endurance at loitering speeds, a definite advantage in observation helicopter operations.

DETERMINATION TWO. Autorotation Test Runs

Procedure

The helicopter was put into autorotation at approximately 3, 000 feet. The aircraft was stabilized at the desired airspeed, which varied between 20 and 70 miles per hour. The time to descend from 2, 500 feet to 1, 500 feet was recorded. The procedure was repeated twice for each speed.

Results

The helicopter showed an overall improvement in rate of descent during autorotations when fitted with the faired crossbars. The standard "G" and "H" crossbars gave almost identical results and are plotted as one curve labeled "standard" in Figures 4 and 5.

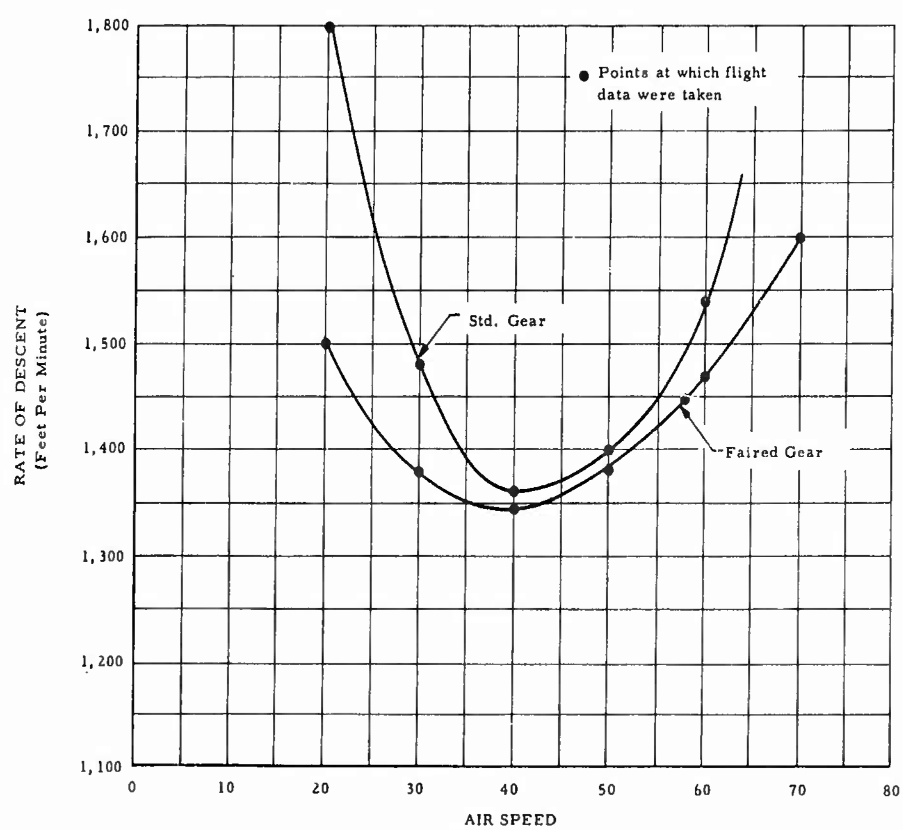

Figure 4. Comparison of Rate of Descent of the Standard and Faired Landing Gears at 3, 100 Engine r. p. m.

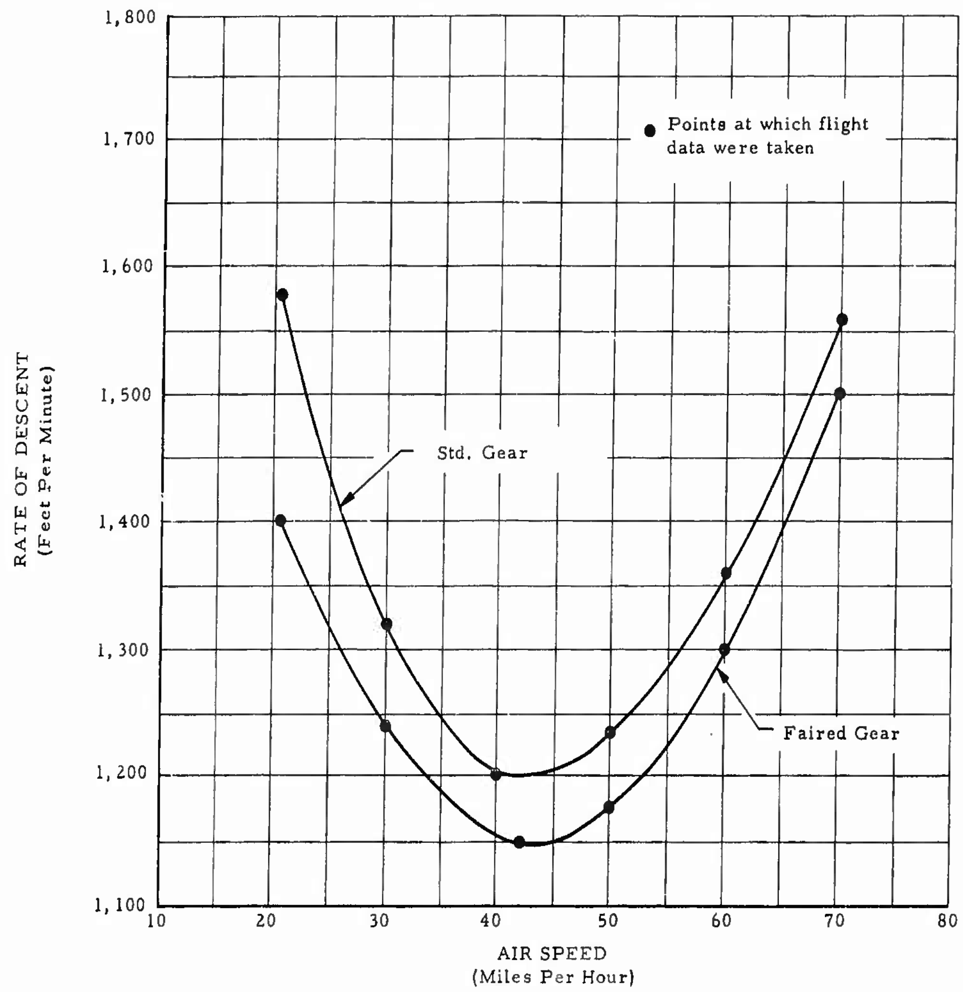

Figure 5. Comparison of Rate of Descent of the Standard and Faired Landing Gears at 2,900 Engine r.p.m.

At 3,100 r.p.m., the minimum rate of descent was comparable for all configurations at approximately 43 knots. The faired gear, however, gave improved rates of descent at lower and higher airspeeds. (See Figure 4.)

At 2,900 r.p.m., the aircraft with the faired gear showed an improved rate of descent at all airspeeds. (See Figure 5.)

Observations

Both on the straight-and-level and on the autorotation test runs, the current weather conditions were recorded. The results have been corrected for temperature. The pressure variations were eliminated by operating at constant pressure altitude relative to 29.92 inches of mercury. The airspeed indicator and the manifold pressure gauge were calibrated.

DETERMINATION THREE. Stability and Control

Procedure

The evaluation of the stability of the modified aircraft was performed only qualitatively.

Results

There were no effects such as abrupt trim changes or noticeable pitching moments introduced by the addition of the landing gear airfoil. The vibration of the landing skids in flight was noticeably reduced with the airfoil installed.

EVALUATION

The drag area that results from the addition of the airfoil to the H-13 gear is reduced by 2.85 square feet. This represents a gain of 15 percent in the reduction of drag compared to the total drag area of 18 square feet. During tests, the gain on drag reduction was reduced to about 5 percent as a result of the addition of external instrumentation and side effects. Measuring a gain of this magnitude is difficult without extensive instrumentation; only a trend can be shown if relatively simple sensing devices are used. This trend, however, was definitely toward improvements in the flight characteristics of the H-13. No stability and control deficiencies were inherent when the gear was faired. The vibration level was significantly reduced in the skid and crossbar areas of the aircraft.

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Unclassified report

Results of tests that have been conducted to compare the effects

(over)

1. Helicopter Aerodynamics
2. Helicopter Handling Qualities
3. Helicopter Landing Gear Configurations

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