Sideslip Bias Error

Summary

The sideslip angle, β, was measured during the UH–60A Airloads Program with a yaw vane mounted on the test boom at the front of the aircraft. An erroneous bias error was used for Flights 89 to 103 and was corrected in the data base for Flights 91 to 103 as well as some counters for Flight 90. However, the bias error is still uncorrected in the TRENDS data base for Flight 89 and parts of Flight 90.

Level Flight Performance Tests

Level flight performance measurements were made on Flights 84–90 during the UH–60A Airloads Program. Data were obtained as airspeed was varied for six weight coefficients. The airspeed limits in most cases were determined by available power. The pilots employed different strategies for aircraft trim during these level flight tests depending upon the airspeed. At low airspeeds the pilots normally attempted to maintain a zero sideslip angle and they accepted the consequent non-zero roll attitude. However, for airspeeds above the minimum power speed, the pilots normally trimmed the aircraft to ball-centered flight where the roll attitude was zero. To achieve ball-centered flight, however, the pilots allowed some sideslip which provided the roll moment required for trim through the aircraft's static dihedral. The aircraft's static dihedral tends to increase significantly with forward speed so that very little sideslip is required for ball-centered flight at the highest speeds.

Level flight performance testing of the 1st-year production UH–60A (Nagata et al. 1981) and the 6th-year production aircraft (Marshall et al. 1985) include charts of "inherent sideslip," which is defined as the sideslip required for ball-centered flight. For these tests, a sensitive lateral accelerometer was used to determine the ball-centered flight conditions. The sideslip measured during the level flight performance tests of Flights 84–90 are compared to the inherent sideslip values of these two referenced tests in Figure 1. At low airspeeds the inherent sideslip angle for the USAAEFA tests does not necessarily show good agreement with the present measurements and this is expected as the pilot does not attempt to fly ball centered at the lower airspeeds. At higher airspeeds generally good agreement is seen with the sideslip angles from Marshall et al. (1985). The UH–60A configuration tested in the Airloads Program is more similar to the 6th-year production aircraft tested by Marshall et al. (1985) than the 1st-year aircraft. The most significant difference between the two configurations is the installation of fairings for the Extended Stores Support System (ESSS) in the 6th-year production aircraft[1]. The cause of the difference between the inherent sideslip angles determined by Nagata et al. (1981) and Marshall et al. (1985) is not known. It seems unlikely that the installation of the ESSS fairings would cause a difference of this size.

[1] The UH–60A Airloads Aircraft, S/N 82–23748, is in fact the same aircraft tested by Marshall et al. (1985). However, the aircraft has been updated since those tests. The most significant external change is the installation of the wire strike protection system.

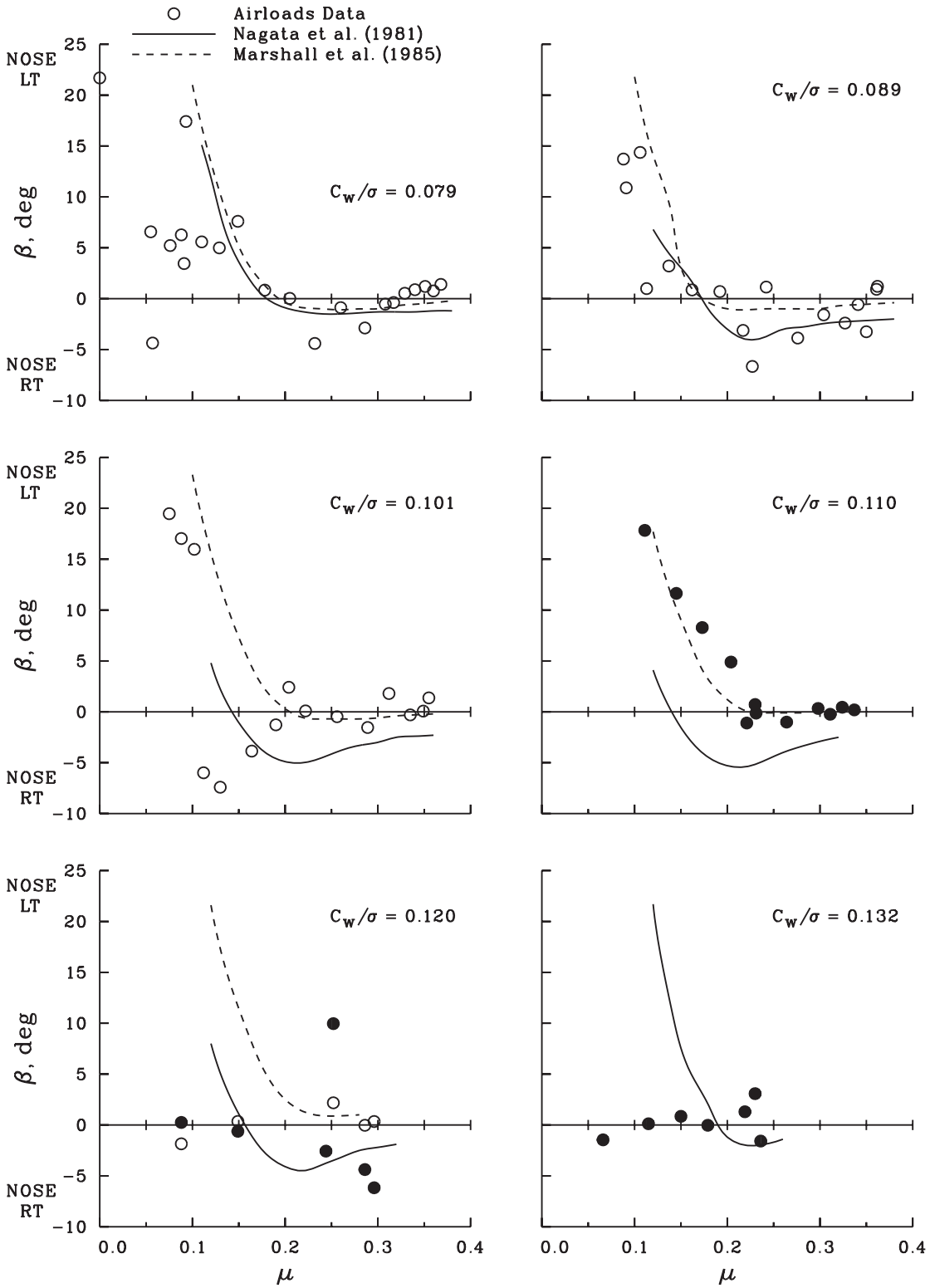

Figure 1 – Comparison of measured sideslip angle for six level flight performance conditions with measurements obtained by Nagata et al. (1981) and Marshall et al. (1985). Solid circles have been shifted by –39.77 deg.

The boom sideslip angle (and angle of attack) are measured with pivoting vanes installed on the front end of the test boom. Normally, the bias for these measurements was not determined using the calibration equivalence method as the measurement of offset was considered more accurate as determined by laboratory calibrations compared to measurements with the sideslip vane installed on the aircraft. However, during Flights 89 to 103, a static calibration value was inadvertently used for the data reduction and this static calibration value caused a shift of –39.77 deg. This error was discovered and corrected for the data obtained on Flights 91 to 103, and for Counters 9023, and 9027 to 9032 on Flight 90. However, the error was not corrected for the other counters on Flight 90 or for any of counters on Flight 89, as these data had already been written to the optical disk at this time.

Presently, the sideslip bias error remains in the TRENDS data base for Flight 89 and portions of Flight 90, and the sideslip requires correction for these counters.

Conclusions

There is a bias error of –39.77 deg. in all sideslip data for the counters on Flight 89 and most of the counters on Flight 90. This bias error occurred because of the inadvertent use of the static calibration value for Flights 89 to 103. The bias error has been corrected for Flights 91 to 103 and for Counters 9023, and 9027 to 9032 on Flight 90. However, the TRENDS data base has not been corrected for Flight 89 and portions of Flight 90.

References

John I. Nagata, Gary L. Skinner, Robert M. Buckanin, Robert D. Robbins, and Robert A. Williams, “Airworthiness and Flight Characteristics Evaluation, UH–60A (Black Hawk) Helicopter,” USAAEFA Project No. 77–17, September, 1981

Arthur R. Marshall, Jr., Robert MacMullin, Roy A. Lockwood, Thomas L. Reynolds, Edward J. Tavares, Robert M. Buckanin, Gary L. Skinner, Michael K. Herbst, Charles F. Cassil, Patrick J. Sullivan, and Robert A. Williams, “Airworthiness and Flight Characteristics Test of a Sixth Year Production UH–60A,” USAAEFA Project No. 83–24, June 1985

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Revision 1 (November 13, 2000):

The bias error discussed in the original Occasional Note was treated as an anomaly. However, a Memorandum for Record, by Dwight Balough, dated April 12, 1994, provides a detailed history of the sideslip bias error and, hence, the present Occasional Note has been revised (and re-titled).

The ordinate sign convention in the original Occasional Note was shown erroneously on Figure 1 and has been corrected.