

Strake Technology Brief

Bell Models: 205A-1, 212, 412, UH-1 & AH-1

Boundary Layer Research, Inc.
Fixed-Wing & Rotor-Wing Aerodynamic Solutions...

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Patented Technology

Helicopter Tailboom Strakes

The BLR Tailboom Strake Kit is the most cost-effective performance enhancing modification for single rotor helicopters on the market today. The design and configuration are based on more than eight years of research completed by a NASA/US Army team of researchers at the Langley Research Center. The team used wind tunnel and flight test data to design a device that *improves handling qualities, reduces tailboom fatigue, improves climb and cruise performance, and increases yaw control safety margins for all single rotor helicopters with enclosed tailbooms.* The resulting technology has earned the distinguished 'NASA Space Act Award' and the 'US Army Achievement Award for Research and Development.' In 1998, NASA granted Boundary Layer Research an exclusive license to commercialize this patented technology. BLR has since validated the earlier work done by the NASA/Army team and refined the Tailboom Strakes for optimal performance and ease of installation. This document will help to explain some of the benefits associated with the tailboom strake device that were revealed during the first three years of the BLR development program. The following remarks pertain to Bell Models UH-1H, 205A-1, 212 and 412 type helicopters. The tailboom of these models are very similar in terms of aerodynamic shape; therefore benefits associated with altering airflow over the tailboom have proven to be similar.

Proven benefits of Tailboom Strakes

1. Improves altitude performance

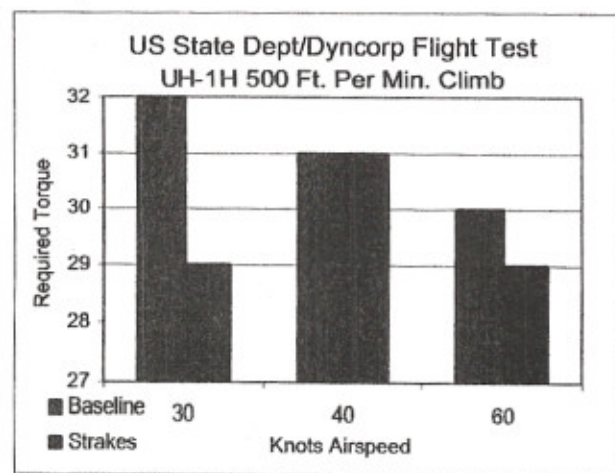
A. Increases hover ceiling. The Strakes can raise the helicopter hover ceiling by as much as six thousand feet (as related to yaw control). NASA

Technical Paper 3278 states that "simple calculations" for a UH-1 or AH-1 class helicopter indicate that a 10% improvement in pedal control margin (about 0.7 in. for the UH-1 test helicopter) at the critical condition can improve the operational altitude by as much as six thousand feet.

B. Increases payload at altitude. By reducing the horsepower required by the tail rotor, more horsepower is available for vertical lift. NASA reports additional payloads of as much as twelve hundred pounds at pressure altitudes above seven thousand feet. Other users have reported amounts anywhere from five hundred to nine hundred additional pounds of payload without reaching yaw control pedal limits.

2. Improves climb

Improves obstacle climb performance. In a US State Department flight test, the aircraft modified with the BLR Tailboom Strake Kit out-climbed the same unmodified aircraft by an average of 300 feet per minute while using the same torque settings.



3. Reduces pedal input

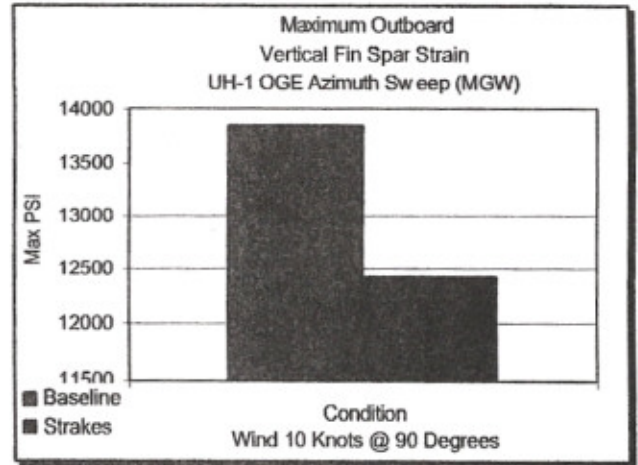
A. Improves hover stability. The improvement in hover stability is a result of the pilot no longer having to make numerous pedal adjustments to compensate for varying degrees of rotor-wash-in pedal generated "lift" caused by aerodynamic forces on the tailboom. The reduction in pedal activity is directly related to the fact that the strakes eliminate the "airfoil effect" by stalling the boom, resulting in a significant reduction in pilot workload. NASA has documented as much as a fifty-percent reduction activity using the strake technology. This reduction is measured in both amplitude and frequency of pilot pedal input.

B. Reduces tailboom fatigue. Reductions in pedal input reduce fatigue, torsional stress and wear experienced by the tailboom and associated anti-torque components such as pitch change links, control rods and tail rotor bearings.

C. Reduces vertical fin spar fatigue. In Tech Paper 3278, NASA reports as much as a 34% reduction in yaw required tail rotor horsepower when measured at the ninety-degree gearbox on the strake-modified UH-1H.

4. Reduces maintenance costs

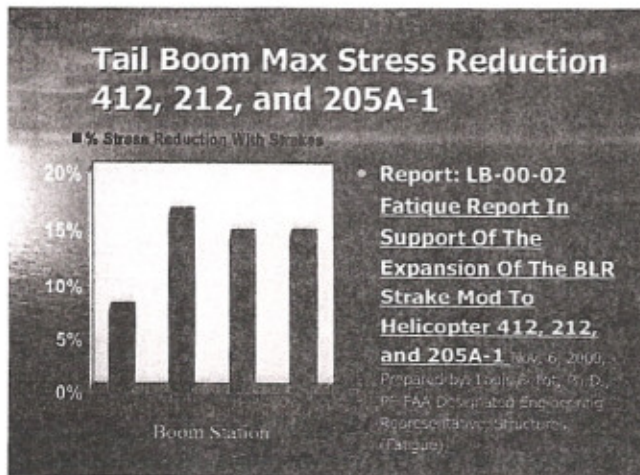
Extends service life. Time in service of tail rotor bearings, pitch change links, tail rotor control rods, and other on-condition items related to the anti-torque system is extended greatly reducing replacement costs due to the decrease in required pedal inputs by the pilot.

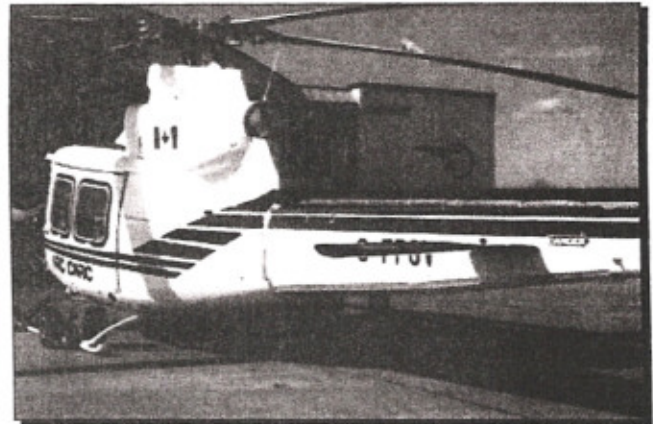
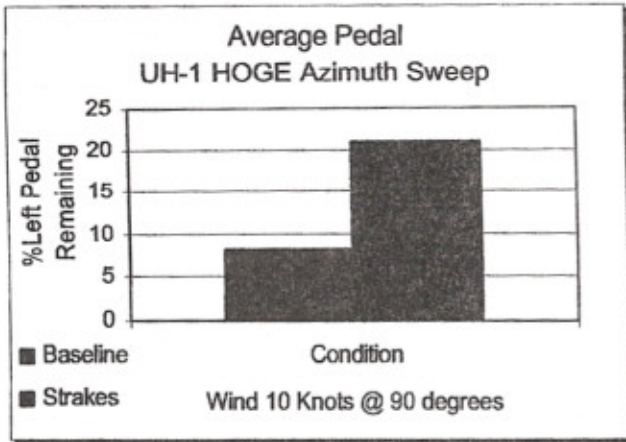


5. Improves yaw control

A. Increases crosswind tolerance. BLR test pilots demonstrated right sideward flight to sixty-three knots during FAA certification flight testing using a modified UH-1H at maximum gross weight. In the unmodified helicopter, the pilot contacted the left pedal stop at only thirty-four knots. The BLR Tailboom Strake Kit improves crosswind performance by as much as eighty-five percent.

B. Improves yaw safety margins. Yaw safety margin is improved at critical conditions by as much as 150%, with an average improvement of 28% for crosswind conditions between zero and thirty-five knots.

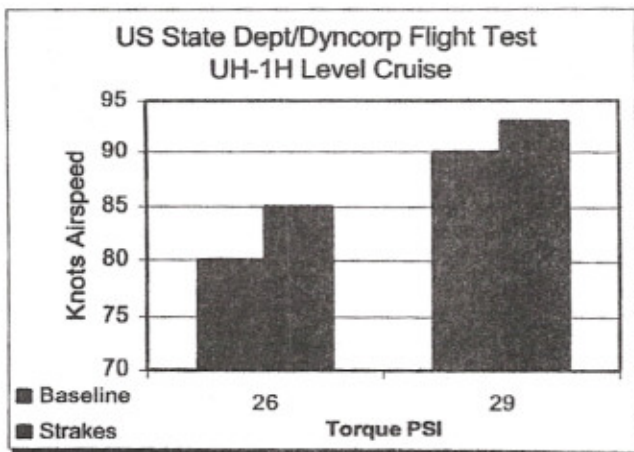
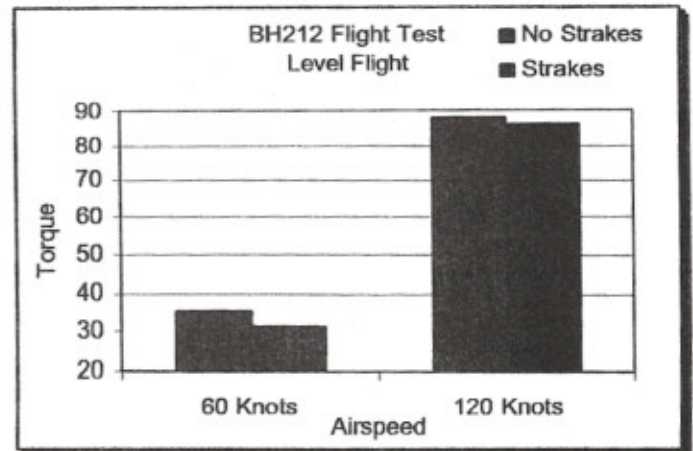




National Research Council of Canada's Bell 412EP ARSA (Advanced Stability Research Aircraft) during BLR Strake testing in Ottawa

6. Improves cruise performance

Reduces fuel consumption in cruise flight. Global Helicopter Technology, Inc. flight-tests revealed a four PSI torque reduction during cruise at eighty, ninety and one hundred knots. The US State Dept/Dyncorp had similar findings. Final BLR strake testing with a BH 212 helicopter revealed a 4% torque reduction at 60 knots and a 2% torque reduction at 120 knots. This torque reduction results in reduced fuel consumption and effectively extends helicopter range.



References

- NASA TP 2506/AVSCOM TR 85-B-3: Aerodynamic Characteristics of Several Current Helicopter Tailboom Cross Sections Including the Effects of Spoilers
- USAAEFA Project No. 85-07: Flight Characteristics of the UH-60A With Tailboom Mounted Strake
- NASA TM 4248/AVSCOM TP 90-B-010: Aerodynamic Effects of Strakes on Two-dimensional Tailboom Models of OH-58A/D Helicopter.
- NASA TP 3278/AVSCOM TR 93-A-003: Flight Investigation of Effect of Tailboom Strakes on Helicopter Directional Control
- Dyncorp Unclassified Memorandum JB99-45: Test Results BLR Helicopter Tailboom Strake Modification.
- Global Helicopter Tech, Inc. Report No. GHT-365-102: UH-1 Flight Test Results, IR Sept. '99
- Global Helicopter Tech, Inc. Report No. LB-00-01: UH-1 Tailboom/Vertical Fin Fatigue Analysis

What the industry is saying:

National Research Council of Canada, Institute For Aerospace Research Report — Initial Handling Qualities Assessment of Bell 412 Tail Boom Strakes: Maneuvering of the strake-equipped Bell 412 consisted of pirouettes, sidesteps and precision landings. In each case the extent of pedal activity, both in frequency and amplitude, were subjectively judged significantly reduced compared to the baseline configuration. Maneuvering to maintain a quartering left tailwind of 25 to 30 knots required only infrequent small (1/2"-1") pedal inputs. The sharp, high frequency pedal control strategy required to suppress the directional gust response of the helicopter was alleviated almost completely. Robert Erdos, NRC Flight Test Pilot/Engineer

Larry Jenkins, Director (Retired), Research and Technology Bell Helicopter Textron Inc. — Impact of the Addition of Tailboom Strakes on the Performance of the Bell 205 Helicopter; Dec. 22, '00: It has been shown that the Bell 205 helicopter with tailboom strakes installed can operate at 3000 feet higher density altitude using the power margin provided by the strakes in the critical sideward flight regime. Conversely, at the same density altitude, the aircraft is shown to be capable of increasing its take-off and landing capability by 700 pounds without exceeding any main rotor limits.

US State Department/DynCorp UH-1 Flight Test After-Action Report — Hover: "It was obvious from the moment the aircraft was lifted to a 3-5 foot hover, that the effort required to maintain directional control or position over the ground with a 90 degree right crosswind or tail-wind component was greatly reduced with the Strake Kit installed." **Cruise:** "A 3-5 knot increase in airspeed was noticed at cruise flight when flying with the strake kit installed when compared to the speeds recorded when flying at similar torque settings during baseline flight." Chief Pilot Jim Busquets, Oct. 14, '99, Patrick AFB

NASA Technical Report 3278/ATCOM Technical Report 93-A-003 — 5% improvement in pedal control margin will provide an additional 2000 ft of operational altitude capability or 500 lbs. of payload. Recorded time histories of angular yawing velocity, pedal position and tail rotor torque agree with pilot comments that dual strakes reduced pedal amplitude and frequency by approximately 50%.

Engineering Evaluation of the Structural Effect from Strake Installation — The mean stresses in the vertical fin and pylon will decrease due to reduction in mean T/R power. This coupled with the reduction in pedal reversal will reduce fatigue aft of BS 190.5. Prepared By: Mr. G.G. Tenbrink, Base Structures Engineer, Aero Structures, Australia, 2/10/99

M. T. Cox, FAA Designated Structures Engineer, Cox Engineering Arlington Texas — Structural Analysis of Bell Helicopter Model UH-1H Dual Tailboom Strake Installation; Conclusion;"The tension stresses are reduced when the strakes are added.... Therefore the resulting fatigue stresses are reduced for the condition with the strakes added. Therefore the tailboom with strakes added has higher fatigue margins of safety than the tailboom without strakes". Report No. BL-UH-01-03 Rev. I/R Dated Feb 08 2000



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