HELO SHIP TAKE OFF AND LANDING – FLIGHT TEST GUIDANCE MATERIAL

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Abstract

In the past ten years, French MOD DGA Flight Test Center was commissioned to conduct flight tests aiming to define the helo-ship takeoff and landing flight envelope of the NH90 and the Tiger. Before every test campaign, the same issue rose: chasing bad weather conditions in order to have useful data while the campaign calendar was chosen months in advance. In addition, which parameter was mainly driving the helicopter limits: pitch and roll of the platform? wind? weight? The present study is giving piece of clarification on these questions based on an engineering method in 3 steps:

- <u>First step:</u> a model, predicting shock and power margins issues,
- <u>Second step:</u> a guidance material for on-shore flight tests aiming to collect all the data and to refine the model
- <u>Third step:</u> an off-shore flight test campaign, not necessarily in worst conditions, enabling to validate the model and to extrapolate test results up to the limits.

This method, validated with Dauphin and NH90 flight results, demonstrates that flight test data collection can be made on-shore (with different weight, wind, platform attitudes) to validate a mechanical model. This model, once spot checked at the occasion of a real off-shore test, enables extrapolation up to the limit of the helicopter, limits that were not possible to test in real conditions.

Flight safety during flight test phase is improved by highlighting helicopter limits in advance. Risk on the program's calendar is significantly reduced by avoiding numerous off-shore test campaigns.

1. Introduction

Helo Ship Operations are never easy duty.

Before letting pilots play, flight test teams have to ensure that the helicopter is capable of achieving these particular maneuvers. Certification Specifications provides limited guidance materials on this subject. Flight performances, handling qualities, maneuverability and controllability have to be assessed. Which criteria is limiting the maneuver? Engine power? Controls margins? Rotor dynamics? Landing gear strength? On which platform will the test be performed? A big one, not moving a lot but with important vertical displacements? Or a small one, in rough conditions with important roll and pitch movements but with limited vertical displacements? What are the pass fail criteria?

Are the achieved results depending of the ship/helicopter couple or can you conclude on the helicopter itself directly? How to take into account particular wind effects due to every different ship superstructures? Any flight test engineer involved in helo-ship takeoff and landing tests had these questions. The answer is that there are too many variables… Except by following a comprehensive approach, hundreds of test points would be necessary to fill in the multi dimension table leading to something you could conclude on...

2. Method

2.1. Separating the influencing parameters

One first idea becomes clear: the ship is a limiting factor itself, due to the turbulences induced by superstructures. But one ship class does not induce the same limitations as another one. Therefore, the first driving idea for the heloship flight tests is to decouple the helicopter own capabilities from the shipborn limits. In other words, determine helicopters own limits inside which we can determine SHOL (Ship Helicopter Operating Limitations) afterwards. Otherwise, helicopter limits would be limited by the ship that was used for the test. With this separation, the determined envelope becomes independent of the ship and can be used for any kind of ship afterwards.

2.2. Influence of the deck roll

A second idea rose: helicopter characteristics are not influenced the same way by pitch and roll of the deck. The roll is mainly influencing the shock during the landing (especially at the second gear contact as shown in Figure 3). This figure presents the computed reaction force at different deck bank angle from 0 to 6°. It shows that the maximum effort is achieved when the angle is maximal. It is also demonstrated that the deck roll-acceleration is preponderant over the roll-induced vertical speed in shock effect. Therefore, it is proposed:

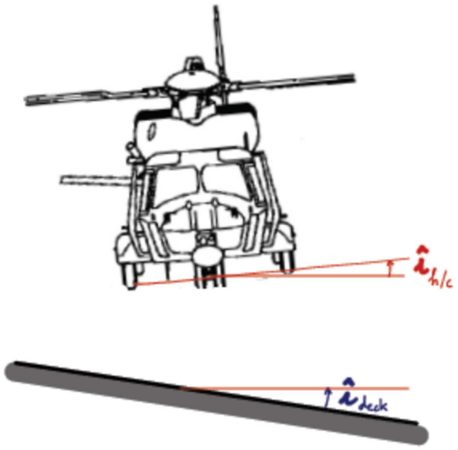

Figure 1 – Worst case scenario

- to test helicopter on-shore on a slope
- to inject real deck accelerations afterward in the model to refine the “moving deck”.

The worst case to be tested is presented in Figure 1.

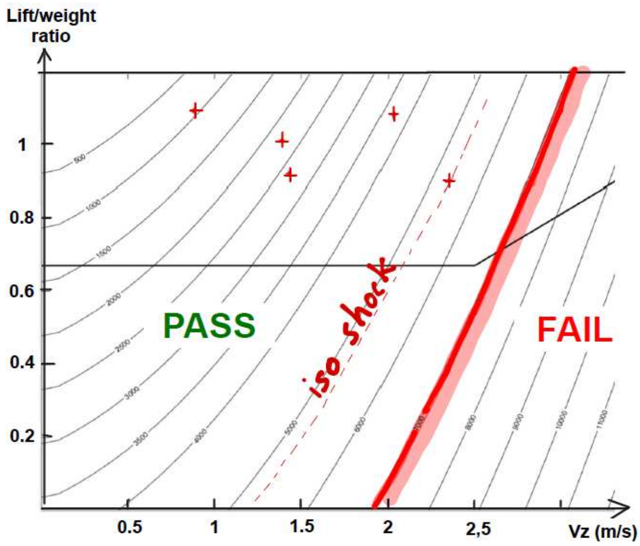

Figure 2 – Iso-shocks diagram

The test results, combined with the mechanical model enables to produce iso-shock curves that can be used to extrapolate one test point to another, especially from one bank angle to another or from one couple ($\frac{Lift}{Weight}$;Vz) point to another. This kind of chart, one example being given in Figure 2, enables to limit tremendously the number of test points by highlighting equivalence in term of efforts at touch down.

Last point, failure cases can be predicted knowing the limiting factor of the helicopter by design (e.g. maximum strength on the undercarriage) and thanks to the model and the iso-shock curves. This is a safety improvement before flight test phase and a risk reduction for the program.

All computations are based on a collective pitch reduction presented in Figure 4, based on representative but slightly conservative landings, observed through hundreds of landing on NH90, Dauphin and Lynx.

2.3. Influence of the deck pitch

A third idea is that long ship moving at +/-2° of pitch induces important vertical displacements of the spot. Therefore, hovering above the spot with ship high pitch is mainly limiting the power margin of the helicopter. The test method consists in flying the real aircraft, on-shore, with a simulated deck movement presented inside the cockpit on a dedicated screen part of the flight test instrumentation. This FTI presents orders to the pilot, based on real deck movement's records. The crew is flying in free air, out of ground effect, and trying to follow a virtual deck indicator with a precision of about ± 5 feet. At a given weight, the records of the power necessary for this maneuver gives an immediate idea of the margin available for off-shore real operations.

3. Conclusion

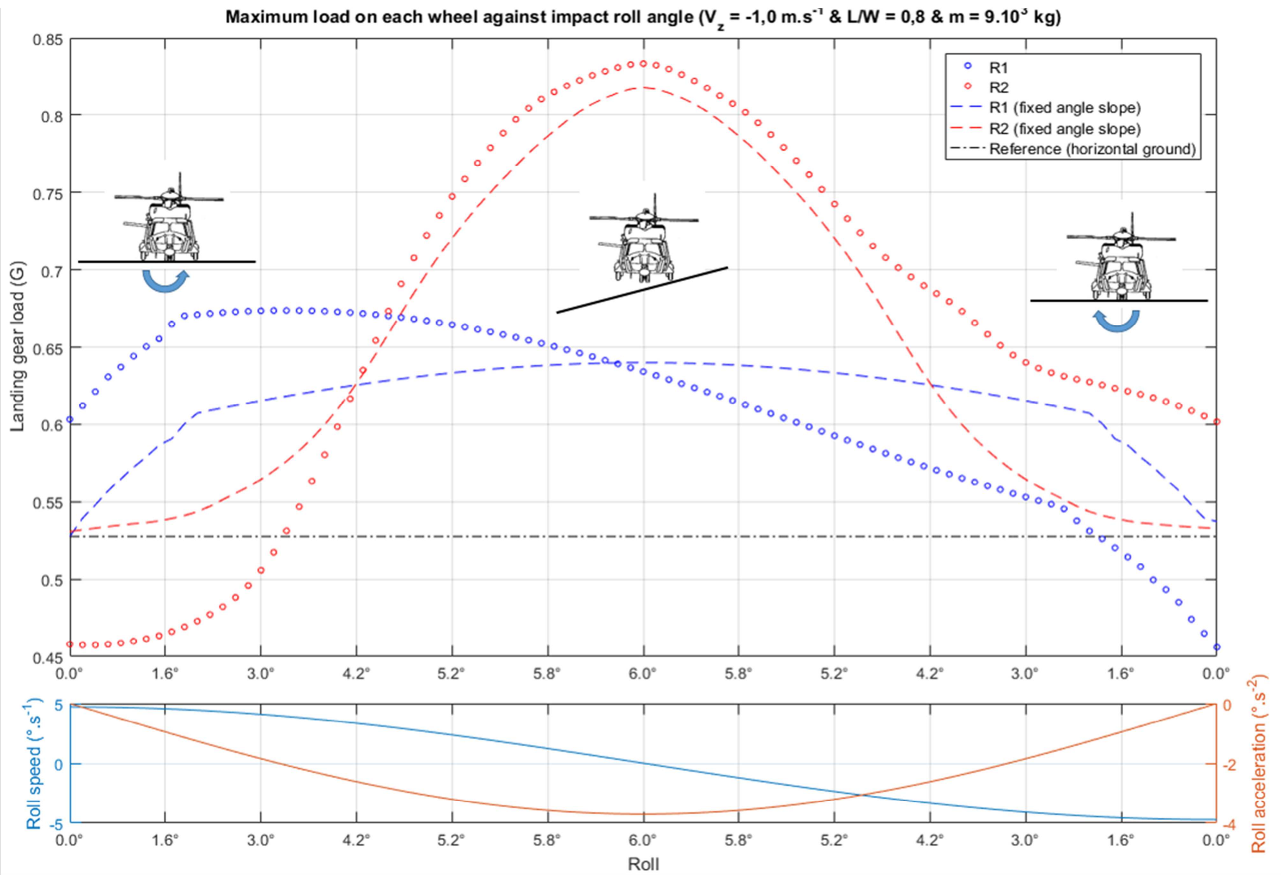

Figure 3 – Landing gear load against impact roll angle, R1 being the 1st contact, R2 being the 2nd

The proposed method enables to collect flight test data on-shore (no weather constrains, no ship constrains, selected wind conditions, repeatability of test points).

The proposed method limits also the engineering risk on the program schedule (by avoiding an overstress of a helicopter component during an extreme condition test) risk for the flight test (by avoiding the necessity to test up to the limits).

The proposed method provides an envelope that is representative of the helicopter own capacity, the SHOL being the responsibility of the operator.

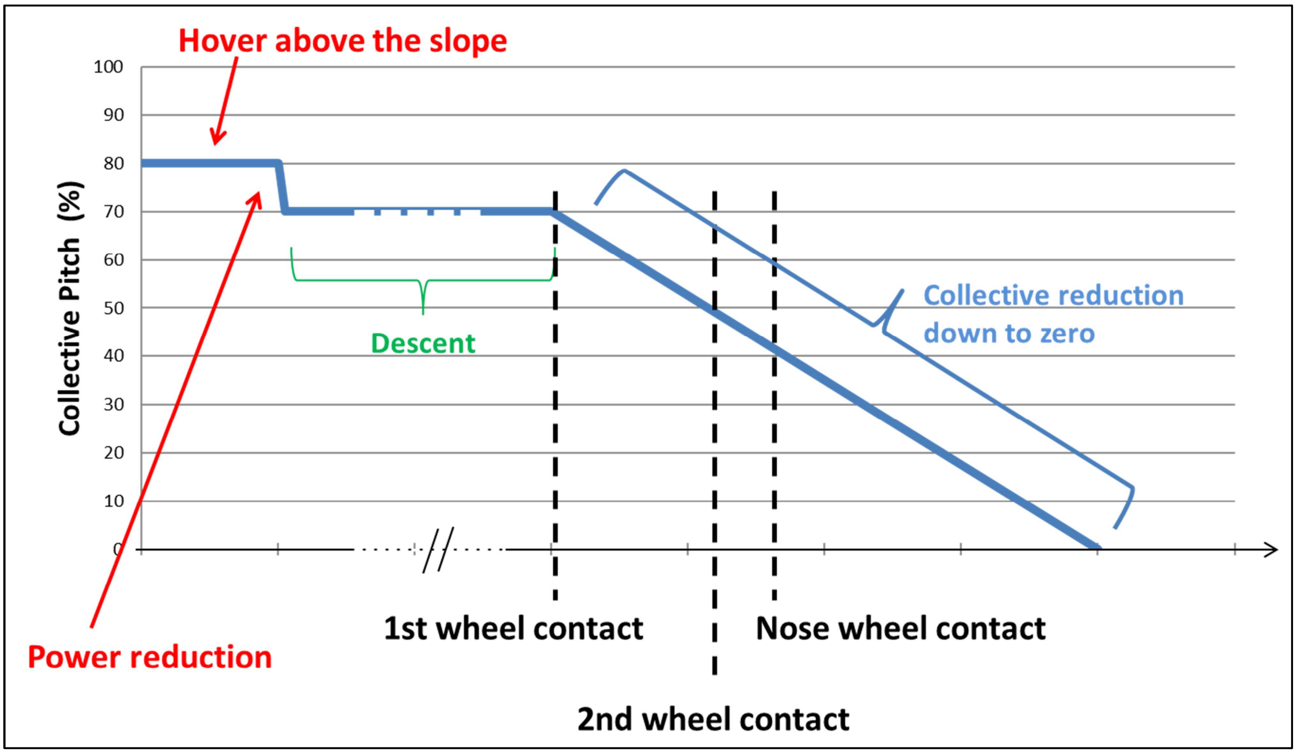

Figure 4 – Slope landing method