

Review Paper on Design of Air Craft Landing Gear using Simulation

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ABSTRACT

In this paper, a new methodology supporting the design of landing gears is proposed. Generally, a preliminary step is performed with simplified FE model, usually one-dimensional, to achieve the reaction forces involving each component during all aircraft operations. Though this approach gives a valid support to the designer, it is characterized by several problems, such as the related approximations. So, it is important, by a numerical point of view, to develop an isostatic FE model equivalent to the real one. In fact, if the landing gear is modelled as hyperstatic, the static equilibrium equations are insufficient for determining the internal forces and reactions on each sub-component; so, the modelled material properties and geometries assume an increasing importance, which gets the model too approximating. The proposed methodology consists of achieving the reaction forces by means of multibody simulations, by overcoming such problems, since each component is modelled as rigid. In this paper, also a FE model for the investigation of the structural response is proposed. Aimed to Certification by Analysis purposes, the developed multibody and the FE models have been assessed against an experimental landing gear drop test carried out by Magnaghi Aeronautica S.p.A., according to the EASA CS 25 regulations. In this paper, an approach to the application of ADAMS in the analysis of landing gear behaviour and ground manoeuvring characteristics of a trainer aircraft is presented.

KEYWORDS: Landing gear; Multibody; FE analysis; Dynamic behaviour; Drop Test, ADAMS.

I. INTRODUCTION

In the context of the development of an incipient advanced trainer aircraft, Aermacchi and Politecnico di Milano are co-operating on a project aimed at the evaluation of the loads transferred to the fuselage and the structural compartment of the landing gear during impact and ground manoeuvring utilizing dynamic and kinematic simulations. The desideratum for integrated models as early as in the design phase, able to cater for the requisites of the different project design areas, led, during a homogeneous cooperation in the 1980s, to the development of a dedicated code, GRAALL (Ground Roll Air And Landing Loads), utilized for such aircraft as AMX, S211, SF260 and MB339 [1]. As with most dedicated codes, it was relatively simple to construct and tune a model, obtaining very precise results, as long as one remained within the circumscriptions of its development: any endeavor to transcend encountered the indispensability of adscititious, onerous programming. In order to surmount this intrinsic, time consuming circumscription, an incipient approach, predicated on the utilization of an industrial, multi-purport, multi-disciplinary code was prospected. As matter of the fact, a landing gear can be considered as an aircraft subsystem characterized by such subcomponents as brake, wheels, tyres, shock absorber and some structural kinematic components aimed to the extraction and retraction of the landing gear. The last two sub-components play a consequential role during the flight. In fact, the landing gear dimensions are such to get it so bulky to increment significantly the drag coefficient. Hence, it is consequential to retract it during the flight. In this paper, an incipient methodology is proposed. Such method sanctions achieving, by denotes of multibody simulations, rather than the reaction forces involving each sub-component, the kinematic replication of whole landing gear, the coherence of the spatial dimensions of each sub-component, which should not impede the kineticism of another one, and the dynamic deportment such as the in-play mass values, the equipollent stiffness and the damping coefficients of the landing gear components.

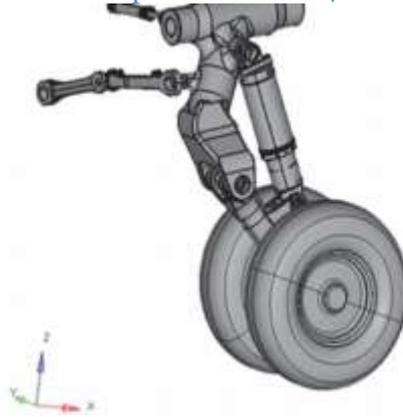


Figure 1: Main Landing Gear.

II. LITERATURE

The experience acquired with the previous code has proved to be very useful for the construction of landing gear multi-body models in ADAMS. The versatility of the latter has in fact allowed an easy implementation of the dedicated software equations, reducing the conversion time between the two calculation procedures. For example, the oleo-pneumatic shock absorber model was developed following the method already implemented in the dedicated code, which allows for both conventional orifice and variable diameter metering pins. Analogously, the FIALA tire used for the simulations with ADAMS was tuned using both experimental data and simulations with the GRAALL tire model applied in ADAMS as a user-defined subroutine. Furthermore, the first validations on the multi-body model were carried out by comparing the results obtained on the corresponding models built and simulated with the previous method. The first step taken towards the construction of the complete model for the new advanced trainer aircraft was the separate implementation in ADAMS of the main and auxiliary landing gear with rigid body models, designed on the basis of an existing undercarriage with similar performance requirements. Experimental drop test results and previously developed models were therefore available for validation of the basic model. Successive modifications, either geometric or functional, corresponding, for example, to variations of the shock absorber metering pin geometry or initial pressure value, could then be carried out on the basis of the validated model. In references 8 and 9 Moreland characterizes shimmy by defining the relationship between a single non-dimensional quantity called the inertia ratio and the dynamics of the airframe. In most cases he studied, when the simplest systems were stable, the higher order systems were not less stable. To precisely describe the system and the shimmy phenomena, the mathematical model required 5 degrees of freedom: tire deflection, swivel angle, strut deflection, damper-linkage strain, and airframe motion. Comparisons of various systems were made with and without tire elasticity. The stability of the gear was influenced by 15 system parameters that were brought together in the shimmy analysis by a seventh order characteristic equation of the model. Routh's stability criterion was applied to the equation to study the effects of changing gear parameters on the stability of the gear. Plots of dimensionless quantities such as velocity ratio, damping ratio, mass ratio, trail ratio, and inertia ratio defined the stability boundaries. In 1960 at NASA Langley Research Center a simple experimental model of an aircraft was used to study the effects of gear and airframe variables on nose landing gear shimmy behavior. (Ref. 13) A dynamically scaled skeleton model of an aircraft with a single main skid and castering wheel was towed on a moving belt runway at constant speed. The simplicity and size of the model made it relatively easy to vary model parameters for different configurations. This enabled evaluation of the gear through repeated observations of the model's response to varying conditions. Nose wheel steering and forms of shimmy damping were shown to have a stabilizing effect when the wheel was at an angle to the direction of motion. Another study of the role of airframe dynamics in shimmy analysis is described in reference 14. This report describes the theoretical and experimental study of the F-101 and F-104 nose landing gear shimmy. The dynamic response characteristics of the airplane fuselage were simulated during these tests with a mechanical fixture attached to an overhead platform that served as a mounting structure for landing gear. Frequency response characteristics were obtained experimentally by applying a periodic input to the fuselage at the nose gear station and recording the resultant bending and torsional motions. A graphical technique was used to fit the theoretical frequency response data to the experimental data to determine the parameters of the simulator from the transfer functions. Fuselage simulators were then designed and used to test the F-101 and F-104 aircraft systems. Technological advances in aircraft led to smaller brakes with more energy to dissipate, lighter shock struts with higher strength materials, and increased flexibility all of which increased the likelihood of vibrations of landing gear due to braking action. Brake-induced vibrations in landing gear may be induced for several reasons. The self-excitation of modes due to negative damping arises from variations in the coefficient of friction with instantaneous slip velocity. Forced oscillations are due to

irregularities in the friction surfaces. Self-excited whirl vibration is caused by eccentricity of rotating and non-rotating brake parts. The Information Report on brake dynamics of the SAE Committee A5 in 1997 (Ref. 22) categorized these landing gear dynamic vibration problems. A uniform method of classifying brake characteristics was given in terms of coefficient of friction, dynamic variation of friction coefficient, wear variation, and torque versus pressure characteristics. Self-excitation may be induced by large variations in the stiffness of brake components, poorly phased feedback in the anti-skid system, and tire lock-up corresponding to maximum drag. Solutions to these vibration problems included provision of basic aircraft parametric data from airframe manufacturers for analysis and testing. Data collection from flight testing is needed for skid control on wet and dry surfaces at shimmy speeds. Brake history and frequency and amplitude of vibration are desirable in order to characterize a pattern.

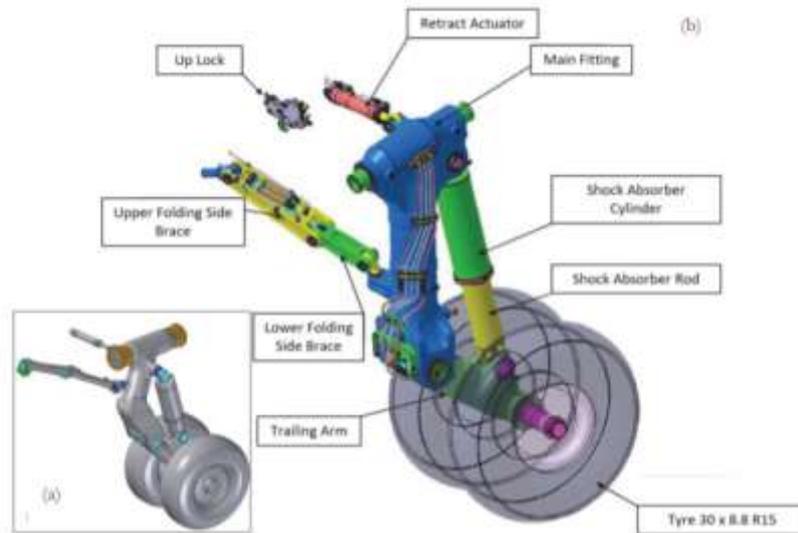


Figure 2: Landing gear: a) Multibody model; b) main structural components.

III. MODELING

Aircraft landing Gear and its components have been simulated in order to investigate the energy flow, performance and efficiency. Fluid flow ,pressure, stress. A “contact-automatic-surface-to-surface-offset” algorithm has been defined; in particular, a master surface has been defined around the piston and a slave one inside the cylinder tube. The model includes the aircraft inertia and tire flexibility effects without integrating extensive computational expense. Advantages of utilizing this method over more commonly used linear involute finite element analysis are conspicuous in the nonlinear transient analysis capability, the faculty to model nonlinear stiffness and damping effects of hydraulic fluid, modeling whirl and squeal instabilities with negative damping, and provision for modeling a sliding interface. A modal abbreviation routine is utilized for abstracting unwanted modes in order to preserve the efficiency of the software. The oleo, bogie, brakes and wheels, braking servo, steering actuation, control systems, tires, and runway profile are withal included in the model. The software has been validated with test data and an example of a drop test is given in the paper.

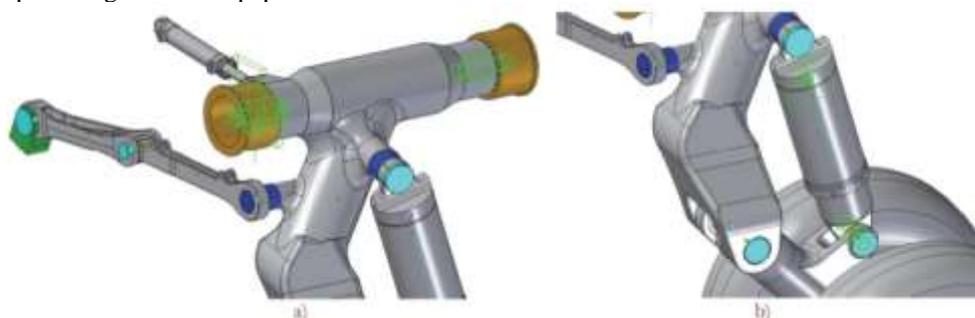


Figure 3: Revolute joints between: a) main fitting and the support fixture; b) main fitting, trailing arm and shock absorber.

IV. CONCLUSION

In this review study I have utilized sundry parameter of Landing Gear of AirCraft, We studied about how to Simulink on landing Gear with visualize output linkage programming. So many authors have done already great work antecedently but I am doing for getting better output than previous research.



Figure 4 :Stick model of the landing gear.

V. REFERENCES

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