

Presentation Title: A Landing Gear FEM Analysis Using MSC Patran/Nastran

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ABSTRACT

ELEB's main products are: landing gear systems, hydraulics and electro-mechanical sub-assemblies, such as actuators, valves, accumulators and pylons. Its main markets are the medium size commercial aviation, helicopters, executive aviation and defense aircraft segments. An aircraft landing gear system has four basic features: to support the aircraft on ground, to maneuver the aircraft, to absorb loads during landing and to provide safe breaking. It comprises structural and hydraulic items composed of landing gear leg strut, shock absorber, wheel, tire, break, beams, up and down lock actuators and retraction actuator. Considering the leg strut components, one of the most important structures is the main fitting, which transmits bending, torsion and shear loads to the aircraft structure. In this paper is presented a main fitting linear analysis as a preliminary study and a material and geometric nonlinear analysis as detailed study. This analysis is important to the Nose Landing Gear weight optimization, being one of the biggest challenges for the aircraft development nowadays.

1. Introduction

ELEB's history dates way back to the 1970's, when Brazil and Italy resolved on a joint program for the development of a new subsonic attack jet, the AMX. According to directives from the Brazilian Government. The responsibility for bringing this new technology to Brazil was assigned to Embraer – Empresa Brasileira de Aeronáutica S.A., which, in its turn, created EDE – Embraer Divisão Equipamentos in 1984. The main products are: landing gear systems, hydraulics and electro-mechanical sub-assemblies, such as actuators, valves, accumulators and pylons. ELEB masters the whole product cycle as an in-house development, from product design and development, through qualification tests, certification and manufacturing up to after-sales support. ELEB's main markets are the medium size commercial aviation, helicopters, executive aviation and defense aircraft segments. In this paper will be presented an example of a Landing Gear part stress analysis by using Nastran/Patran software.

2. Problem Definition

During the landing gear system baseline definition the Engineering Department is responsible for designing aeronautical structures that focus on weight reduction, easy maintenance and low cost. In this product development process, the Structural Engineering is responsible for dimensioning the landing gear parts regarding airworthiness requirements, which encloses limit and ultimate loads. For complex geometries, the Strength of Material Theory is not accurate enough to evaluate stress results, becoming necessary the use of finite element tools. To accomplish this objective, ELEB has used MSC Patran/Nastran software that has demonstrated good accuracy for stress evaluation.

3. Analysis

An aircraft landing gear system has four basic features:

- 1- Support the aircraft on ground,
- 2- To allow to maneuver the aircraft,
- 3- Absorb loads during landing and
- 4- Provide safe braking.

It comprises structural and hydraulic items composed of landing gear leg strut, shock absorber, wheel, tire, brake, beams, up and down lock actuators and retraction actuator. Considering the leg strut components, one of the most important structures is the main fitting, which transmits bending, torsion and shear loads to the aircraft structure. Figure 1 presents a Nose Landing Gear general view.

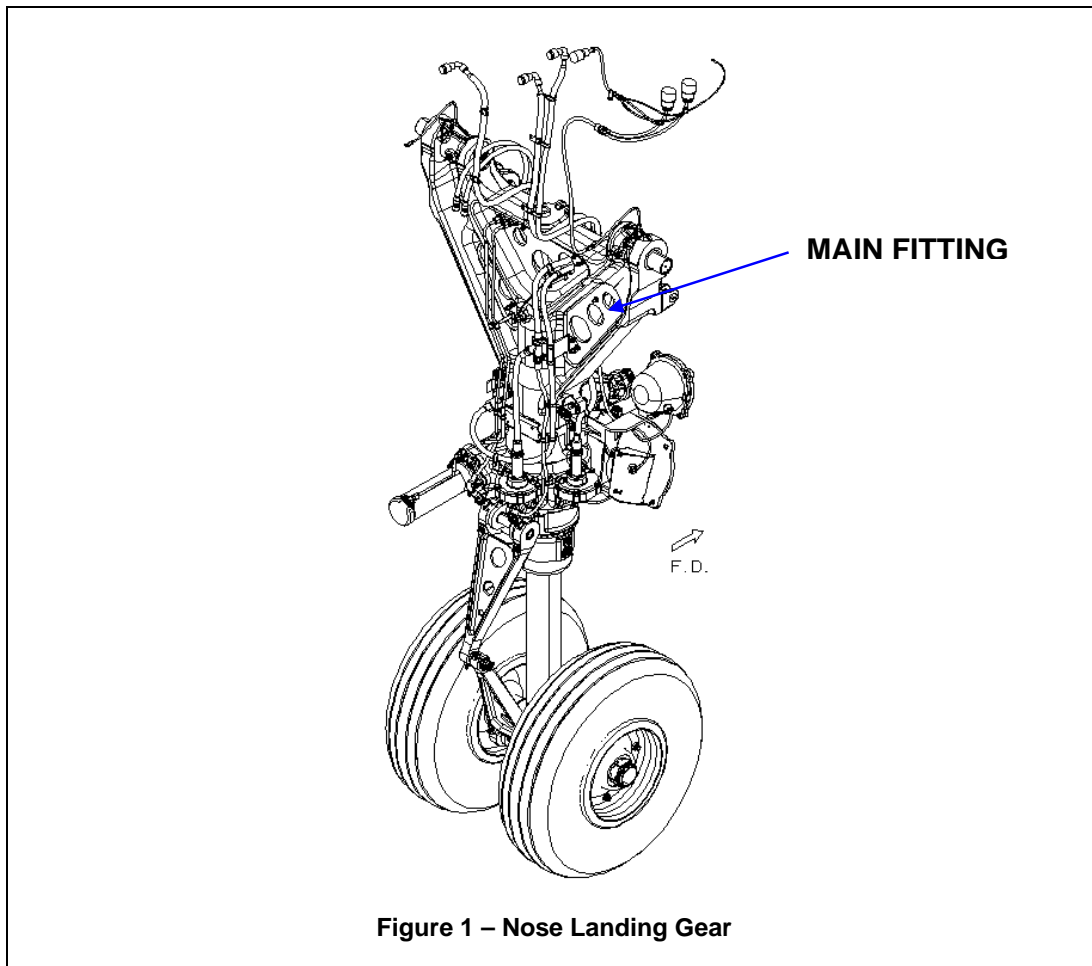
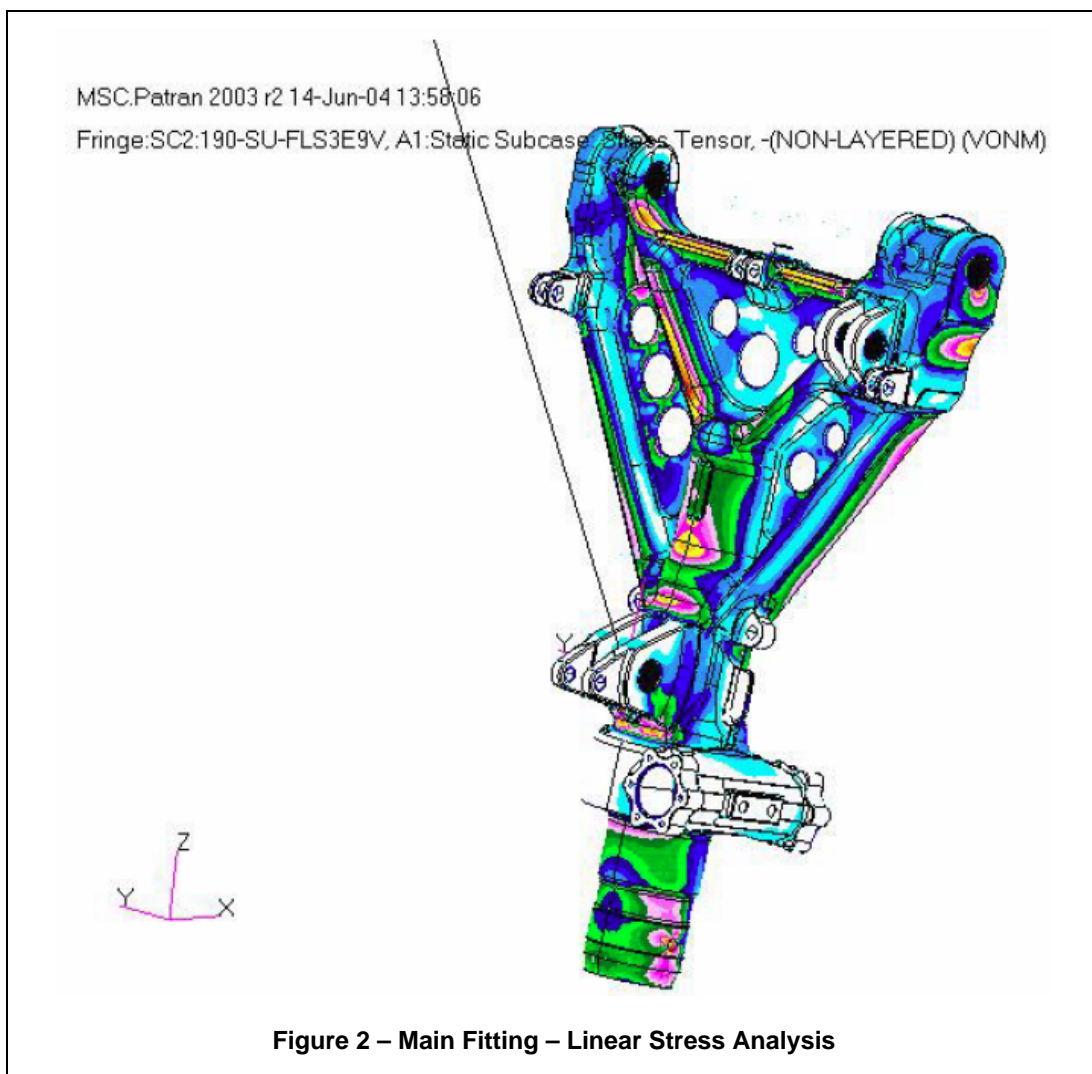


Figure 1 – Nose Landing Gear

The main fitting analysis was performed in two steps to improve the time in geometry definition. In the first step a preliminary analysis with linear elements was performed to reduce the processing time. In the second step, a detailed analysis with gap elements and material nonlinearity was performed to obtain accurate stress results.

STEP 1: Linear Stress Analysis

Linear stress analysis of the main fitting was used to obtain a preliminary stress results. This analysis does not consider gap elements or material nonlinearity and therefore get a faster convergence. The load cases applied to the main fitting were chosen among the critical conditions of landing and ground maneuvering. Figure 2 presents the stress results obtained with linear stress analysis by using MSC Patran/Nastran software.



As the linear stress analysis model does not represent the correct stiffness for some regions, detailed models must be performed in order to obtain more accurate stress results for those cases.

STEP 2: Material and Geometric Nonlinear Analysis

Material and geometric nonlinear analysis was performed after the main fitting geometry basic definition. Interface regions shall also be analyzed by using gap and plasticity material curve. Figure 3 presents results obtained with nonlinear stress analysis by using MSC Patran/Nastran software.

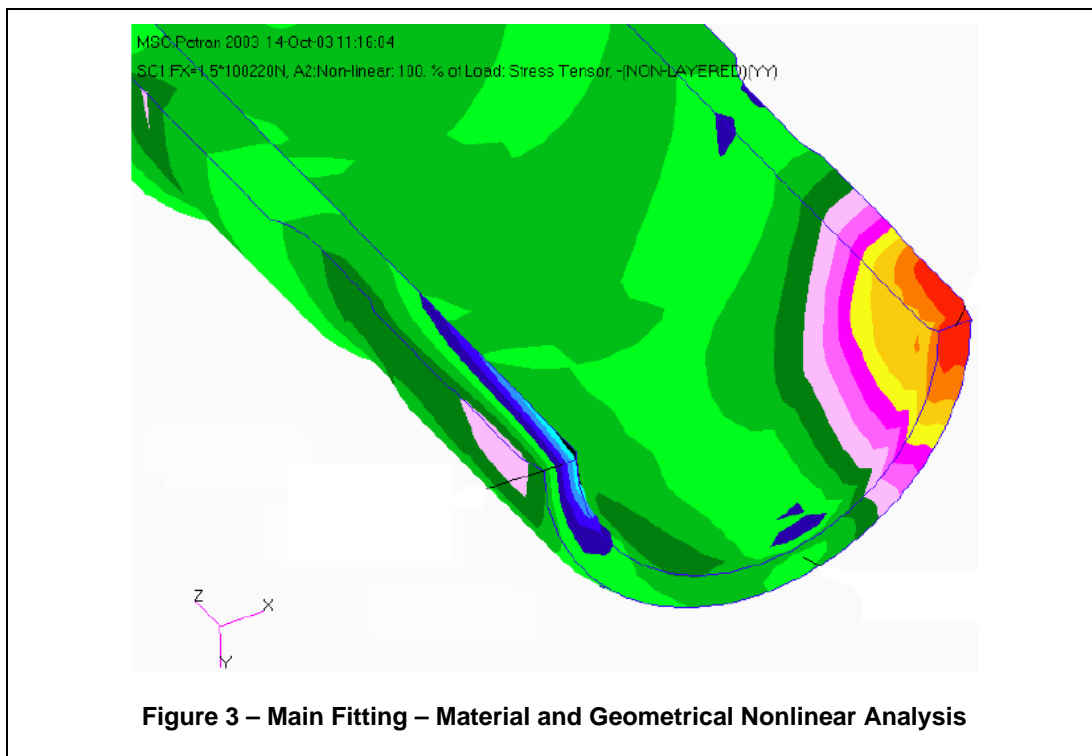
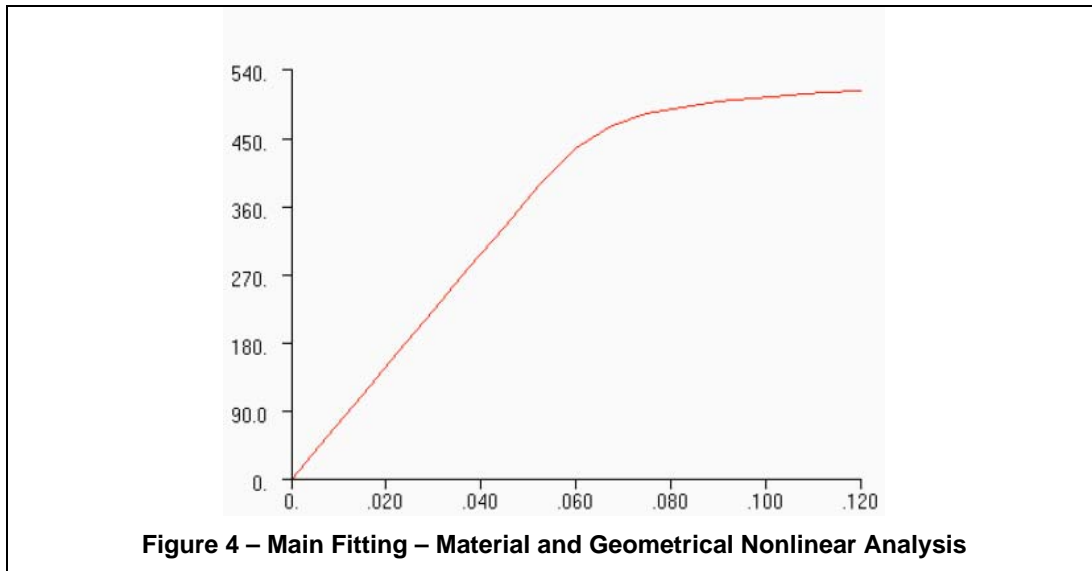


Figure 4 presents the plasticity material curve for Al 7475-T74 Hand Forging (Main Fitting material) obtained from MMPDS – Metallic Materials Properties Development and Standardization that was included in MSC Patran/Nastran for nonlinear analysis.



4. Discussion

Considering that in aeronautical design the structural weight is one of the principal engineering challenges, the material and analysis methodologies are employed up to its limits, becoming necessary to use MSC Patran/Nastran to obtain more accurate stress results. Comparing strain gauges results and finite element models, it was observed an accuracy of approximately 5%, what is considered a very good precision for finite element model.

5. Conclusion

This analysis is important to the landing gear system weight optimization as well as for other aircraft systems, being one of the biggest challenges for new aircraft developments.

It is possible also to preview stress results, reducing time schedule of the Landing Gear development. This kind of analysis shows the possibility to do a finite element model of complex parts as the main fitting presented.