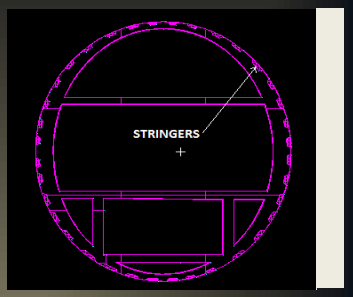

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Aircraft Safety and Security

AIRCRAFT DITCHING CERTIFICATION BY SIMULATION USING SMOOTHED PARTICLE HYDRODYNAMICS (SPH) FORMULATION IN MSC NASTRAN

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1. ABSTRACT

This paper presents the simulation of an emergency landing (ditching) of a large aircraft fuselage, using Smooth Particle Hydrodynamics (SPH) method in MSC Nastran. The aircraft crashworthiness is usually a complex phenomenon since it involves impact dynamics, material damage and fracture mechanics. The ditching simulation on soft surfaces like water will add to its complexity due to the physics involved predicting the fluid and structure behavior during the crash. It is also important to determine the worst case crash scenario by using different aircraft configurations, positions, velocities, pitch angle and impact surface etc. The goal of this investigation is to determine the damage and rupture of a large aircraft fuselage during ditching conditions, and develop realistic crash loads that can be utilized during the design and certification phase of a large aircraft fuselage to increase survivability and cabin safety margins. For this purpose MSC Nastran SOL 700 explicit solver is used to simulate the ditching of an aircraft onto the water using Smooth Particle Hydrodynamics (SPH) method.

2. INTRODUCTION

Ditching refers to a land-aircraft making an emergency landing on water, e.g., the ocean or any kind of water surface. Airliner ditching is relatively rare, but successful examples include the recent 2009 case of the Yemenia airways A310 that crashed on the ocean Indian "Comoros Island", and from the 2011, the case of EMB 120ER that landed in the some country with some fatal in the aircraft wing. However, compliance with ditching

regulation for extended overwater operation can be an option and is not a requirement to obtain Part25 certification.

In these studies a large aircraft fuselage model has been worked for to analyse the different configurations of the impact, ditching and some hard landing without controls of the pilot.

Two flights phases have been enough explain in this presentation:

- The supersonic phase of the flight
- The subsonic phase of the flight

However, this presentation is more focused on ditching simulations of large aircraft fuselage using Msc Nastran, history to understand the damage and rupture of the structure during this emergency landing. The validation of the model will presented for to perform the different results of this numerically simulation based on the SPH method.

The control of the pressure between the fuselage and the impact surface was taken into consideration during the different simulations and this pressure is compared with the stress deviatoric, history to respect the theory of fluid structure interaction (FI).

3. REGULATION

Transport - Category Airplanes," Section 25.801, "Ditching," mention the transport-category certification requirements that pertain to the behavior and response of the airplane during a ditching. Therefore, if certification with ditching provisions is requested, the airplane must meet the requirements of Section 25.801, which states, in part, the following:

- ✓ Each practicable design measure, compatible with the general characteristics of the airplane, must be taken to minimize the probability that in an emergency landing on water, the behavior of the airplane would cause immediate injury to the occupants or would make it impossible for them to escape.

- ✓ The probable behavior of the airplane in a water landing must be investigated by model tests or by comparison with airplanes of similar configuration for which the ditching characteristics are known.

- ✓ It must be shown that, under reasonably probable water conditions, the flotation time and trim of the airplane will allow the occupants to leave the airplane and enter in the life rafts required by [Section] 25.1415. If compliance with this provision is shown by buoyancy and trim computations, appropriate allowance must be made for probable structural damage and leakage.

For to optimize the cost of certification and repair procedure, it will be important to think to another method like the certification by analyses for to support the industry, ‘’Emergency Landing Conditions” Amendment 25-23, recommended that the airplane must meet these requirements.

> (a) The airplane, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this paragraph to protect each occupant under those conditions.
>
> (b) The structure must be designed to give each occupant every reasonable chance of escaping injury in a minor crash landing when…
>
> (3) The occupant experiences the following ultimate inertia forces relative to the surrounding structure:

Regarding these recommendations, today an aircraft has to respect some performance and the using of numerically model for the certification of ditching can reduce considerably the time and cost of certification of space vehicular.

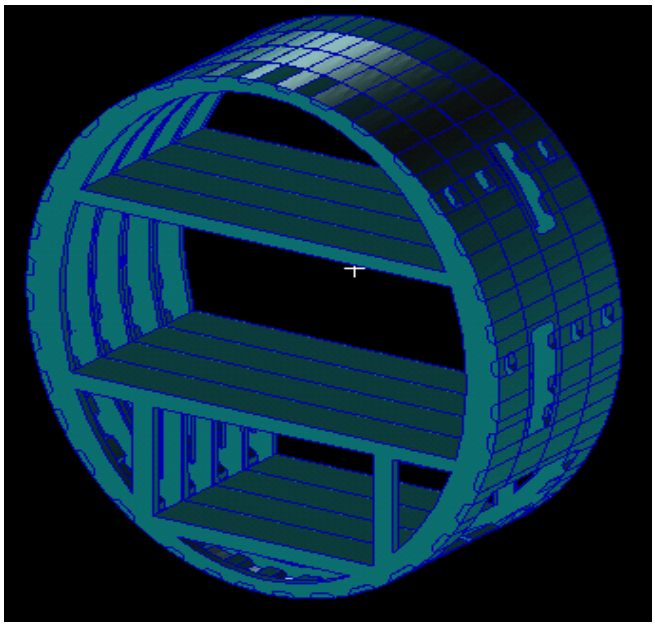

Figure 1 : General presentation of the fuselage before simulation (Patran model)

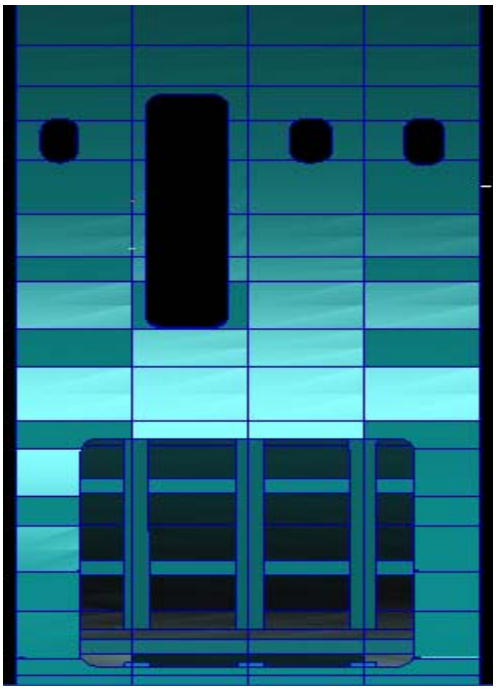

Figure 2 : Windows, Cargo and passenger doors configurations

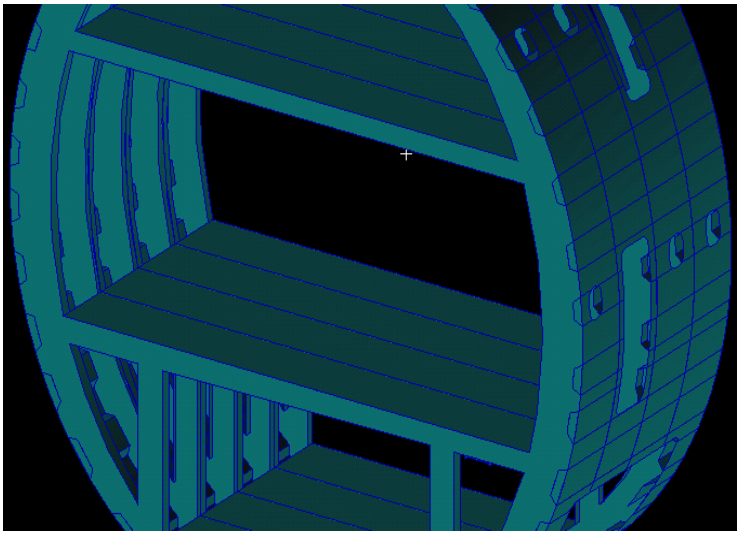

Figure 3 : Passenger and cargo levels design

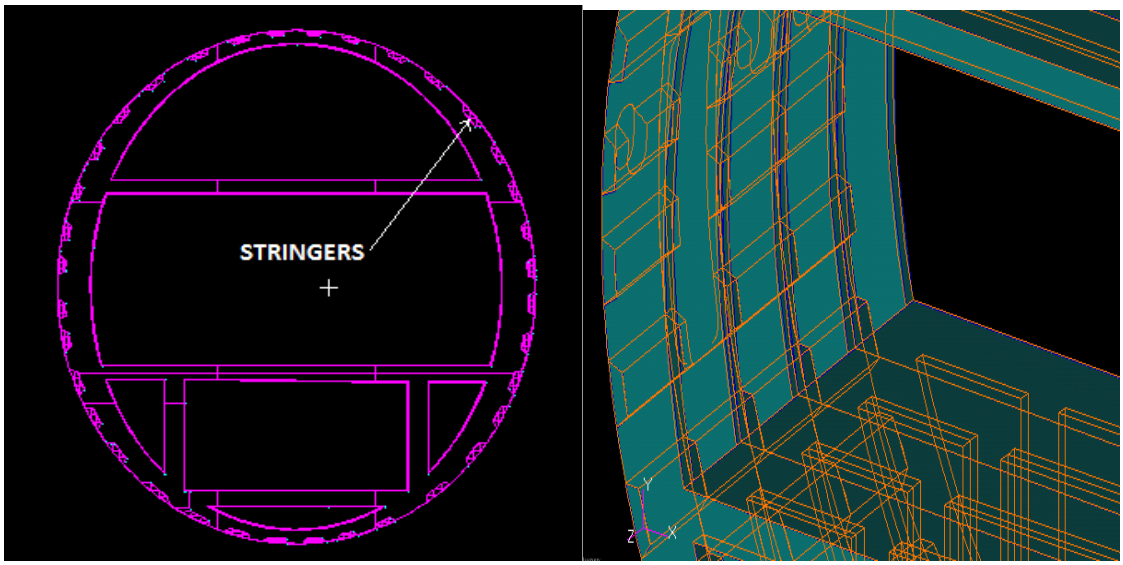

Figure 4: Internal structure design

Conclusions

These studies demonstrate the possibility to use MSC Nastran in aircraft certification by analyses, the time of CPU is taken into consideration, MSC Nastran has optimize the time of analyses and the SPH method has a good promise in fast dynamic impact . However, Hydrodynamic loads are the most important forces acting on aircraft during the impact phase because they may affect the airplane's structural integrity.