EFFECT OF PLY NUMBER & ORIENTATION OF COMPOSITE STRUCTURE IN BIRD STRIKE ANALYSIS

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ABSTRACT – Recently Birdstrike is very commonly encountered issue taken into account for all the aircrafts engine designs. Considering Birdstrike as a major concern, everyone is concentrating to develop the bird hit proof structure, as an indication composite material is the most suitable one. FE method is very commonly used for analyzing such issues. This is large deformations, high strain rate problem. And the bird material is very soft material and is as good as considering a packet of fluid with high velocity approaching the structure. The fluid modeling in explicit codes like LS-DYNA is very well represented and supported as material model SPH. For modelling ANSA is being used with its robust capabilities for generating SPH elements. In this work, attempt has been made to understand the effect of two factors PLY-Number and PLY-Orientation in laminate of the composite structure.

First by varying PLY-Numbers of laminate the study is being made. In the second stage by changing the PLY-Orientation of laminate, effect on the damage to the structure is being studied and various advantages and disadvantage is being reported using mETA Post as post processing tool.

1. INTRODUCTION

Composite Material is the most modern drift in the Aerospace Industries, as because of its vast properties like High strength, Cost Effective & light weight. In the present work effort has been made to study the effect of the ply number and ply orientation of composite structure in the Birdstrike simulation. Mostly the composites are applicable to road pavements in the form of steel and aggregate. The daily usage like shower bulb and bathtubs are made of fibreglass. But among all application of composite on spacecraft is today's demand [1]. Bird strike simulation is extensive example of explicit dynamic analysis and LS-DYNA is preferred explicit solver which can be used for such a simulation. Since Birdstrike is most challenging and may lead or cause to serious aircraft crash.

Figure 1 – After the Bird hit first on the Engine and 2nd hit on Engine Casing [4]

Figure 2 – After the Birdstrike on Aircraft wing [4]

In LS-DYNA 970 version the composite modelling was done using *PART, *SECTION_SHELL & *INTEGRATION and in latest version of LS-DYNA 971composite can be represented with the help of *PART_COMPOSITE in which the composite is defined without *SECTION _SHELL and *INTEGRATION. The *PART_COMPOSITE can be very well modelled in ANSA_13.1.3 version as shown below:

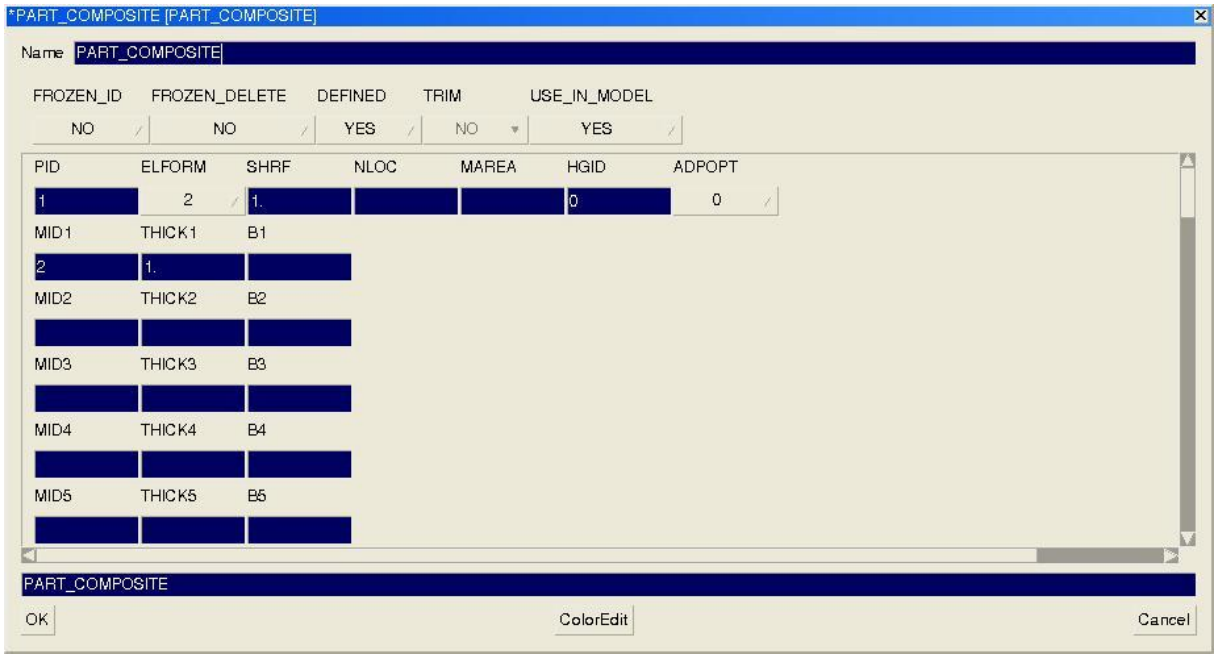

Figure 3 – Shows the *PART_COMPOSITE card represented in ANSA

Here :

MID1- Material ID of Layer-1 / Integration Point-1
THICK1- Thickness of the Layer-1 / Integration Point-1
B1- Material Angle of Layer-1 / Integration Point-1

The most complexity is into modelling of the Bird. Two methods like ALE & SPH are methods are being used from past some years. ALE (Arbitrary Lagrangian Eulerian) which is multi-material Eulerian formulation, where material flows through a mesh, in which each element is allowed to take two or more material [8]. In Eulerian mesh, there are dissipation and dispersion associated with the flux of mass between elements. In addition many elements might be needed to completely enclose the material space located during the simulation [8]. Here the multi- material ALE takes extra advantage. By translating, rotating & deforming the multi- material mesh in controlled way, the mass flux between the elements can be minimized and the mesh size can be kept smaller than in an Eulerian model.

SPH (Smooth Particle Hydrodynamics) is particle method which is applicable to wide range of physics like Crash, Mechanics, fracture models in Brittle & Ductile materials of solids [7]. It is treated to be very easy for representing the physics which makes SPH very extraordinary method.

Due to the reason that SPH is very simple method many problems that are hardly reproduced with classical methods. The fluid is generally represented as set of particles moving with some flow velocity[7]. And compared to ALE method, from computation point of view SPH is more economical with its capabilities to calculate only on particles.

From the literature review and the various references, the SPH method has added advantages over the ALE and decided to go with it.

2. FE MODEL

COMPOSITE MODELING

a. Simple Plate: A simple plate measuring 660 mm X 325 mm X 3mm is considered with *MAT_PIECEWISE_LINEAR_PLASTICITY as shown in the Figure-4 .

Table 1: Material Properties	
Density	4000 kg / m^3
Young's Modulus	2.0E11 N / m^2
Poisson's ratio	0.3

b. Composite Plate-I: A composite with a plate *PART_COMPOSITE and *MAT_COMPOSITE_DAMAGE is used to define the composite plate. Composite with 3 plys with 30 º / 0 / -30º orientation is used with 1mm each ply thickness.

c. Composite Plate-II: A composite with a plate *PART_COMPOSITE and *MAT_COMPOSITE_DAMAGE is used to define the composite plate. Composite with 4 plys with 60º / 30 º / -30º / -60º orientation is used with 0.75 mm each ply thickness.

d. Composite Plate: A composite with a plate *PART_COMPOSITE and *MAT_COMPOSITE_DAMAGE is used to define the composite plate. Composite with 3 plys with 45 º / 30 º / -30º / -45 º orientation is used with 0.75 mm each ply thickness.

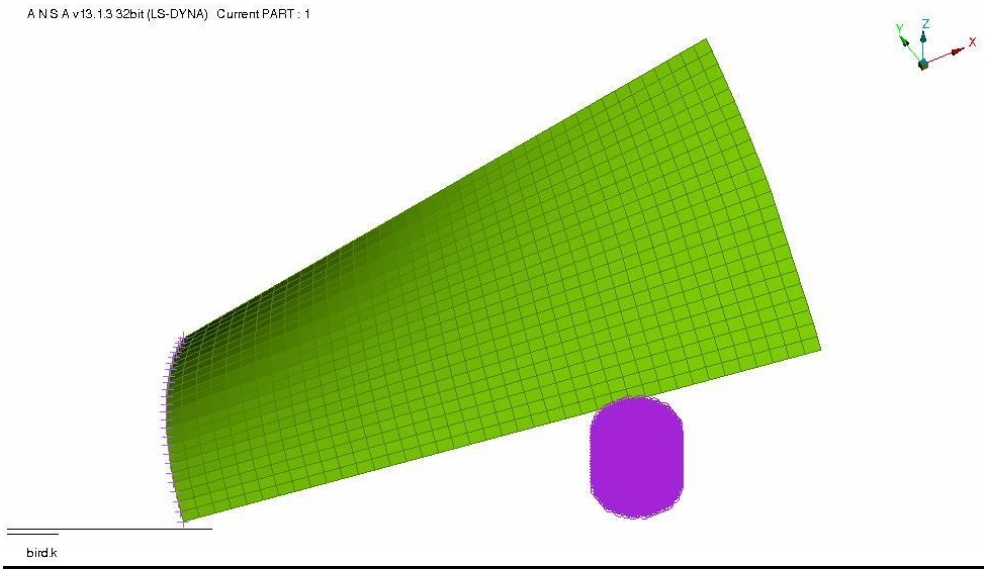

Figure 4 – Simple set up of Plate and Bird for Impact Simulation.

BIRD MODELING

As discussed earlier, SPH method is most suited one for representing the Bird Model. *MATERIAL_NULL is used with the bird properties. Bird is generally represented as a packet of fluid with density =1000 is used.

3. RESULTS AND DISCUSSION

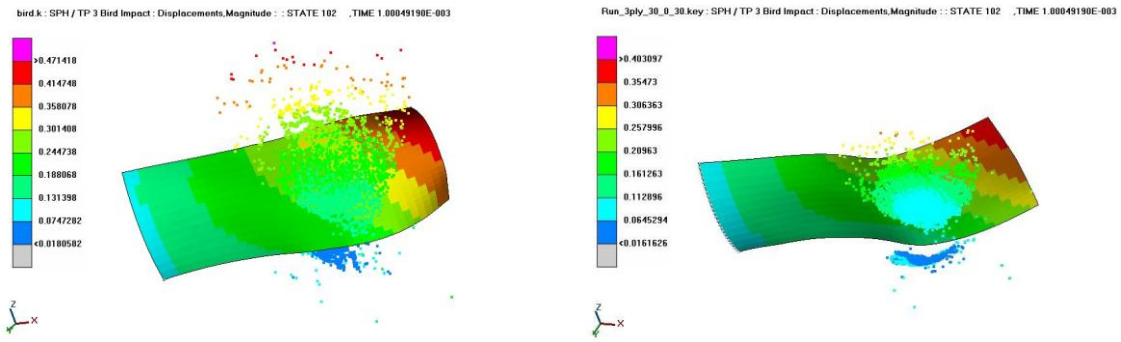

Figure 4a, 4b– Displacement plot of simple plate and Composite plate with 3 ply Orientation 30 º / 0 / -30º respectively.

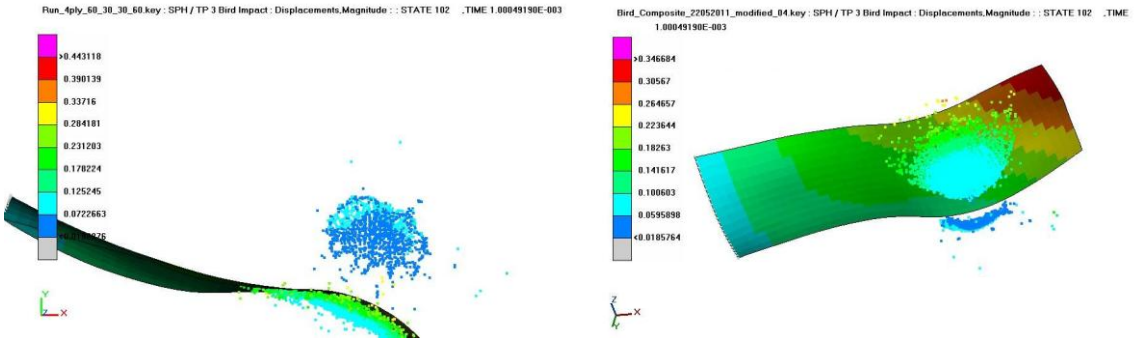

Figure 5a, 5b– Displacement plot of Composite plate with 4 ply orientation 60º / 30 º / -30º / -60º and 45 º / 30 º / -30º / -45 º respectively.

From the above displacements plot we can observe that the maximum displacement reduces as composite material is introduced with equivalent material properties. It makes us to think deeply about the material orientation and also no. of ply in the composite material model.

4. CONCLUSIONS

Composite materials are future of the Aerospace Industry. The same can be applied to various components of the aerospace like Engine Casing, Cock Pit, Nasal, Landing Gear Casing etc.

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(4) http://www.birdcontrol.it/birdstrikegallery-e.html

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