8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

A NEW MULTIPHYSICIS SIMULATION APPROACH FOR ELECTROMAGNETIC FORMING

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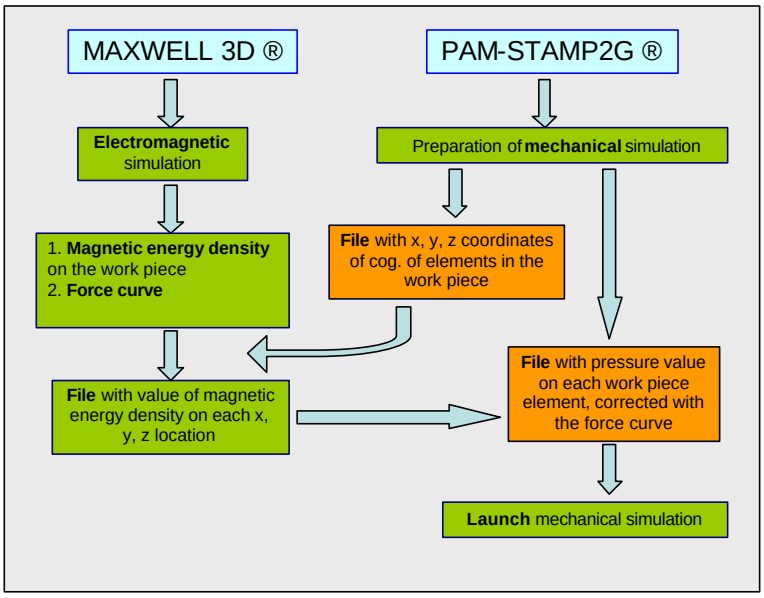
KEY WORDS: *Electromagnetic forming, Numerical simulation, Numerical multiphysics coupling methods*

ABSTRACT

Electromagnetic Forming (EMF) is a high speed deformation process that relies on the use of electromagnetic forces to deform metallic workpieces. In the EMF process a significant amount of electrical energy is stored in a bank of capacitors and, using high speed switches, quickly discharged trough a coil. The transient electrical current running trough the coil generates an intense transient magnetic field that penetrates the nearby conductive workpiece where Eddy currents are induced. The combination of the magnetic field and the Eddy current gives rise to Lorentz forces that drive the deformation of the workpiece against the dies. In an EMF process, materials with good electrical conductivity, such as aluminium, are launched at velocities in the order of 100m/s using high density magnetic fields in a very short time (less than 0.1ms) [1]. The dynamics of the process enhances the formability of the work piece and reduce the springback effect [2].

Trying to simulate the EMF process is a hard work, because several physical problems must be taken into account and all these problems are tightly related to each other. Nowadays, there are three different strategies to tackle the numerical simulation of the electromagnetic and mechanical coupling: direct coupling, sequential coupling and loose coupling. At LABEIN-Tecnalia a loose coupling between Maxwell®3D and Pam-Stamp2G® has been developed. The electromagnetic problem is solved with Maxwell® 3D, which has a transient solution type that allows solving 3D magnetic fields caused by windings supplied by voltage and/or electrical current sources with arbitrary variation as functions of time. From this calculation the magnetic energy density is obtained and it is applied as pressure on the surface of the workpiece that is facing the coil, for the mechanical calculation.



Sequence of the coupling between Maxwell®3D and Pam-Stamp2G®

To evaluate the accuracy of the Maxwell®3D-Pam-Stamp2G® coupling method, some experimental tests were made in order to compare their results against the simulation ones. The experimental tests consisted on the deformation of a 1mm thick 1050 aluminium sheet against a 90º conical die. Three different energy amounts were discharged (3KJ, 6KJ and 9KJ) trough the coil. As a result of the comparison, it can be observed a very good agreement between the simulation and the experimental results, so this loose coupling can be used as a simulation tool for predicting the sheet deformations in the electromagnetic forming processes.

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