T012: Loosely-Coupled Tool Stress Analysis

Introduction

The following describes the DEFORM-3D loosely-coupled tool stress analysis feature, which calculates tool stress and deflection during the forming process simulation (as opposed to a secondary simulation), while reducing the computational expense.

Problem Description

In a metal forming process, forming tools deflect elastically as the part forms. In most cases, the elastic deflections and associated stresses are either small enough to neglect during simulation, or can be handled after the forming simulation using decoupled tool stress analysis.

There are cases where tool deflection has a significant influence on the final part shape, or where knowledge of stress is desirable throughout a process. In these cases, it is desirable to run a coupled tool analysis, where tool stress and deflection are calculated throughout the process.

However, fully coupled tool stress analysis is computationally expensive -- requiring long calculation times or higher powered computers. For this reason, a so-called "Loosely-Coupled" tool stress analysis is available.

Background Information

The loosely-coupled die stress simulation performs analysis on elastic tools only at selected steps, rather than at every step. This gives a reasonable balance of coupled stress with efficient run times. It features intermittent stress, deflection and temperature calculation (user selected intervals, for example 5 or 10 steps, rather than every step) combined with optional staggered calculations to reduce matrix size and memory use.

Solution

There are several options for coupling the interactions of the workpiece and tool.

Fully-coupled (Option 1) means the deflection of the tool is reflected in the deformation of the workpiece at the current step.

One-way coupling means the stresses are calculated in the tool. If die geometry is updated (Option 2), it will not be reflected in workpiece shape until the next step. This is more numerically efficient than Option 1, but may cause some inconsistencies in workpiece surface position (and therefore workpiece volume) if the change in the die shape is substantial.

Option	Solution Method	Stress Update	Geometry Update
1	Fully-coupled	Die and workpiece	Die and workpiece
2	One-way coupled	Die and workpiece	Die and workpiece
3	One-way coupled	Die and workpiece	Workpiece only

If Option 3 is used, stress is calculated in the die, but the die geometry is never updated. In general, Option 1 is the most accurate, and most computationally expensive. Option 3 is the least computationally expensive, and offers the most simplification of the process. This method is equivalent to running an automatic, decoupled die stress analysis at each step in a predefined step interval.

If the only interest is tool stress, Option 3 is generally adequate. If tool deflection is important Option 1 or Option 2 should be selected.

To activate loosely-coupled die stress analysis, use a text editor such as notepad to create a file in the same directory as the database, named DEF_LCDSTS.DAT.

The contents should be:

Coupling option (1,2, or 3)

Stress coupling step interval

Temperature coupling step interval (similar to stress coupling).

So a typical file might look like:

2

10

10