One-step sheet metal forming with the aid of the ANSA Inverse Forming Tool

With an ongoing aim to reduce the required time a model needs to be prepared, the sheet metal forming studies have also evolved to catch up. This affects initially the die designers who decide the manufacturing processes early in the design process as well as process engineers who incorporate stamping results in further studies.

Feasibility analyses are a kind of such studies performed to determine whether a part can be created with a forming procedure. The blank shape is estimated and based on it, the cost is estimated. Through such an analysis, results of thinning and work hardening are produced and used in further structural studies.

In either case, CAE/FEA is utilized to analyze and validate these complex processes usually using one-step analysis methods. The Inverse Forming tool of the ANSA pre-processor implements such an inverse one-step method to address the forming feasibility -early in the design phase- and the associated costs.

The Inverse forming tool of ANSA

The Inverse Forming tool comes as an enhancement to the already existing capabilities of the ANSA pre-processor in the Forming process.

Using an Inverse One-step method, the tool can rapidly predict the final thickness, strains, wrinkles and splits, and the initial blank shape of a stamped part based solely on its final shape.

Model set up

Files with meshed final geometry and for a range of solvers can be used for the Inverse Forming tool. Indicatively, the tool is available for models prepared for NASTRAN, LS-DYNA, PAM-CRASH, ABAQUS, RADIOSS, ANSYS and PERMAS.

With an interface that focuses on user friendly interaction, and on minimum input information, the Inverse Forming is simple and intuitive.

The minimum required information is the shape of the workpiece and its material properties.

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The initial thickness of the workpiece is used to calculate the thickness of the final geometry. The friction coefficient and the stamping direction are also used for the Inverse Forming calculation.

The Hollomon's workhardening law and the Lankford coefficients of the material are the last essential parameters for the calculation. With the Hollomon's workhardening law, values are calculated from used material models.

Further optional information include the Thickness integration points to be taken into account.

Holes in the geometry of the workpiece can be treated to adjust its shape while when a Blankholder is available and can be also used, along with the force with which it is applied.

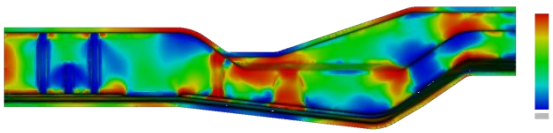
Solving

The Inverse Forming is a robust, accurate and scalable one-step solver that supports the calculation of thickness, initial strain, and equivalent plastic strain. In addition, the initial blank shape can also be estimated.

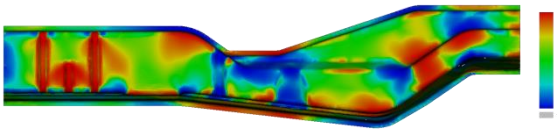
Results

The initial strain and equivalent plastic strain are calculated and visualized while related keywords can be created for LS-DYNA, RADIOSS and Abaqus. The thickness for the final workpiece can be assigned and the blank draw-in is also created.

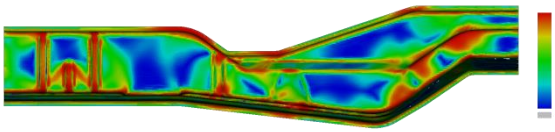
Displays of results for thickness, thinning, strain and equivalent plastic strain are available while the Forming Limit Diagram (FLD) can be plotted and exported on user defined Forming Limit Curves.



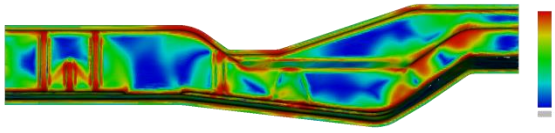
Thickness



Thinning (%)

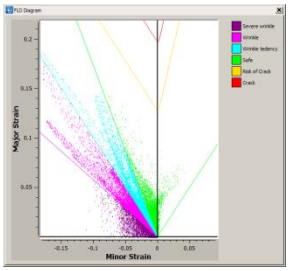


Strain



Equivalent Plastic Strain

Forming Limit Diagram



Automation

As an ANSA entity, the tool stores information of position in space and connectivity, facilitating the identification of the workpiece. The information of the blankholder, material and type of results for calculation are also saved. In this way, the modification and reapplication of the Inverse Forming entity is available at any moment.

Conclusions

The ANSA Inverse Forming tool uses the inverse method to predict final thickness, strains and initial blank shape of a stamped part based solely on its final shape.

- The Inverse Forming tool is simple to setup and fast. It only requires the final part, and produces results within minutes.
- Early manufacturing feasibility associated with the part's geometry is supported.
- It offers the capability to estimate material cost from the early concept stage as the prediction of the blank shape is accurate for any user’s choice assisting in minimizing the material scrap.
- The initial conditions and thickness calculation incorporate the thinning and work hardening manufacturing results from stamping in the structural performance, improving the predictive accuracy for Crash, Structure, NVH and Durability analysis.
- The Forming Limit Diagram identifies areas of the part susceptible to wrinkling and/or tearing while, the Thickness and Thinning fringe plots identify areas where excessive thinning occurs.

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