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Forming of Sheet Metal Analysis

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***Abstract**: A review of metal forming analysis, which is extensively utilized in the automotive industry, is presented in this work. Numerous processing techniques have been used in industries to achieve productivity and repeatability. Nonlinearity, complicated material behavior, and machining technology are all part of the metal forming process. Nowadays, in the metal forming process, FEM is used to calculate stresses and other failure criteria for formability prediction. The main goal of material optimisation for sheet metal is to reduce the size of the raw material. The die is scanned in a coordinate majoring machine to create a computer-aided design model. The criteria utilized for metal forming include FEM, forming limit stress diagram, press forming analysis, probabilistic design, numerical analysis, stress diagram, and material optimisation.*

***Keywords**: Metal forming process, FEM, Forming analysis, Forming limit diagram, Metal forming process*

I. Introduction

Many automotive, aerospace, and other industries have relied on the sheet metal forming process to produce necessary sheet metal products because the advantages of sheet metals over lightweight items are their great strength and productivity. There are numerous uses for sheet metals in the automotive industry for the production of vehicle parts, hence research into their formability is essential. A few of the variables that affect sheet metal forming operations are press speed, blank holding pressure, and material property. These restrictions are found using constructing limit diagrams, which show the allowed limit of strain with two primary surface strains. The criteria utilized for the sheet metal forming analysis are numerical analysis, press forming analysis, and finite element approaches.

II. Developing Procedures and Limitation Plans

Currently, metal formation is an important process in the modern manufacturing sector that makes a variety of products. processes of formation. The predominant products, probably as a result of intensified competition, are either the forged ones, such as shafts, tubes, cranks, pipelines etc.

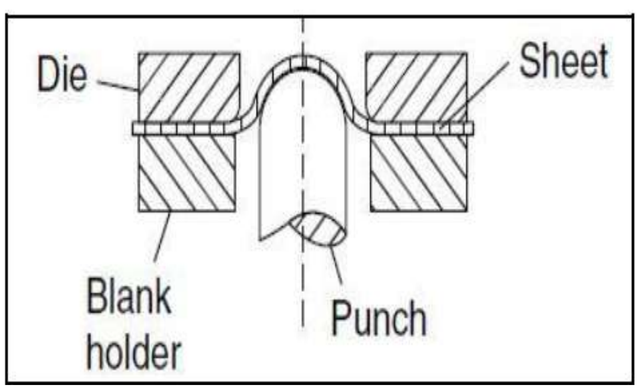


Fig 1: Forming process parameters

The metal forming process that is always used in a lot of industries, like automotive and aerospace, makes the metal product that is needed. There are different ways to form the metal sheet. Example like cutting, bending, heating etc.

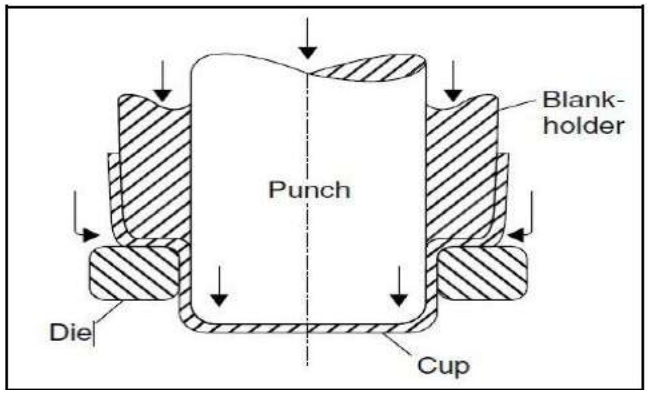


Fig 2: Punching and blanking

Because sheet metals are utilized in many different industries, particularly in automotive parts, it is vital to research their formability. Developing limit diagrams are used to examine the sheet metals' formability. The complicated states of strain pathways and total strains are involved in the wide range of shapes that sheet metal can take. The formability of the sheet metal cannot be predicted theoretically. The material's ability to sustain a specific ratio of strains without failing is predicted by the forming limit diagram.

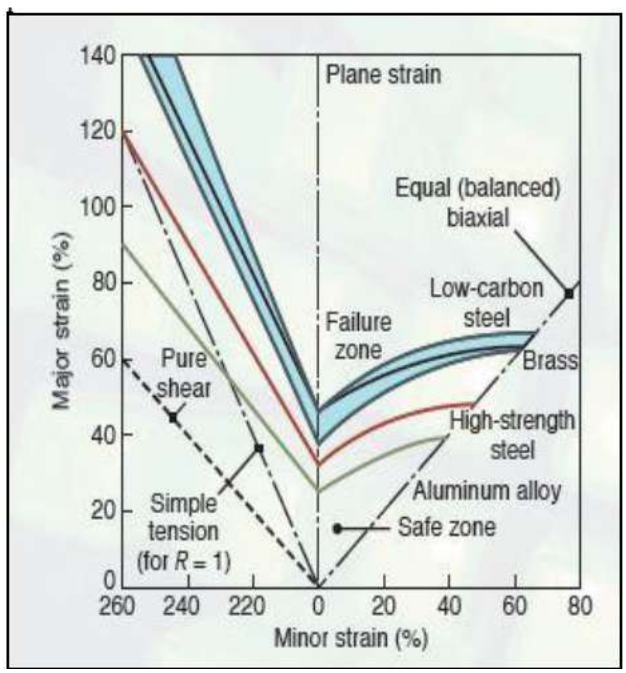


Fig 3: Limit diagram forming

The experimental method was used to print a certain circle diameter in grid-looking pattern on the surface of the sheet metal. This deformation of the sheet metal takes place in segments. At every deformation stage the grid pattern is analysed. An advantage of printing the circular grids on sheet metal is that as the material deforms the circles will then turn into ellipses and have their major or minor axis in the principal directions of strain.

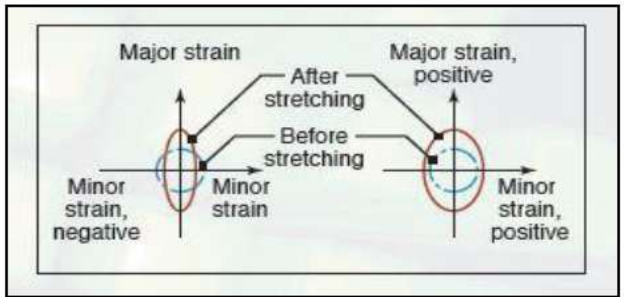


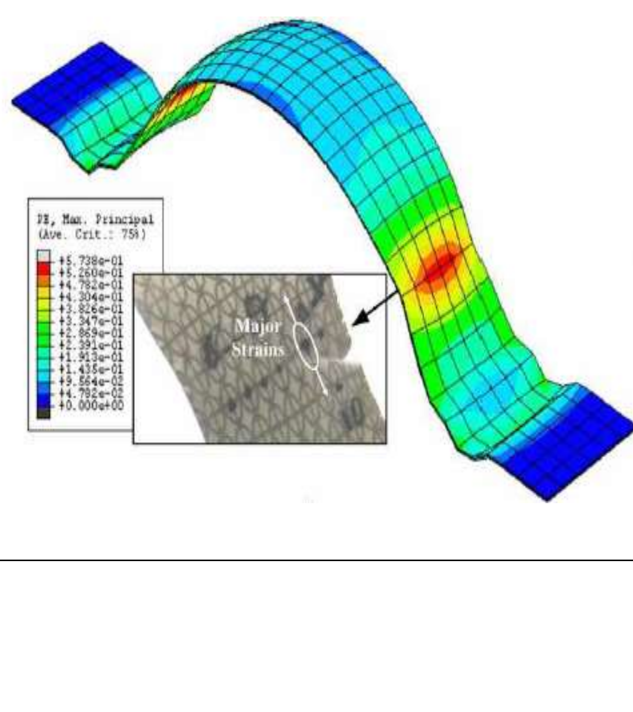
Fig 4: Minor strains in positive and negative

The measurement of the axis and the diameter of the circles can be used to identify the principal strains and their directions. At some point during the formation process, a neck may appear. At that location, the strain ratio is calculated. This is a point on a curve or finite limit diagram that delineates the safe and risky areas. The area below the lines is safe, whereas the area above them is the failure zone. For a given material, the strain condition during forming must be such that it is below the curve.

III. Methodologies

The following are the different ways that sheet metal can be formed: We use the explicit nonlinear finite element method to look at how a wheelhouse in the automotive industry is made from mild steel sheet metal. Failing and design uncertainness are also there. In the case of system-level design, quantitative characteristics of the margins ripping and wrinkles are determined by the indicators of stresses. In this complex process of engineering, a efficient uncertainty propagation tool allows to design a design model which will last. This effective tool ensures that a probabilistic design is executed. The weighted three-point based method (an iterative approach) that looks at the statistical properties of the responses of interest through a methodical path to planning a sheet metal forming process within the framework of design under uncertainty is an analytical process.

The result shows how the robust design study been employed in the sheet metal stamping process where the robust design process is capable of replacing the uncertainties and the systematic determination of margin of safety or failure to enable the production of the robust design model within the system. The objective of the robustness of a wheelhouse stamping procedure would be to reduce the total variance of the margins, and increase and maximize the total average of the margins. In a case study of the automotive industry, numerical predictions are made by aging sheets of the automotive industry based on theoretical failure modelling. A numerical strategy is given on which the emerging limit diagrams are calculated computationally using conditions of planar stress deformation. The directional variation in yield stress that is given by the Hill orthotropic yield criterion is described as a numerical model.



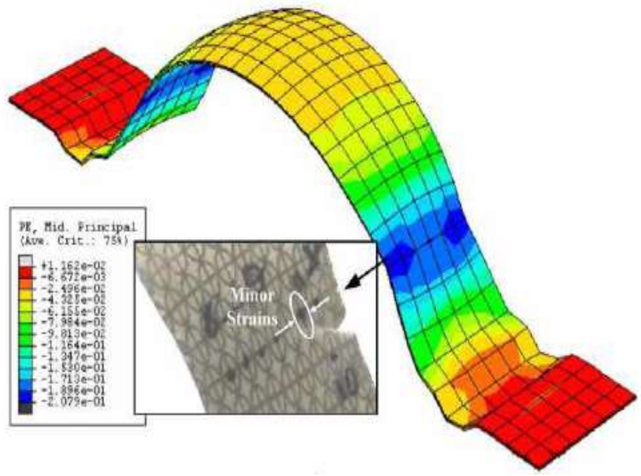


Fig 5: Major strains

Finite limit curves, according to the paper [4] must be warning and close enough on either side of finite limit diagrams in steels. The sheet metal forming operations are very crucial yet the formability of the metals is an important factor as well. The dependence of forming limit diagram on strain path and forming history is not supported by the stress-based criterion. This requirement is better able to withstand changes in the strain path which could be experienced during the forming.

IV. Conclusion

At this moment much research has been done on the sheet metal, locating the finite limit diagram, through numerical analysis, experiment, finite element analysis and material optimisation. In accordance with the above-mentioned criteria, we are trying to create an analysis of a bracket of automobile air filter.

References

[1] Rehaman, Sameer and Sk Abdul, (1982), "Machine designing with respect to plastic fracture in sheets", IEEE Trans. Vol 5(2), December 1982, Qatar

[2] Stalone and Arnold. (2001), "Deformation and Formation od stretched sheets application", Springer, March, 2001

[3] Thaweepat Buranathiti, Jian Cao, Z. Cedric Xia, Wei Chen, "Probabilistic Design In A Sheet Metal Stamping Process Under Failure Analysis", 2312 Volume A. Numisheet 2010.

[4] Mehmet Firat, "A numerical analysis of sheet metal formability for automotive stamping applications", IEEE, computational material science 21(2010) 323-333.

[5] F Max Savio, M Sasi Kumar. "An Effective Control Technique for an Impedance Source Inverter Based Wind Energy System". 2012 IEEE International Conference on Emerging Trends in Electrical Engineering and Energy Management (ICETEEEM-2012)

[6] Sasikumar M and Chenthur Pandian S. "Characteristics Study of ZSI For PMSG Based Wind Energy Conversion Systems". Journal of Electrical Engineering (JEE). ISSN: 1582-4594.