JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Optimization of Sheet Metal Forming Parameters using ANSYS - Review

EKTA SINGH[1], Lakshman Sondhi[2]
[1]M. Tech Scholar, Department of Mechanical Engineering, SSTC, Junwani, Bhilai
Email: singh.ekta161294@gmail.com
[2]Associate Professor, Department of Mechanical Engineering, SSTC, Junwani, Bhilai
Email: lsondhii@gmail.com

Abstract: The sheet metal forming is critical process in manufacturing. The process involves bending of sheet metal using dies. The current research reviews existing work conducted in improving sheet metal forming process using numerical and experimental methods. The researchers have also proposed various numerical algorithms, new experimental techniques and theoretical methods in evaluating and enhancing the sheet metal forming process.

Key Words*: Sheet metal, forming*

1. INTRODUCTION

Sheet metal forming (SMF) techniques are widely used in many industries to produce final-shaped components from a work piece. In an SMF process, a thin piece of metal sheet is stretched into a desired shape by a tool without wrinkling or excessive thinning. In the past decade, methods for forming high-strength material with low plasticity and difficult-to-form metals have been developed for cold, warm and hot forming conditions [1,2].

2. LITERATURE REVIEW

P. S. Thakare [1] Author told in recent year's pipe bending machine is used in both industry and domestic purpose for bending the pipe under the required angles and dimensions. Sometimes Heat treatment is used for pipe bending but the heat treatment technique is not safe and have problems are produced in the pipes, such as wrinkling, curve forming, reduced thickness, whole forming, reduced strength, easy breakable. In the hydraulic pipe bending machine having a good advantage compared to heat treatment methods.

V. Senthil Raja [2]. In this paper, a bicycle integrated pipe bending mechanism has been designed and developed. The applications of bent pipes are in frames, barricades, handle of bicycle. Most of industries uses bent pipes as air conditioning, boiler, power generation, ship building, furniture, railroad, automotive, off-road and farm equipment, aircraft etc. Due to adequate human power in countries like India, the human powered machine will result in improvement of the economy and employment of nation. In Asian countries people are facing electricity cut-off during most of the days so such system plays an important role in rural areas.

H. A. Hussain [3]. Hydraulic equipment has wide use in various automobile fields. These hydraulic instruments are used for lowering and raising chair in Barber shops and in dental clinics. Hydraulic bending machine is the suitable equipment to bend pipes, rods and bars. The pipe or rod to be bending is kept between the rollers. With use of hydraulic jack, we implement force on the pipe and bend it to the required angle depending on the dies used. Hydraulic bending machine is less expensive, flexible and portable compared to those which are discussed earlier. Hence it is better to replace current standard machines by hydraulic pipe bending machine.

Mohan Krishna S. A. [4]. The aim of this paper is to develop a pipe bending machine which is useful to bend a pipe in workshop. This project is to design and construct a portable pipe bending machine. This

machine is used to bend steel pipes into curve and the other curvature shapes. The size of machine is very convenient for portable work. It is fully made by steel. Moreover, it is easy to be carry and use at any time and any place. It decreases human effort and requires low skill labours for operating the machine. In this paper they designed manually operated pipe bending machine with use of gears, motors, pulley, and frame. This bending machine is both manually and power operated.

Prashant P. Khandare [5]. Metal forming is a process in which the desired shape and size are obtained through plastic deformation of a material without any loss of material. Bending is a metal forming process in which straight length is transformed into a curved length. Roller forming process is a continuous bending operation in which a long strip of metal is passed through typical roller adjustments, until the desired curvature shape is obtained. The bending changes according to material and according to the loading condition and thickness of sheet

Panthi, S.K. et al. (2007) [6] used analyzed elastic recovery in sheet metal bending with the help of finite element simulation. This study examined the effect of load on spring b back with varying thickness and die radius.

Bahloul R.et al. [7] used finite element simulation for the prediction of punch load and stress distribution during the wiping-die bending process. Here numerical simulation was modelled using elastic plastic theory coupled with Lemaitre's damage approach. They used ABAQUS for finite element simulation. The punch load and stress distribution was be predicted in view of optimization using response surface methodology (RSM) based on design of experiments.

Patil and Satao (2014) M.K.N., Patil, B.T. and Satao, M.S. (2014) [8] provided detail literature review about optimization aspects of deep drawing as well as use of finite element simulation in this area. This comprehensive review article clearly reveals importance of finite element simulation in sheet metal forming simulations.

Patil, B.T. and Joshi, K.N. (2016) [9] optimized various aspects of tube hydro forming process (without axial feed) using finite element simulations. Essentially tube hydro forming is the process of manufacturing light weight parts by passing pressurized fluid through tube. Modelling hydro forming process is complicated but essential for accurately producing parts. The author has also developed 3-dimensional finite element model for tube hydro forming using Creo Parametric 2.0. They used Hyper Mesh for pre-processing and used LS-DYNA explicit solver.

Joshi, Patil and Satao (2014) [10] studied optimization of variation in wall thickness of deep drawn cup using combined methodology of design of experiments and finite element methodology. They called this methodology as virtual design of experiment. Their investigation involved the effect of die radius, sheet metal thickness and blank holder force on wall thickness variation in cup drawing using finite element simulation.

In 2020 Han et al. [11] proposed a microstructure-based multiscale modelling of large strain plastic deformation by coupling a full-field crystal plasticity-spectral solver with an implicit finite element solver. The model which was developed takes both dislocation density and phenomenological hardening law into account and is suitable for modelling materials with complex microstructural characteristics (e.g., grain morphology, multiple phases and textures).

Ma et al. [12] employed the plastic strain criterion depending on the triaxial nature of stress in the prediction of fracture in stamping parts using the simple tensile test. They also applied the digital image grid method (DIGM) to measure the strain localization behaviour and local strain distribution. Based on DIGM, a new method for the identification of the ductile damage limit of steel sheets was proposed with the aid of the historical path of nonlinear local strain and local fracture strain that had been measured. The commonly used Cockroft damage criterion, in which the plastic strain and the maximum principal stress are integrated, is an effective method to predict fracture under various loading conditions [13].

Ma et al. [14] combined the measured transient displacement field with the FEM and a measurement-based FEM (M-FEM) was developed for the computation of the distribution of the local stress and strains, and the accumulation of ductile damage in a tensile test piece.

Su et al. [15] proposed a new two-step electromagnetic forming process which combines EMF with electromagnetic calibration for local features of large-size sheet metal parts. During this process, the work piece is first electromagnetically formed by a flat spiral coil and then electromagnetically calibrated by a helical coil with a similar shape to the final profile of the work piece.

Su et al. [16] studied the uneven deformation behaviour of a 2219 aluminium alloy work piece formed by electromagnetic flanging. The authors established a numerical model in LS-DYNA 8.0 software to study the effect of different axial angles between the flanging direction and the normal direction of the sheet. They concluded that uneven deformation behaviour is essentially due to the uneven deformation requirement.

Russo et al. [17] proposed a method in which a haptic device is connected to a computer numerical control (CNC) spinning machine; this device allows a human operator to control the working roller manually while feeling the force applied to the work piece. Haptic devices provide users with force feedback and have found applications in gaming and robotic surgery [18,19]. A control system consisting of force, position and work piece shape sensors allows the collection of information on the tool path followed by the operator and on its effect on the mechanics of the forming process.

3. CONCLUSION

The FEA is a viable tool in investigation of various design and operational parameters involved in sheet metal bending process. Various parameters like die radius, sheet metal thickness and die speed are investigated by various scholars. The use of damage identification devices is also emphasized which can detect zones of maximum principal stress and crack initiation. The use of response surface method enabled to predict the effect of punch load on stress distribution during sheet metal forming process.

REFERENCES

[1] P. S. Thakare, P. G. Mehar, Dr. A. V. Vanalkar and Dr. C. C. Handa, "Productivity Analysis of Manually Operated And Power Operated Sheet Bending Machine: A Comparative Study", International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622, Vol. 2, Issue 2, Mar-Apr 2012, PP.111-114.

[2] V. Senthil Raja, R.Maguteeswaran, C. Karthik, S.Rajarajan and D. Shanmuga Vadivel, "A New Model in Design and Manufacturing of Mobile Hydraulic Pipe Bending Machine in Industry", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 3 Issue 1, January – 2014 PP 2706-2713.

[3] H. A. Hussain, M. Sohail Pervez, Md. Naushad Alam and Atul. P. Ganorkar, "Design and Development of Bicycle Integrated Pipe Bending Machine", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X, 2014, PP 24-28.

[4] Mohan Krishna S. A., "Experimental Design and Fabrication of a Portable Hydraulic Pipe Bending Machine", International Journal of Development Research, ISSN: 2230-9926, Vol. 4, Issue, 12, pp. 2681-2684, December, 2014, PP 2681-2684.

[5] Prashant P. Khandare, Dhiral N. Patel, Mayur K. Aher, Ravi S. Parbat and Prof. Swapnil S. Patil, "Study of Portable 3 Roller Pipe Bending Machine", International Conference on Emerging Trends in Engineering and Management Research, ISBN 978-81- 932074-7-5, 23 March 2016, 624-630.

[6] Panthi, S.K., Ramakrishnan, N., Pathak, K.K. and Chouhan, J.S., 2007. An analysis of springback in sheet metal bending using finite element method (FEM). Journal of Materials Processing Technology, 186(1), pp.120-124.

[7] Bahloul, R., Mkaddem, A., Dal Santo, P. and Potiron, A., 2006. Sheet metal bending optimisation using response surface method, numerical simulation and design of experiments. International journal of mechanical sciences, 48(9), pp.991-1003.

[8] Joshi, M.K.N., Patil, B.T. and Satao, M.S. 2014 Review of Optimization Aspects for Metal Forming Process. An International Journal (ESTIJ),ISSN: 2250- 3498,Vol.4,no.2 pp 71-75

[9] Shinde, R.A., Patil, B.T. and Joshi, K.N., 2016. Optimization of Tube Hydroforming Process (without Axial Feed) by Using FEA Simulations. Procedia Technology, 23, pp.398-405.

[10] Joshi, M.K.N., Patil, B.T. and Satao, M.S., 2014. Optimization of Variation in Wall Thickness of a Deep Drawn Cup using Virtual Design of Experiments. Optimization, 4(5).

[11] Trzepieci ´nski, T.; Lemu, H.G. Effect of computational parameters on spring back prediction by numerical simulation. Metals 2017, 7, 380.

[12] Ma, N.; Takada, K.; Sato, K. Measurement of local strain path and identification of ductile damage limit based on simple tensile test. Procedia Eng. 2014, 81, 1402–1407.

[13] Takuda, H.; Hama, T.; Nishida, K.; Yoshida, T.; Nitta, J. Prediction of forming limit in stretch flanging by finite element simulation combined with ductile fracture criterion. Comp. Meth. Mater. Sci. 2009, 9, 137–142.

[14] Ma, N.; Sato, K.; Takada, K. Analysis of local fracture strain and damage limit of advanced high strength steels using measured displacement fields and FEM. Comput. Mater. Contin. 2015, 46, 195–219.

[15] Su, H.; Huang, L.; Li, J.; Ma, F.; Huang, P.; Feng, F. Two-step electromagnetic forming: A new forming approach to local features of large-size sheet metal parts. Int. J. Mach. Tools Manuf. 2018, 124, 99–116.

[16] Su, H.; Huang, L.; Li, J.; Ma, F.; Ma, H.; Huang, P.; Zhu, H.; Feng, F. Inhomogeneous deformation behaviors of oblique hole-flanging parts during electromagnetic forming. J. Manuf. Process. 2020, 52, 1–11.

[17] Russo, I.M.; Cleaver, C.J.; Allwood, J.M. Haptic metal spinning. Procedia Manuf. 2019, 29, 129–136.

[18] Wong, C.C.; Dean, T.A.; Lin, J. A review of spinning, shear forming and flow forming processes. Int. J. Mach. Tools Manuf. 2003, 43, 1419–1435.

[19] Xia, P. Haptics for Product Design and Manufacturing Simulation. IEEE Trans. Haptics 2016, 9, 358–375.