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Optimization Of Sheet Metal Forming Parameters Using ANSYS

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Abstract: The automotive and aerospace components are manufactured using sheet metal bending process. The quality and defects generated during the bending process depends upon various design parameters. The objective of current research is to investigate the effect of forming parameters on stress and strain generated using ANSYS explicit dynamics. The material investigated is copper sheet metal and optimization is conducted using Taguchi response surface method. The critical regions of high stresses are identified during the bending process. From the optimization results, the minimum shear stress was observed for die angle of 92^0 and maximum shear stress was observed for die angle of 88^0.

Key Words: Sheet metal bending, stresses, optimization.

I. INTRODUCTION

The various components of automobile, aircrafts and other components are manufactured by deformation process. This “comprises manufacturing methods that are used to create the primary shape of products by plastically deforming the material and some of the well-known examples are forging, rolling, extrusion, sheet metal forming and hydroforming” [1,2]. The sheet metal forming process involves bending, flanging, stretching, punching, deep drawing and some other processes. The elastic plastic deformation of metal takes place during the metal forming process. The sheet metal bending types include U bending type and V bending.

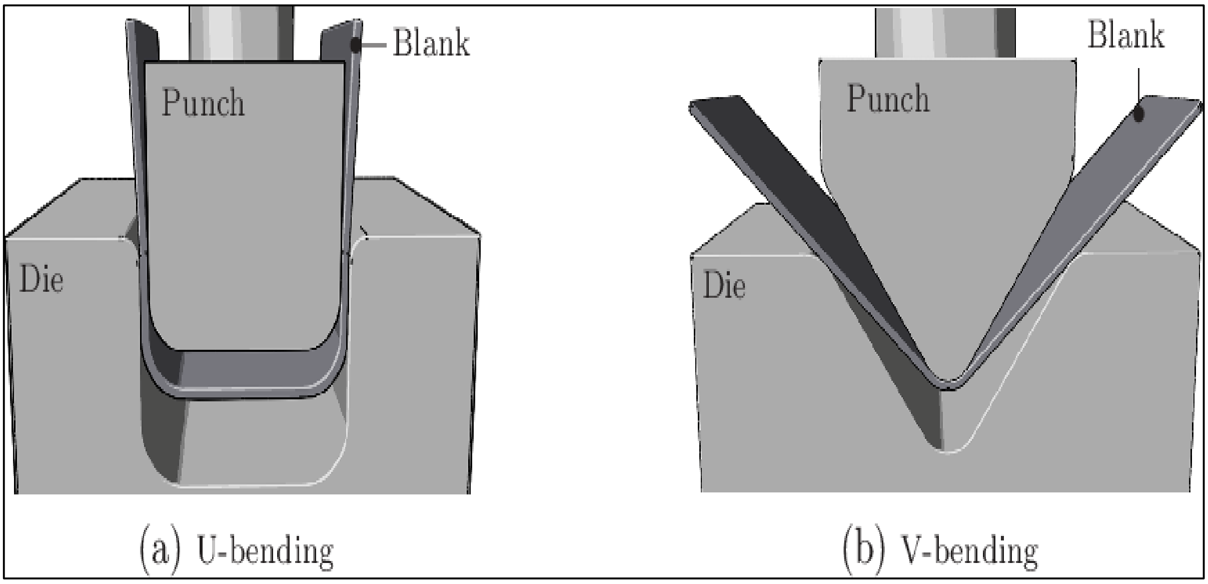

Figure 1: U type and V type bending

II. LITERATURE REVIEW

P. S. Thakare [3] have worked on hydraulic pipe bending under required angles to be used for domestic and industry applications. The use of heat treatment techniques is not safe and results in various problems like curve forming, wrinkling and reduced strength. The use of pipe bending machine was preferred as compared to heat treatments process.
V. Senthil Raja [4] have worked on development of pipe bending mechanism for pipes used for air-conditioning, bicycle handles and aircraft etc. The bending can be achieved using human powered machines and therefore the bending operation can be conducted in power deficit rural areas.

H. A. Hussain [5] have worked on the application of hydraulic bending machines for manufacturing of pipe bends, rods and bars. The rollers are used with dies with different angles. The hydraulic pipe bending machines have better performance as compared to current standard machines.

Mohan Krishna S. A. [6] have worked on development of portable pipe bending machine to be used in workshop. The portable machine is used to bend steel pipes and other curvature shapes. The use of this portable machine reduces human effort and less skill. The components manufactured using portable bending machines are gears, motors, pulley, and frame.

Prashant P. Khandare [7] have worked on investigation of roller forming process. The effect of various design parameters on strength and deformation of metal sheet is investigated. The long strip of metal is passed through roller to attain desired curvature. The change in loading condition and material thickness has significant effect on strength and deformation.

III. OBJECTIVE

The objective of current research is to investigate the effect of forming parameters on stress and strain generated using ANSYS explicit dynamics. The material investigated is copper sheet metal and optimization is conducted using Taguchi response surface method.

IV. METHODOLOGY

The FE simulation is conducted on metal sheet and punch geometry. The stages of FE simulation involve pre-processing, solution and post processing. The CAD model of punch and sheet metal is developed in ANSYS design modeller using sketch and extrude tool. The dimensions of sheet metal forming structure is taken from literature [8].

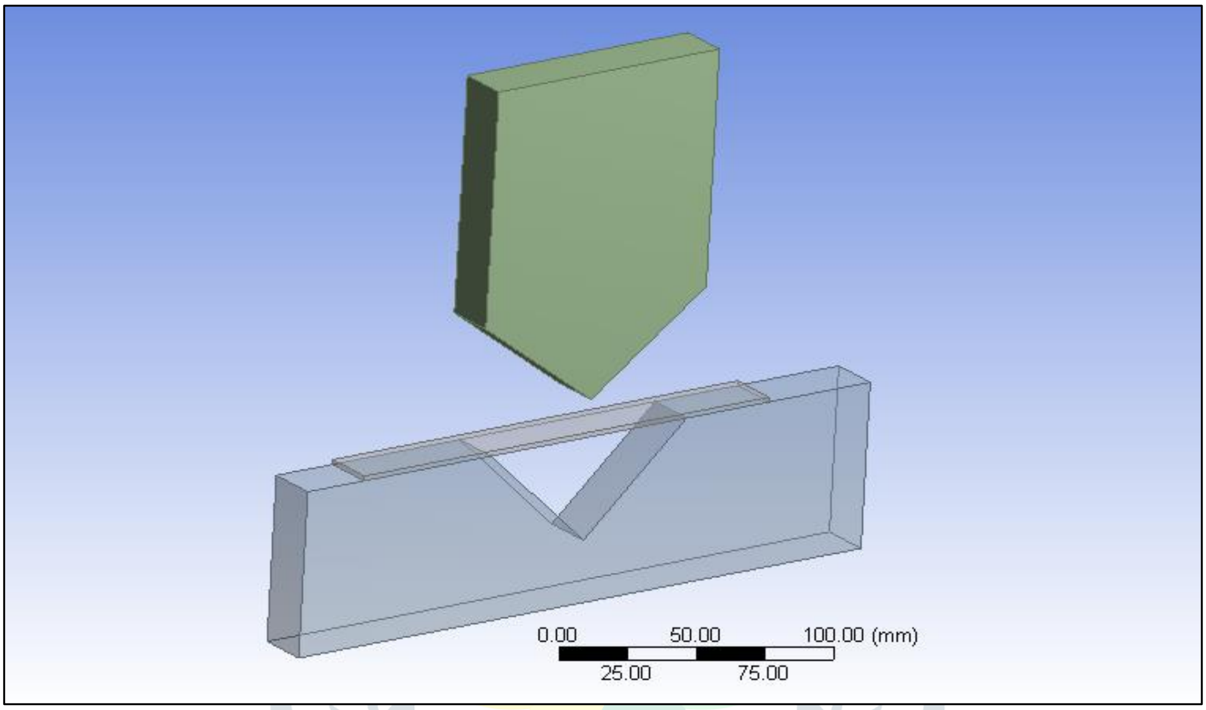

Figure 2: CAD model of sheet metal bending

The CAD design is meshed using hexahedral elements. The discretization process involves setting fine sizing and adaptive with normal inflation and growth rate set to 1.2. The number of elements generated is 2148 and number of nodes generated is 3260.

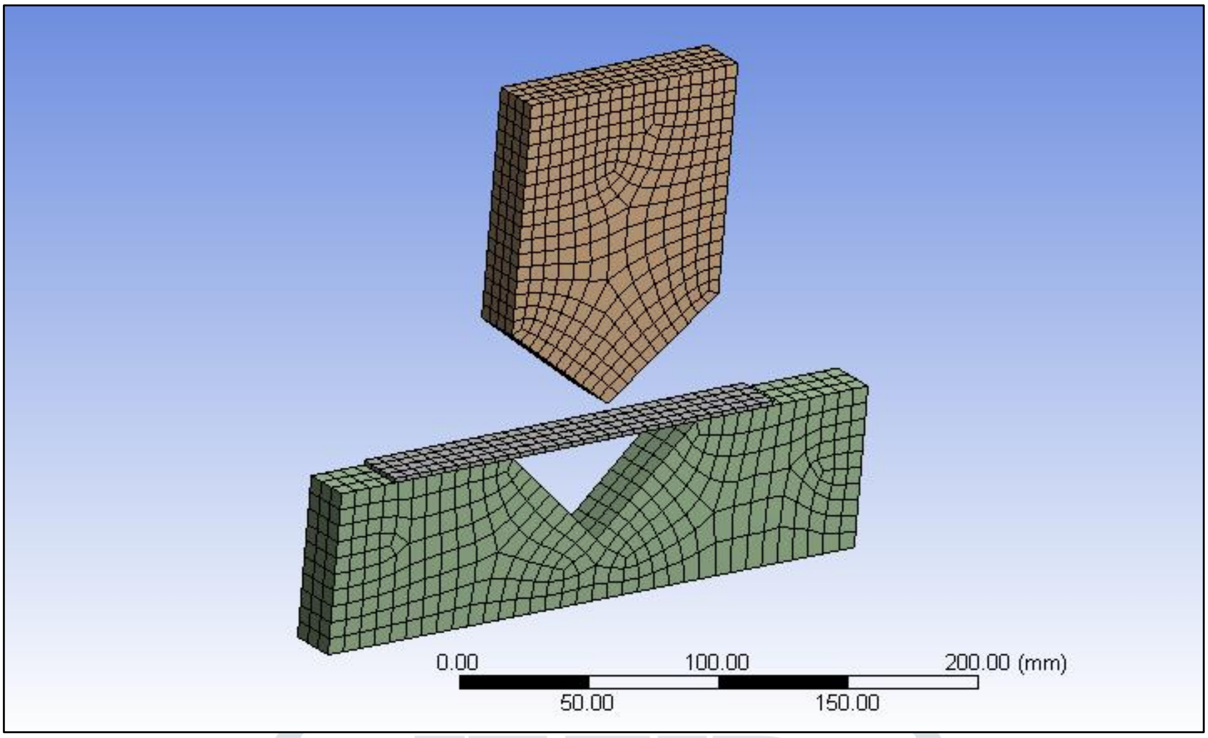

Figure 3: Meshed model of sheet metal bending

The boundary conditions are applied on sheet metal bending set up as shown in figure 4 below. The base of die is applied with fixed support and punch is applied with initial velocity of 5m/s [6].

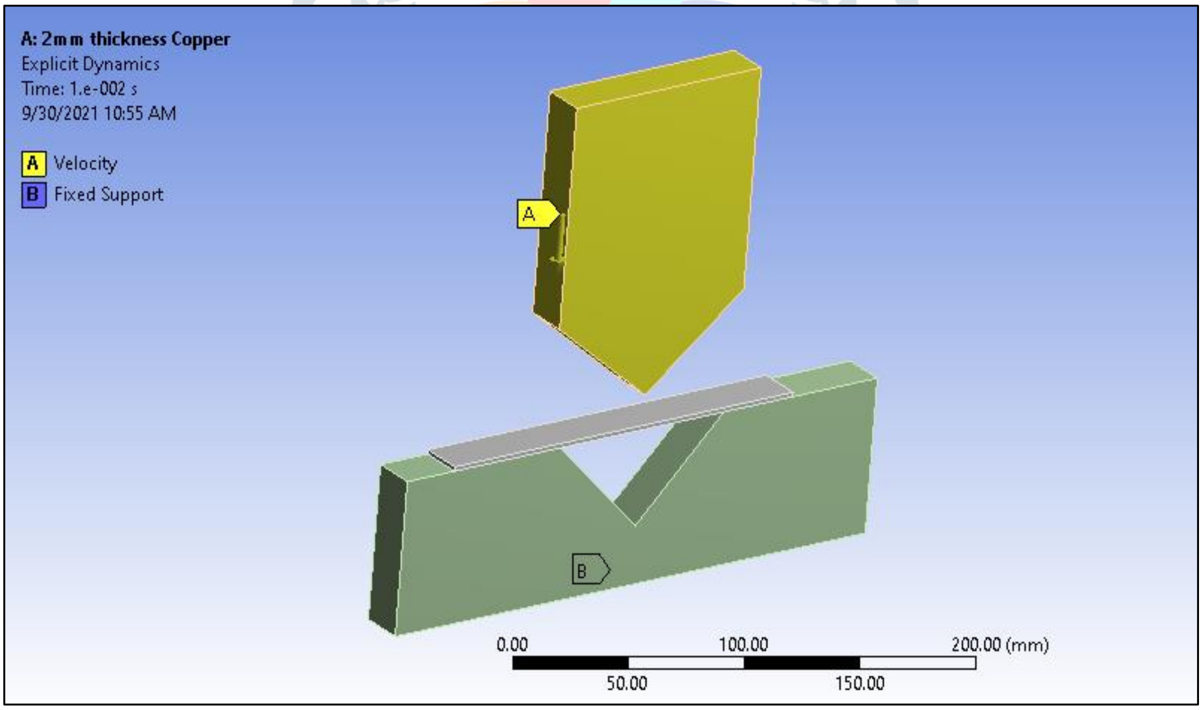

Figure 4: Loads and boundary condition

After applying loads and boundary conditions, the sparse matrix solver is initialized. The simulation is run which involves formulation of element stiffness matrices, assemblage of global stiffness matrix. The calculation is made at nodes and interpolated for entire element edge length.

V. RESULTS DISCUSSION

The results of FE simulation are generated for copper metal sheet. The deformation plot is obtained at different time intervals. The deformation at .00045secs is shown in figure 5 below.

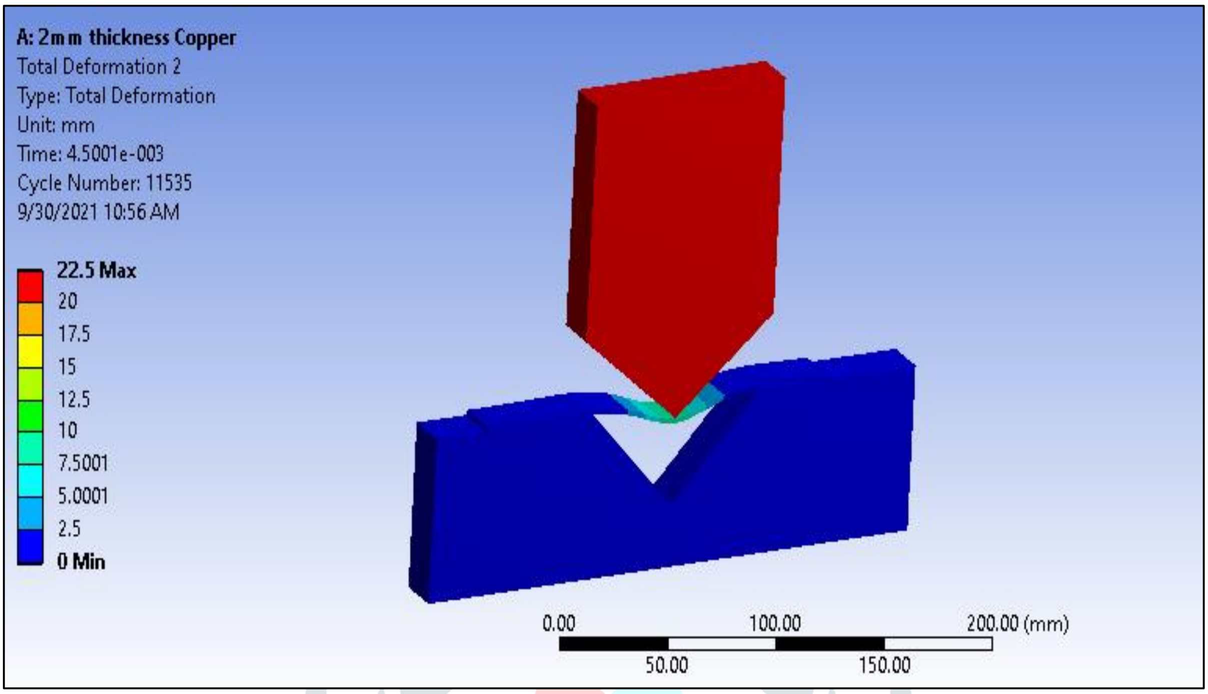

Figure 5: Deformation at .00045secs

The deformation plot is obtained at .00045secs. The sheet metal starts to deformation under subjected load. The deformation obtained is 22.5mm. The deformation is further evaluated at .0007secs which is observed to be 35.001mm.

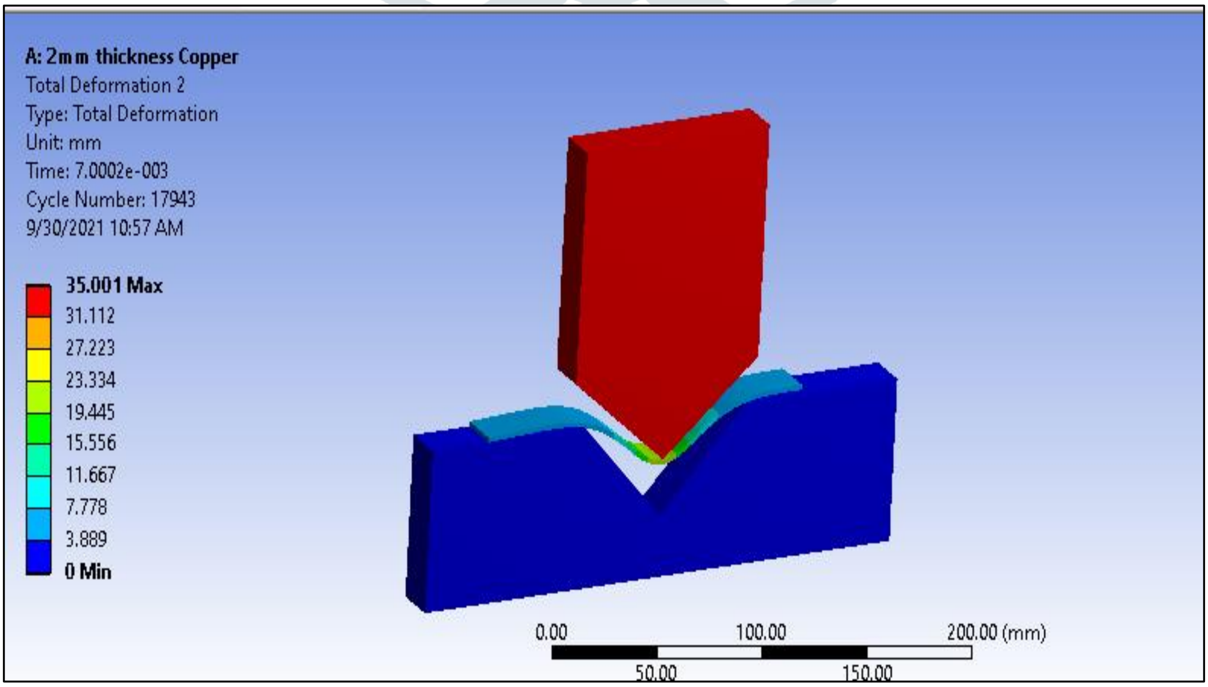

Figure 6: Deformation at .0007secs

The deformation at .0095 secs is observed to be 47.501 mm. The deformation of sheet metal reaches to lowest region. The maximum deformation is represented by yellow coloured region. The deformation at the slant faces is nearly 15.834 mm.

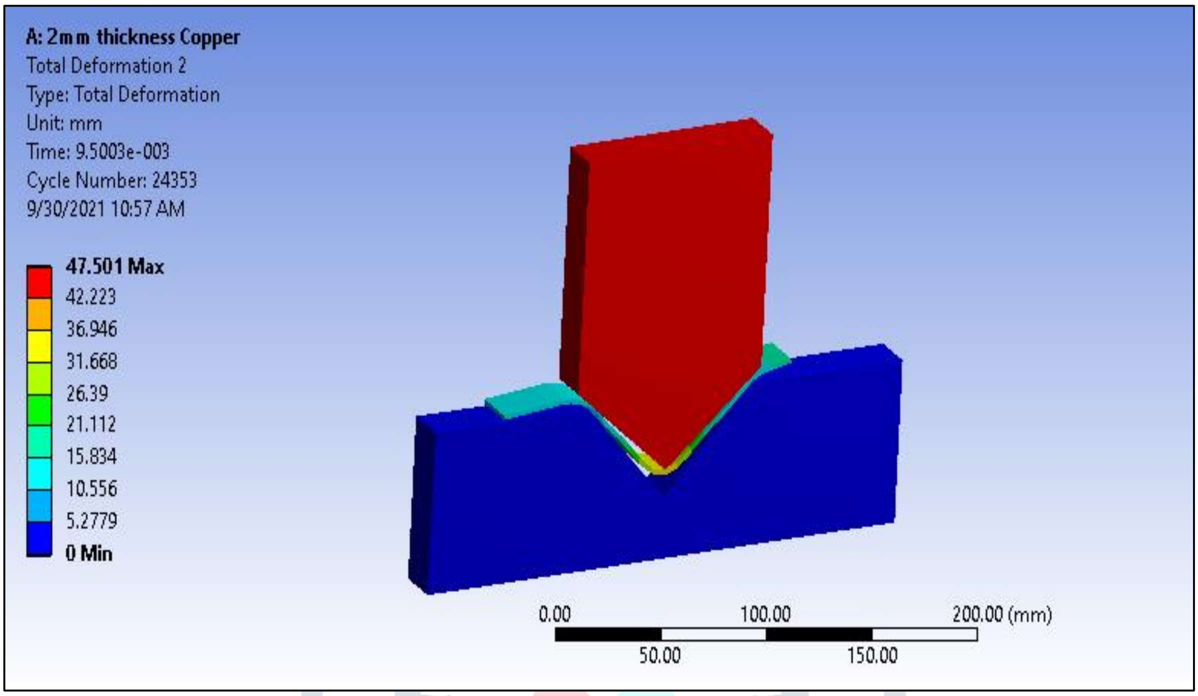

Figure 7: Deformation at .0095secs

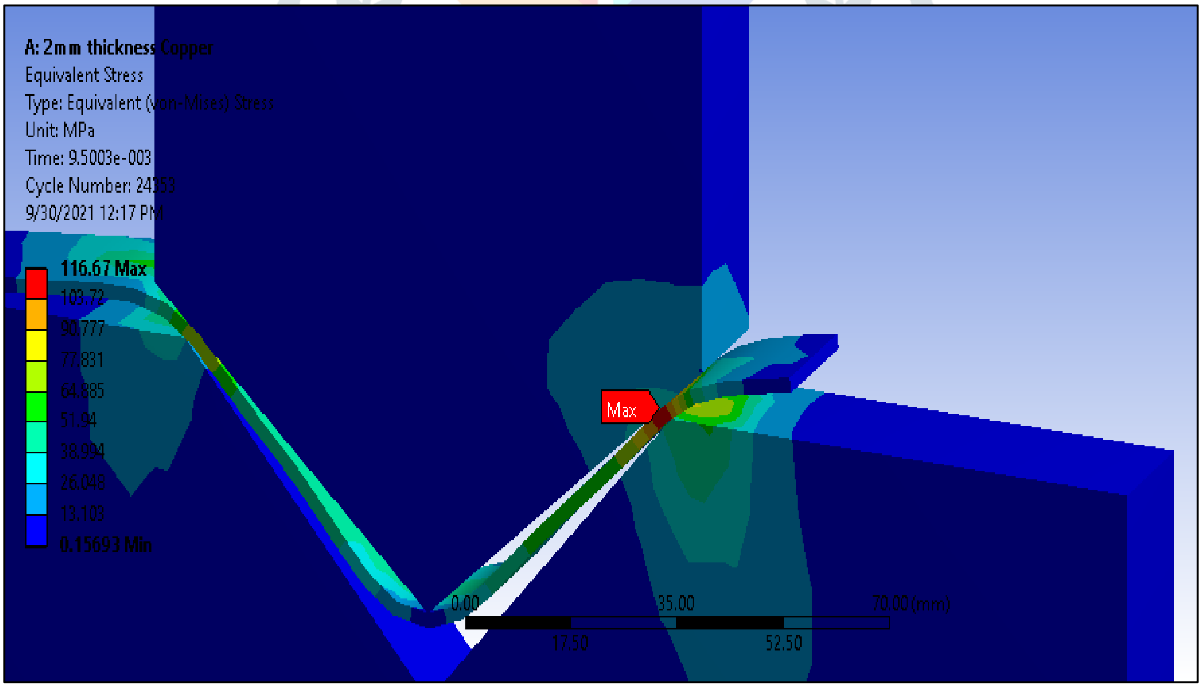

Figure 8: Equivalent stress at .0095secs

The equivalent stress plot is evaluated at .0095 secs which is found to be 116.67 mm. The equivalent stress is observed to be maximum at the corner regions where the punch makes contact with the metal sheet.

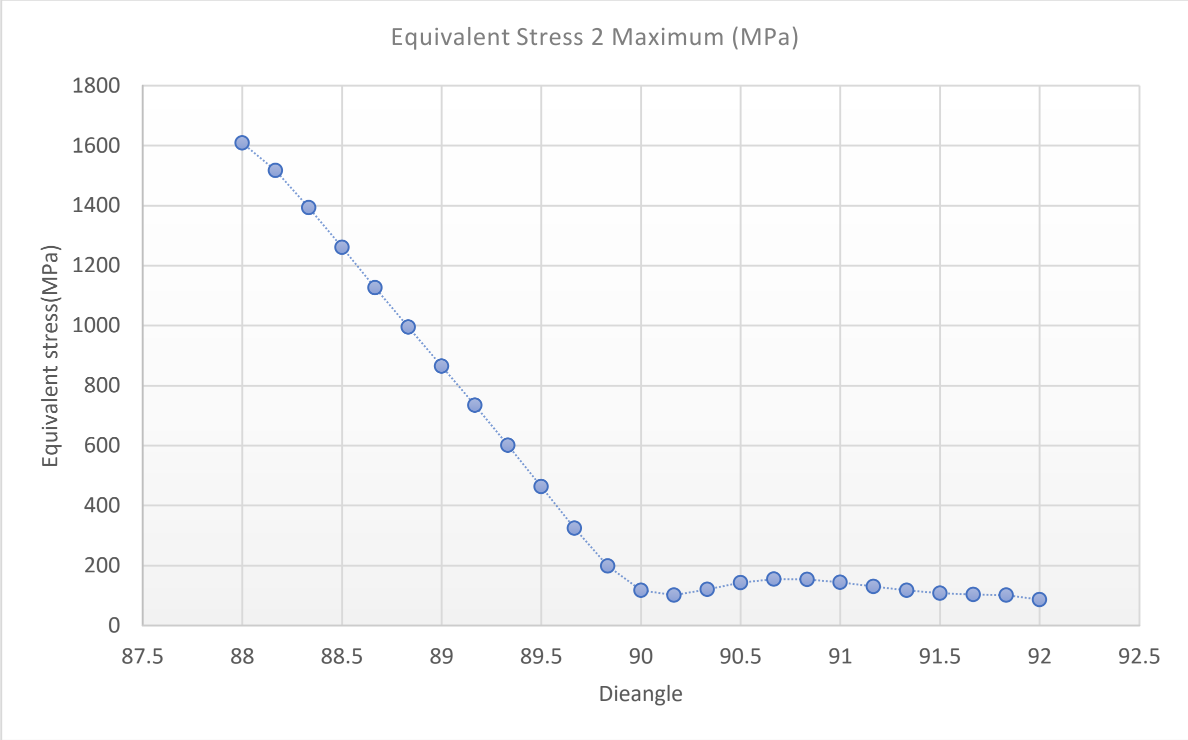

Figure 9: Equivalent stress vs die-angle

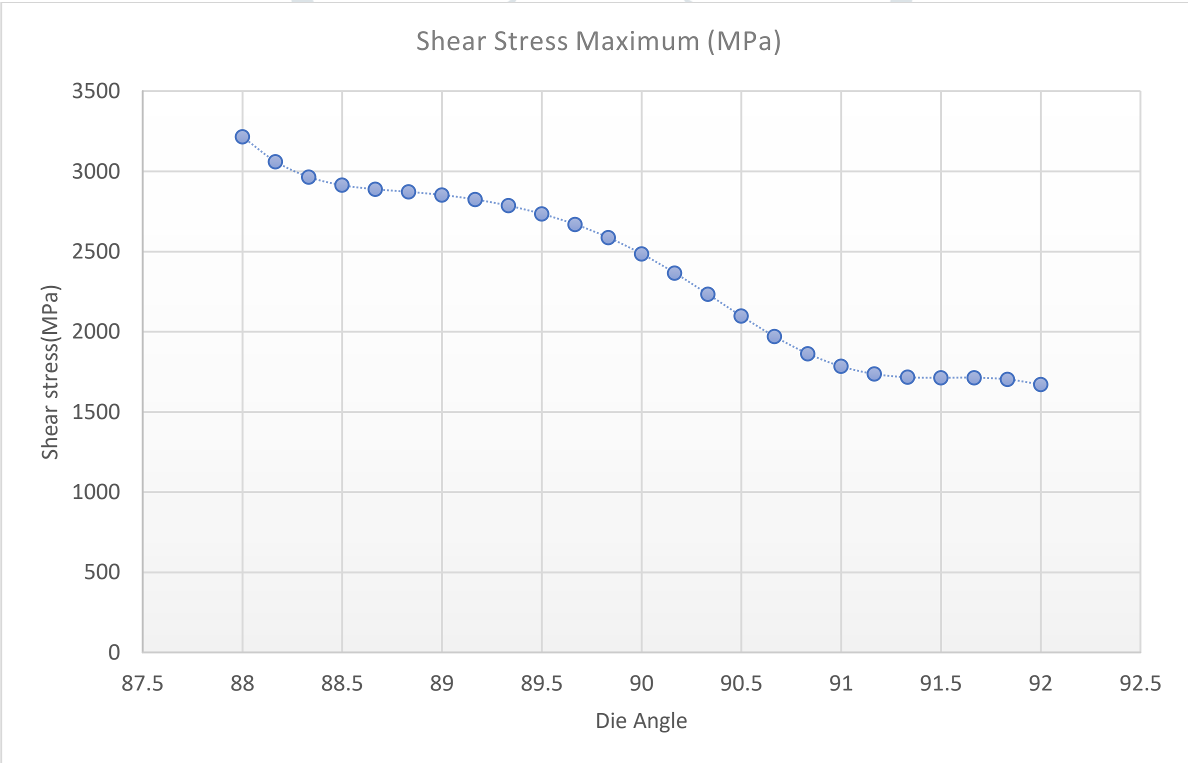

Figure 10: Shear stress vs die-angle

The variation of equivalent stress with respect to die angle is show in figure 8 above. The equivalent stress decreases linearly and reaches to minimum at the die angle 90^0 and the stress is maximum at the die angle 88^0. The equivalent stress increases linearly to 153 MPa and then reduces to reach minimum value of 86.49 MPa. The shear stress variation with respect to die angle is shown in figure 9 above which shows nonlinear decrease in shear stress with minimum shear stress at die angle of 92^0.

VI. CONCLUSION

The FEA is a viable tool in determination of elastic plastic behaviour of sheet metal during bending process. The Taguchi optimization method aided to determine the effect of optimization variables on stresses and deformation generated on metal sheet. The critical regions of high stresses are identified during the bending process. From the optimization results, the minimum shear stress was observed for die angle of 92^0 and maximum shear stress was observed for die angle of 88^0.

REFERENCES

[1] M.F. Ashby. Materials selection in mechanical design. Butterworth-Heinemann, 2nd edition, 1999.

[2] R. Pearce. Sheet metal forming. Adam Hilger, 1991.

[3] 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.

[4] 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.

[5] 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.

[6] 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.

[7] 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.

[8] Jabbar Gattamah "Sheetmetal forming process for various materials using Finite Element Analysis" 1st International Conference on Advances in Mechanical and Mechatronics Engineering, ICAMMEN 2018.