Studies On Effect Of Process And Geometry Parameter On Deep Drawing : A Review

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ABSTRACT

Nowadays to make more stiff, light weight automotive and aviation parts are focus of research to increase the fuel efficiency and strength of the body,which is made by sheet metal forming process . In deep drawing process various factor affect the product's quality. In this paper various process and geometry parameters and their effect are considered. Good knowledge and experience is required to make product with minimum defects.

keywords : *Deep drawing , Blank holder force , Thinning , Wrinkles , Clearance , Friction*

INTRODUCTION

Deep drawing is one of the technique of sheet metal forming process. Which is important process in metal forming. Application of deep drawing are like in automotive and aircraft industries, kitchen utensils , appliance bodies ,beverage can etc. Required tools for deep drawing are blank, die , blank holder , punch. In deep drawing blank holder force , distance between die and blank , die radius , clearance between die and punch , velocity of punch , drawing force , friction between die and blank , blank and blank holder , punch and blank also play role in deep drawing. Due to lack of knowledge and experience of this process and geometry parameter defects like wrinkles , thinning , earing occurs. Author of paper did the number of analysis using LS-DYNA explicit code to see their effect on deep drawing. Defects due to this parameters will describe in detail in this paper later.

Suggestions address by H.Zien et al. , die curvature radius should be 10 times the thickness of sheet , punch nose radius should be 4 times the thickness of sheet. clearance between die and punch should be more than the sheet thickness[1]. H.Ibrahim et al. , he did experiment by taking the different blank holder pressure from 0.4 MPa to 15 MPa. And suggestion given by him is less than 0.65 MPa blank holder pressure may increase the chances of wrinkles[2]. S.M,Mahdavian et al. , suggest the effect punch geometry on deep drawing , Flat punch don't change the bottom of cup. but change the wall thickness. conical profile punch produce thicker wall of cup[3]. As compare to constant blank holder force , variable blank holder force is capable for prevent the cracking, Susila candrab et al.[4].Distance between blank and die also play important role in formation of wrinkles. distance should be 1 mm , otherwise it may cause wrinkles, L.Chena[5]. Punch nose radius increase then length of contact also increase which height of cup and requirement of punch load is decrease[8].

SIMULATION SETUP

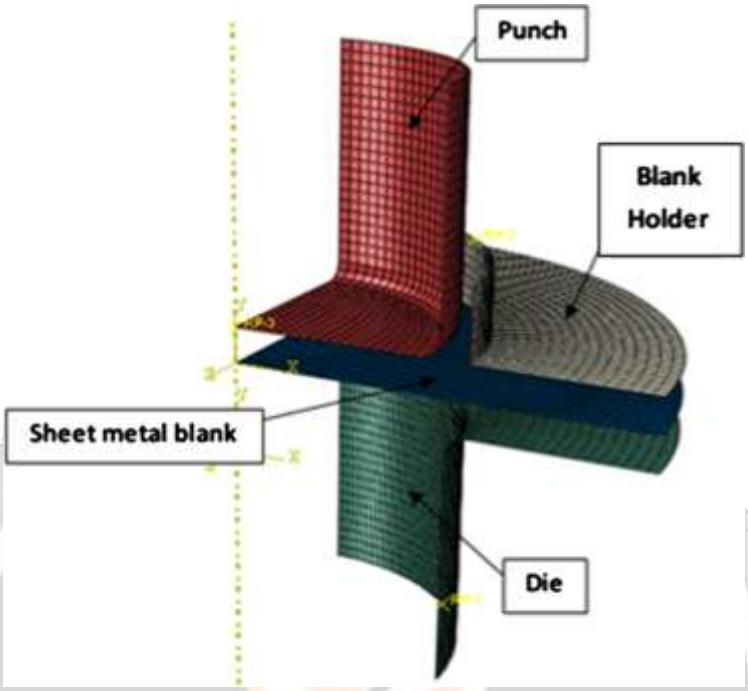

fig. 1 Simulation Setup

LS-DYNA is very useful in case of metal forming , have good material model which provide the nearly approximate results. Parts are made as per the dimension and meshing , material property , section , boundary condition provided and simulation done.

PROCESS AND GEOMETRY PARAMETERS AND THEIR EFFECT

1) BLANK HOLDER FORCE (BHF)

BHF should not be more and less , it should be as per calculations , some minor change is tolerated. BHF affect the product's quality , if BHF is less then it cause wrinkles , and if more then it cause the thinning of cup wall and thickening of flange. It affect the material flow. Distance between blank and blank holder also play significant role in the wrinkle defect. If Distance between blank and blank holder is more than 1 mm then blank holder is not able to distribute their load properly over the blank , It cause the wrinkles. Author of the paper did the number of analysis by considering the different BHF and different BHG (Blank Holder Gap- Distance between blank and die). At low BHF and more BHG wrinkles are observed , which is shown in Fig.2.

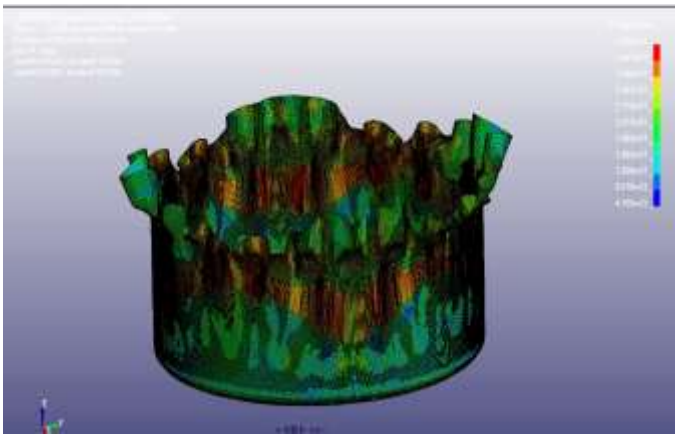

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Fig.2 Wrinkles

2) CLEARANCE BETWEEN DIE AND PUNCH

As per the author's experience , clearance between die and punch play a significant role in material flow , thinning of cup wall. Clearance between die and punch must be more than the sheet thickness, Author take less clearance between punch and die to see their effect , which shown in Fig.3. we can see thinning at the wall and start cracking at wall of cup and even at bottom radius of cup.

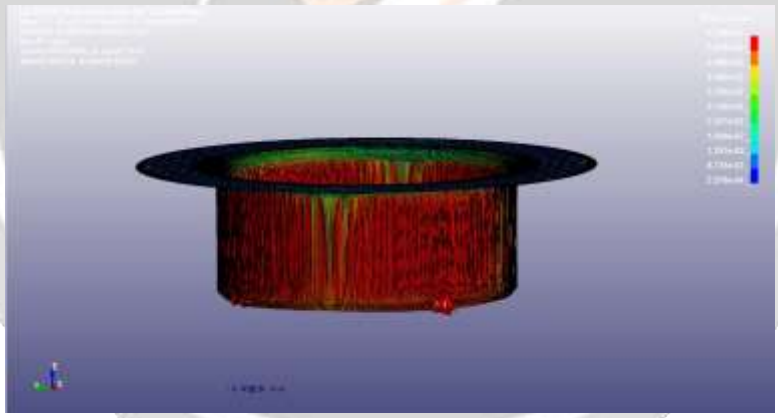

Fig. 3 Thinning

3) DIE RADIUS

Die radius play significant role in material flow and prevent crack. Die radius should be as per the calculation , but in some case change can be tolerated. Die radius should not be sharp otherwise blank will crack as punch is impact on it. If die radius is proper then material is flow in smoothly into die , but if die radius is more then there is chance that blank holder not able to distribute their force on blank and it cause the wrinkles at wall of cup.

4) FRICTION

Friction is depends on the material , and their draw-ability. Friction affect the surface finish of product. If friction is more then it resist the material flow , so stretching occurs and it causes the thinning of the cup wall. Author did the analysis by taking different friction value and see their effect in deep drawing. friction between

punch and blank is should be 0.25 which reduce the spring-back and thinning of cup. friction between blank and blank holder should be between 0.125-0.2 it helps to reduce the effect of thinning and spring-back. friction between die and blank should be 0.16 reduce the thinning and residual stress in cup wall.

5) PUNCH SPEED

Punch should be in as per the calculation so that material flow in die smoothly. If velocity is more then it cause the cracking of blank at the starting of simulation . More speed cause the large amount of vibration it may lead you in wrong direction. speed should be increase continuously then remain steady at for some time and start decreasing continuously. punch speed should be in such a way that it form the cup as per the required height of cup with minimum amount of time required for simulation.

CONCLUSION

Successful development of the deep drawn cup is depends on the process and geometry parameters. FE analysis is the powerful tool nowadays in deep drawing , reducing the time and try and error efforts. FE analysis reduce the cost of manufacturing , and gives the results approximately near the experimental values.

studies shows that :

BHF should be high and if possible the as per the calculations , which reduce the wrinkles.

BHG should be 1 mm , which reduce the chances of wrinkles.

Clearance between die and punch should be more than the sheet thickness.

Die radius should be as per the calculation less radius cause the crack and more radius cause the wrinkles at wall of cup.

Friction should be as per material in case of steel , friction between punch and blank 0.25, between die and blank 0.16 and between blank and blank holder 0.125 to 0.2. which helps to reduce the thinning , spring-back and residual stress at wall of cup.

Punch speed should be smooth to reduce the vibration , and make smooth material flow and should be as per calculation so that cup produces as per the height required with minimum simulation time.

REFERENCES

1. H. Zein, M. El Sherbiny et al , Thinning and spring back prediction of sheet metal in the deep drawing Process , Materials and Design , Egypt , 2013
2. H. Ibrahim Demirci ,Mustafa Yasar et al , The theoretical and experimental investigation of blank holder forces plate effect in deep drawing process of AL 1050 material , Materials and Design , Turkey , 2007
3. S.M.Mahdavian, Tui Mei Yen Fion , Effect of punch geometry in deep drawing process of Al , Materials and Mfg. processes , Australia , 2006
4. Susila Candrab,I Made Londen Batana et al , Analytical study and FEM simulation of the maximum varying blank holder force to prevent cracking on cylindrical cup deep drawing , 12th Global Conference on Sustainable Manufacturing, IRP, Indonesia, 2015
5. L.Chena, J.C. Yang et al , Finite element simulation and model optimization of blank holder gap and shell element type in the stamping of a washing-trough , Materials Processing Technology , PR China , 2006
6. Mark Colgan, John Monaghan , Deep drawing process: analysis and experiment , Materials Processing Technology , Ireland , 2002
7. Min Sik lee , sung jin kim et al , Effect of process parameters on epoxy flow behaviour and formability with CR340/CFRP composites by different laminating in deep drawing process , Procedia Engineering , Korea , 2014

8. Dr. WKJ , Investigation of Contact Interface Between the Punch and Blank in Deep Drawing Process , Eng. & Technology, Iraq , 2005
9. Gheorghe Brabie, Nicolae Nanu , The influence of the punch shape on the residual stresses distribution and spring back in the case of conical drawn parts , University of Bacau, Romania , 2009
10. V. Malikova, R. Ossenbrink et al , Experimental study of the change of stiffness properties during deep drawing of structured sheet metal , Materials Processing Technology, Germany , 2013
11. F. Mirtsch , N. Weinert et al , Vault Structures Enabling Sustainable Products , 13th cirp international conference on life cycle engineering , Germany , 2006
12. Vladimirov IvayloN, Pietryga MichaelP,et al. Anisotropic finite elastoplasticity with nonlinear kinematic and isotropic hardening and application to sheet metal forming. Int J Plasticity.
13. William f. Hosford , Metal forming Mechanics and metallurgy , Cambridge university press
14. B.L. juneja , Fundamentals of metal forming processes , New age international publication
15. Dr. Heinz Tschaetsch , Metal Forming Practise , Springer publication
16. M.A. Ahmetoglu, G. Kinzel, et al , Forming of aluminum alloysapplication of computer simulations and blank holding force control, J. Mater. Process. Technol.
17. R.Di. Lorenzo, L. Fratini,et al , Optimal blankholder force path in sheet metal forming processes: an Al based procedure, Ann. CIRP 48 (1999)
18. K. Osakada, C.C.Wang et al. , ControlledFEMsimulation for determining history of blank holding force in deep drawing, Ann. CIRP 44 (1995)
19. D.K. Siegert, et al., Closed loop control system for blank holder forces in deep drawing, Ann. CIRP 44 (1995)
20. L.B. Shulkin, R.A. Posteraro, et al., Blank holder force (BHF) control in viscous pressure forming (VPF) of sheet metal, J. Mater. Process. Technol
21. H. Wang, W. Xu, Z. Lin, et al., Stamping and stamping simulation with a blankholder gap, J. Mater. Process. Technol
22. L.P. Lei, S.M. Hwang et al., Finite element analysis and design in stainless steel sheet forming and its experimental comparison, J. Mater. Process. Technol
23. I.N. Chou, C. Huang, Three-dimensional finite element analysis of sheet-metal bending with complex die geometry, J. Manuf. Sci. Eng.1997
24. Y.M. Huang, J.W. Cheng, Infuence of tool clearance in the cylindrical cup drawing process, J. Mater. Proc. Tech. 57 (1996)
25. K.P. Rao, J.J. Wei, Performance of a new dry lubricant in the forming of aluminum alloy sheets, Wear 249 (2001)
26. Gedney R., "Tensile Testing for Determining the Formability of Sheet Metals", Admet Report, Inc, Norwood, Massachusetts, 2002
27. Luc Papeleux, Jean-Philippe Ponthot, Finite element simulation of springback in sheet metal forming, Journal of Materials Processing Technology 125–126 (2002) 785–791
28. Dong Hongzhi*, Lin Zhongqin, Investigation of sheet metal forming bynumerical simulation and experiment, Journal of Materials Processing Technology 103 (2000) 404±410,China.
29. S.C. Tang, L.B. Chappuis, Evaluation of sheet metal forming process design by simple models, J. Mater. Manuf. Process. 8(1988) 19±26.
30. T. Balun, S.C. Tang, L.B. Chappuis et al., Application of mechanical methods to evaluation of forming and process design, SAE Transitions on Materials and Manufacturing, No. 930521, 1993