Analysis of Process Parameters of Parabolic Cups of NI201 Fabricated by Single Point Incremental Sheet Forming Process Using ABAQUS Software

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ABSTRACT

Numerical simulation of single point incremental forming process (SPIF) for Ni 201 sheet material was carried out using finite element analysis software and Taguchi experimental techniques. Reduction in thickness during SPIF process of the parabolic cups was estimated. Formability diagrams were drawn based on minor and major strains, and normalized major and minor stresses. The significant process parameters were identified using analysis of variance (ANOVA). Local thing along the walls of the parabolic cups were also estimated. It has been found that the maximum thinning ranges from 58% to 61% in the parabolic cups drawn from Ni201 using single point incremental forming process.

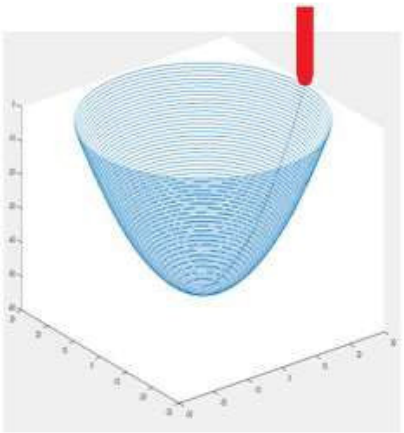

Figure 1: Tool path generation.

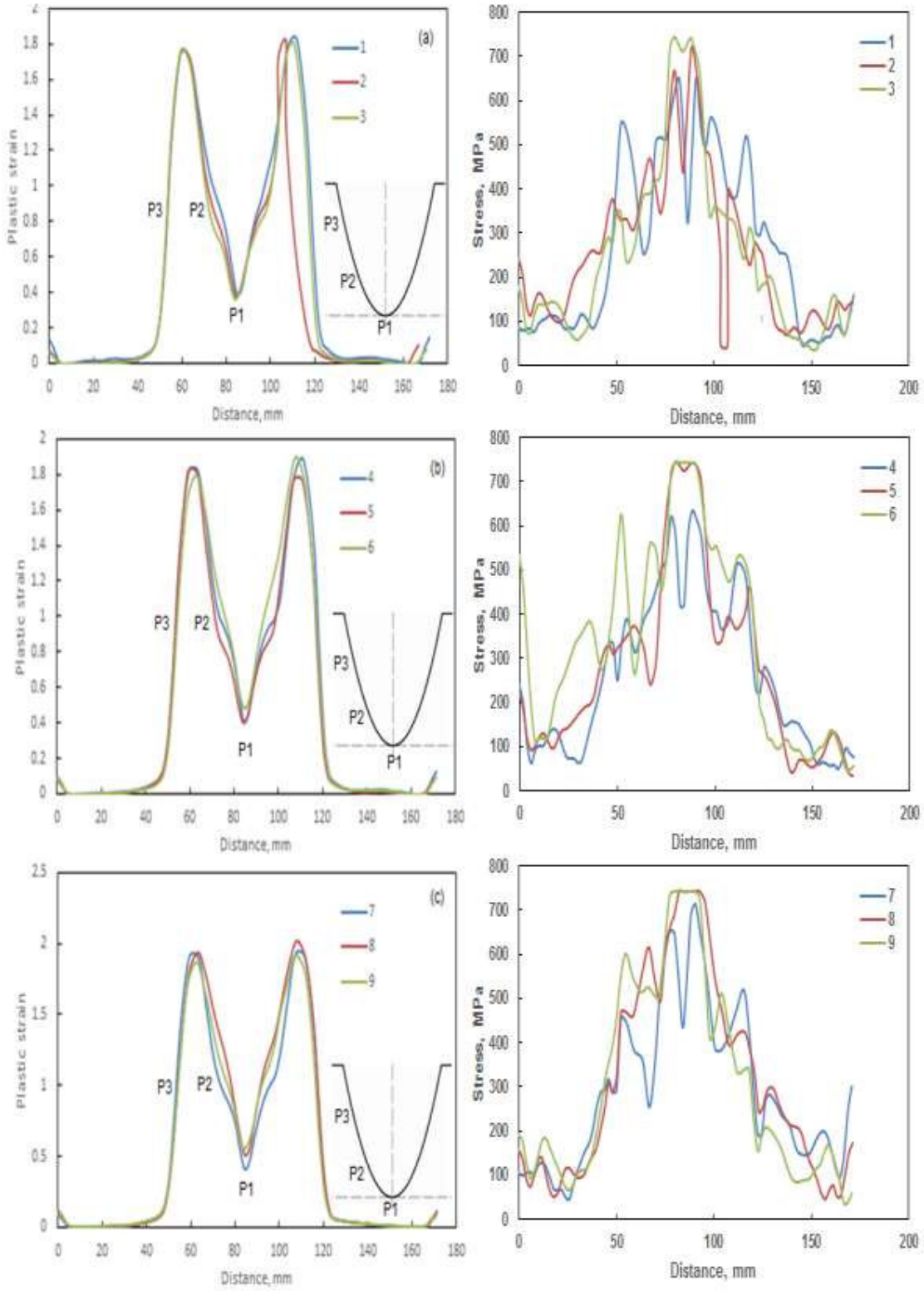

Figure 2: Variation of equivalent plastic strain and von Mises stress along a path from flange to bottom of cup: (a) 1.0 mm, (b) 1.2 mm and (c) 1.5 mm sheet thickness.

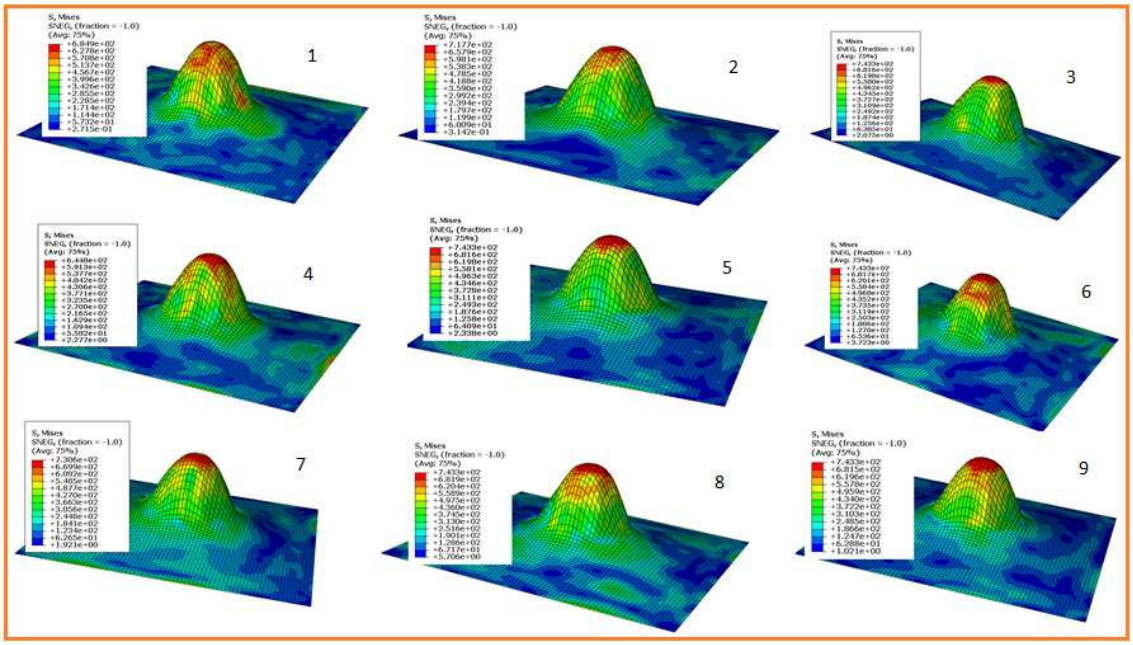

Figure 3: The von Mises stress induced in the parabolic cups of all trial runs.

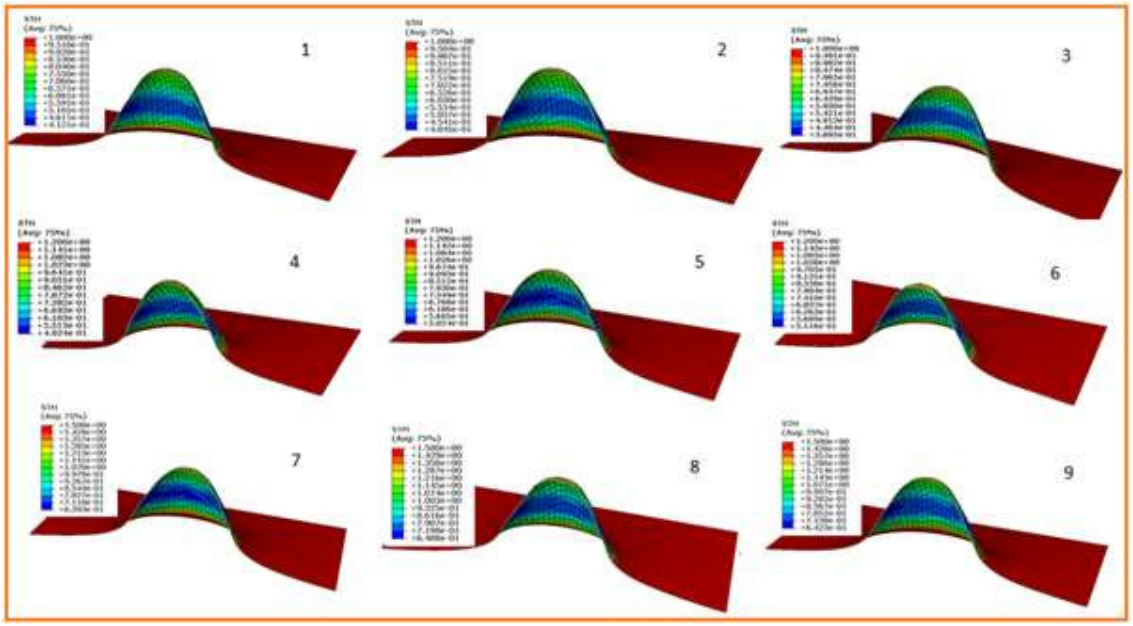

Figure 4: The reduction in thickness of the parabolic cups for all trial runs.

REFERENCES

1. P. Kamesh, A. Chennakesava Reddy, Micromechanical Plastic Behavior of AA5454 Alloy used for Fabrication of Pyramidal Cups, International Journal of Science and Research, Vol.7, No.6, pp.1225-1230, 2018.

2. M. Jaswanth Krishna, A. Chennakesava Reddy, Evaluation of Process Parameters of Conical Cups in Incremental Deep Drawing Process, International Journal of Science and Research, Vol.7, No.6, pp.1345-1350, 2018.
3. Teniya Choppala, A. Chennakesava Reddy, Elastoplastic Behavior of AA2124 Alloy used to make Hemispherical Cups, International Journal of Science and Research, Vol No.7, No.6, pp.1295-1300, 2018.
4. A. Chennakesava Reddy, Formability Analysis of 6063 Al Alloy for Deep Drawn Cylindrical Cups with Constant and Progressive Blank Holding Force, SSRG International Journal of Mechanical Engineering, Vol.4, No.5, pp.26-32, 2017.
5. C. Chagalamarri, G. Devendar, A. Chennakesava Reddy, Assessment of Strain and Stress – Based Formability Diagrams of Inconel 600 Hemispherical Cups Drawn by Single Point Incremental Forming Process Using Abaqus, International Journal of Advanced Technology in Engineering and Science, Vol.5, No.5, pp.710-719, 2017.
6. B. Sumanth Kumar, G. Devendar, A. Chennakesava Reddy, Formability Analysis of Parabolic Cups Drawn from Ni 201 Using single Point Incremental Forming Process, International Journal of Engineering Sciences & Research Technology, Vol.6, No.5, pp.619-628, 2017.
7. A. Chennakesava Reddy, Numerical and Experimental Investigation of Single Point Incremental Forming Process for Phosphorus Bronze Hemispherical Cups, International Journal of Scientific & Engineering Research, Vol.8, No.1, pp.957-963, 2017.
8. A. Chennakesava Reddy, Evaluation of Single Point Incremental Forming Process for Parabolic AA6082 Cups, International Journal of Scientific & Engineering Research, Vol.8, No.1, pp.964-970, 2017.
9. A. Chennakesava Reddy, Experimental and Numerical Studies on Formability of Stainless Steel 304 in Incremental Sheet Metal Forming of Elliptical Cups, International Journal of Scientific & Engineering Research, Vol.8, No.1, pp.971-976, 2017.
10. A. Chennakesava Reddy, Pilot Studies on Single Point Incremental Forming Process for Hyperbolic Brass Cups, International Journal of Scientific & Engineering Research, Vol.8, No.1, pp.977-982, 2017.
11. A. Chennakesava Reddy, Formability of 5083 Al Alloy Hemi-Spherical Shells Using Hot Deep Drawing Process, International Journal of Mechanics and Solids, Vol.9, No.3, pp.257-266, 2017.
12. A. Chennakesava Reddy, Evaluation of Formability Limit Diagrams of Arsenic Brass (70/30) Using Finite Element Analysis, International Journal of Mechanical Engineering and Information Technology, Vol No.5, No.6, pp.1651-1656, 2017.
13. A. Chennakesava Reddy, Impact of High Temperature and Beta-Phase on Formability of Cylindrical Cups from Cu-28%Zn and Cu-37%Zn Alloys, International Journal of Material Sciences and Technology, Vol.7, No.1, pp.17-26, 2017.
14. A. Chennakesava Reddy, Effect of Recrystallization Temperature on Formability of Hot Deep Drawn Cylindrical Cups from 6082 Al Alloy, Indian Journal of Engineering, Vol.14, No.36, pp.157-166, Discovery Publication, 2017.

15. Chennakesava R Alavala, Effect of Temperature, Strain Rate and Coefficient of Friction on Deep Drawing Process of 6061 Aluminum Alloy, International Journal of Mechanical Engineering, Vol.5, No.6, pp.11-23, 2016.
16. Chennakesava R Alavala, Development of High Temperature and High Strain Rate Super Plastic Deep Drawing Process for 5656 Al Alloy Cylindrical Cups, International Journal of Mechanical And Production Engineering, Vol.4, No.10, pp.187, 2016.
17. K. Sai Santosh Kumar, A. Chennakesava Reddy, Die Less Single Point Incremental Forming Process of AA6082 Sheet Metal to Draw Parabolic Cups Using Abaqus, International Journal of Advanced Technology in Engineering and Science, Vol.4, No.11, pp.127-134, 2016
18. T. Manohar Reddy, A. Chennakesava Reddy, Numerical Investigations on the Single Point Incremental Forming of 60-40 Brass to Fabricate Hyperbolic Cups, International Journal of Advance Research in Science and Engineering, Vol.5, No.11, pp.161-170, 2016
19. B. Navya Sri, A. Chennakesava Reddy, Formability of Elliptical SS304 Cups in Single Point Incremental Forming Process by Finite Element Method, International Journal of Research in Engineering & Technology, Vol.4, No.11, pp.9-16, 2016.
20. G. Soujanya, A. Chennakesava Reddy, Analysis of Single Point Incremental Forming Process to Fabricate Phosphorous Bronze Hemispherical Cups, International Journal of Innovative Science, Engineering & Technology, Vol.3, No.11, pp.139-144, 2016.
21. V. Srija, A. Chennakesava Reddy, Single Point Incremental Forming of AA1050-H18 Alloy Frustum of Cone Cups, International Journal of Science and Research, Vol.5, Issue No.6, pp.1138-1143, 2016.
22. T. Santhosh Kumar, A. Chennakesava Reddy, Finite Element Analysis of Formability of Pyramid-al Cups Fabricated from AA1100-H18 Alloy, International Journal of Science and Research, Vol.5, No.6, pp.1172-1177, 2016.
23. A. Raviteja, A. Chennakesava Reddy, Finite Element Analysis of Single Point Incremental Deep Drawing Process for Truncated Pyramidal Cups from AA 1070 Alloy, International Journal of Innovative Science, Engineering & Technology, Vol.3, No.6, pp.263-268, 2016.
24. V. Srija, A. Chennakesava Reddy, Numerical Simulation of Truncated Pyramidal Cups of AA1050-H18 Alloy Fabricated by Single Point Incremental Forming, International Journal of Engineering Sciences & Research Technology, Vol.5, No.6, pp.741-749, 2016.
25. T. Santhosh Kumar, A. Chennakesava Reddy, Single Point Incremental Forming and Significance of Its Process Parameters on Formability of Conical Cups Fabricated from AA1100-H18 Alloy, International Journal of Engineering Inventions, Vol.5, No.6, pp.10-18, 2016.
26. A. Raviteja, A. Chennakesava Reddy, Implication of Process Parameters of Single Point Incremental Forming for Conical Frustum Cups From AA1070 Using FEA, International Journal of Research in Engineering and Technology, Vol.5, No.6, pp.125-129, 2016.

27. . Santhosh Kumar, V. Srija, A. Ravi Teja, A. Chennakesava Reddy, Influence of Process Parameters of Single Point incremental Deep Drawing Process for Truncated Pyramidal Cups from 304 Stainless Steel using FEA, International Journal of Scientific & Engineering Research, Vol No.7, No.6, pp.100-105, 2016.
28. G. Devendar, A. Chennakesava Reddy, Study on Deep Drawing Process Parameters - A Review, International Journal of Scientific & Engineering Research, Vol.7, No.6, pp.149-155, 2016.
29. Chennakesava R Alavala, Fem Analysis of Single Point Incremental Forming Process and Validation with Grid-Based Experimental Deformation Analysis, International Journal of Mechanical Engineering, Vol.5, No.5, pp.1-6, 2016.
30. Chennakesava R Alavala, Validation of Single Point Incremental Forming Process for Deep Drawn Pyramidal Cups Using Experimental Grid-Based Deformation, International Journal of Engineering Sciences & Research Technology, Vol.5, No.8, pp.481-488, 2016.
31. Chennakesava R Alavala, High temperature and high strain rate superplastic deep drawing process for AA2618 alloy cylindrical cups, International Journal of Scientific Engineering and Applied Science, Vol.2, No.2, pp.35-41, 2016.
32. Chennakesava R Alavala, Practicability of High Temperature and High Strain Rate Superplastic Deep Drawing Process for AA3003 Alloy Cylindrical Cups, International Journal of Engineering Inventions, Vol No.5, No.3, pp.16-23, 2016.
33. Chennakesava R Alavala, High temperature and high strain rate superplastic deep drawing process for AA5049 alloy cylindrical cups, International Journal of Engineering Sciences & Research Technology, Vol.5, No.2, pp.261-268, 2016.
34. Chennakesava R Alavala, Suitability of High Temperature and High Strain Rate Superplastic Deep Drawing Process for AA5052 Alloy, International Journal of Engineering and Advanced Research Technology, Vol.2, No.3, pp.11-14, 2016.
35. G. Devendar, A. Chennakesava Reddy, Formability Limit Diagrams of Cold Deep Drawing Process for Nickel 201 Cylindrical Cups, International Journal of Science and Research, Vol.5, No.8, pp.1591-1598, 2016.
36. A. Chennakesava Reddy, Formability of superplastic deep drawing process with moving blank holder for AA1050-H18 conical cups, International Journal of Research in Engineering and Technology, Vol.4, Issue No.8, pp.124-132, 2015.
37. A. Chennakesava Reddy, Performance of Warm Deep Drawing Process for AA1050 Cylindrical Cups with and Without Blank Holding Force, International Journal of Scientific Research, Vol.4, No.10, pp.358-365, 2015.
38. A. Chennakesava Reddy, Formability of High Temperature and High Strain Rate Superplastic Deep Drawing Process for AA2219 Cylindrical Cups, International Journal of Advanced Research, Vol.3, No.10, pp.1016-1024, 2015.
39. A. Chennakesava Reddy, Simulation analysis of four-pass shape roll forming of I-sections, International Journal of Mechanical and Production Engineering Research and Development, Vol.5, No.1, pp.35-44, 2015.

40. Kothapalli Chandini, A. Chennakesava Reddy, Parametric Importance of Warm Deep Drawing Process for 1070A Aluminium Alloy: Validation through FEA, International Journal of Scientific & Engineering Research, Vol.6, No.4, pp.399-407, 2015.
41. Balla Yamuna, A. Chennakesava Reddy, Parametric Merit of Warm Deep Drawing Process for 1080A Aluminium Alloy: Validation through FEA, International Journal of Scientific & Engineering Research, Vol.6, No.4, pp.416-424, 2015.
42. Thirunagari Srinivas, A. Chennakesava Reddy, Parametric Optimization of Warm Deep Drawing Process of 1100 Aluminum Alloy: Validation through FEA, International Journal of Scientific & Engineering Research, Vol No.6, No.4, pp.425-433, 2015.
43. A. Chennakesava Reddy, Homogenization and Parametric Consequence of Warm Deep Drawing Process for 1050A Aluminum Alloy: Validation through FEA, International Journal of Science and Research, Vol.4, No.4, pp.2034-2042, 2015.
44. A. Chennakesava Reddy, Parametric Optimization of Warm Deep Drawing Process of 2014T6 Aluminum Alloy Using FEA, International Journal of Scientific & Engineering Research, Vol.6, No.5, pp.1016-1024, 2015.
45. A. Chennakesava Reddy, Parametric Significance of Warm Drawing Process for 2024T4 Aluminum Alloy through FEA, International Journal of Science and Research, Vol.4, No.5, pp.2345-2351, 2015.
46. A. Chennakesava Reddy, Finite Element Analysis of Warm Deep Drawing Process for 2017T4 Aluminum Alloy: Parametric Significance Using Taguchi Technique, International Journal of Advanced Research, Vol.3, No.5, pp.1247-1255, 2015.
47. Balla yamuna, A. Chennakesava Reddy, Finite Element Analysis of Warm Deep Drawing Process for Conical Cup of AA1080 Aluminum Alloy, International Journal of Advanced Research, Vol.3, No.6, pp.1309-1317, 2015.
48. Kothapalli Chandini, A. Chennakesava Reddy, Finite Element Analysis of Warm Deep Drawing Process for Pyramidal Cup of AA1070 Aluminum Alloy, International Journal of Advanced Research, Vol.3, No.6, pp.1325-1334, 2015.
49. Thirunagari Srinivas, A. Chennakesava Reddy, Finite Element Analysis of Warm Deep Drawing Process for Rectangular Cup of AA1100 Aluminum Alloy, International Journal of Advanced Research, Vol.3, No.6, pp.1383-1391, 2015.
50. A. Chennakesava Reddy, Formability of Warm Deep Drawing Process for AA1050-H18 Pyramidal Cups, International Journal of Science and Research, Vol.4, No.7, pp.2111-2119, 2015.
51. A. Chennakesava Reddy, Formability of Warm Deep Drawing Process for AA1050-H18 Rectangular Cups, International Journal of Mechanical and Production Engineering Research and Development, Vol.5, No.4, pp.85-97, 2015.
52. M. Vidya Sagar, A. Chennakesava Reddy, Finite volume analysis of two-stage forging process for aluminium 7075 alloy, International Conference on Advanced Materials and Manufacturing Technologies, JNTUH Hyderabad, 9789382163466, pp.228-238, Paramount Publishing House, 2014.

53. A. Chennakesava Reddy, T. Kishen Kumar Reddy, M. Vidya Sagar, Experimental characterization of warm deep drawing process for EDD steel, International Journal of Multidisciplinary Research & Advances in Engineering, Vo.4, No.3, pp.53-62, 2012.
54. J.J.V. Jeyasingh, G. Kothandaraman, P. P. Sinha, B. Nageswara Rao, A. Chennakesava Reddy, Spherical dome formation by transformation of superplasticity of titanium alloys and titanium matrix composites, International Journal of Materials Science & Engineering, No.478, pp.397-401, 2008.
55. J. V. Jeysingh, B. Nageswara Rao, A. Chennakesava Reddy, Investigation on failures of hydroforming deep drawing processes, Materials Science Research Journal, Vol.2, No.3&4, pp.145-168, 2008.
56. J. V. Jeysingh, B. Nageswara Rao, A. Chennakesava Reddy, Development of a ductile fracture criterion in cold forming, Materials Science Research Journal, Vol.2, No.3&4, 2008.
57. J. V. Jeysingh, B. Nageswara Rao, A. Chennakesava Reddy, Gas pressure forming of spherical domes from Pb-Sn eutectic alloy superplastic sheet material, Materials Science Research Journal, Vol.2, No.3&4, pp.241-258, 2008.
58. A. Chennakesava Reddy, Finite element analysis of reverse superplastic blow forming of Ti-Al-4V alloy for optimized control of thickness variation using ABAQUS, Journal of Manufacturing Engineering, Vol.1, No.1, pp.6-9, 2006.
59. A. Chennakesava Reddy, Residual stress measurement of reverse flow formed components by X-ray diffractometer, Engineering Advances, Vol.11, No.9, pp.54-55, 1999.A. Chennakesava Reddy, Fluidity and microstructural features of Al-alloy weld beads, Engineering Advances, Vol.15, No.3, pp.28-32, 2003.
60. C.R. Alavala, Finite Element Methods: Basic Concepts and Applications, PHI Learning Pvt. Ltd., New Delhi, 2008.
61. C.R. Alavala, CAD/CAM: Concepts and Applications, PHI Learning Pvt. Ltd., New Delhi, 2008.