International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 7, July-2018

BENDING ANALYSIS OF SHEET METAL PLATE BY USING ANSYS

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Abstract: This study performed to optimized the bending process of AISI1020 steel, 1060 Aluminum alloy, Duranickel alloymaterial sheets using bend testfor 'V' shape punch tool. The stable deformation takes place on the sheet metal strip as a result of severe plastic strain. One of the major issues in the sheet metal bending process is that the formation of spring back during unloading. This study involves design of experiment and finite element analysis to understand the bending behavior of sheet metal. The elasto-plastic behavior is studied by parametric numerical simulations. The static mechanical behavior metal sheet is investigated for various materials to achieve its correlations. The systematic approach is carried by developing FEM analysis of three-point bending of sheet metal.

Keywords: FEA, Sheet metal bending, ANSYS, Aluminum Alloy, geometric nonlinearity, material nonlinearity.

I. Introduction

Sheet metallic bending is one of the maximum widely applied sheet steel forming operations. The fabrication of sheet steel bending is widely utilized in car and plane commercial strategies with the trial-and-errors approach being employed to bend the sheet to the specified attitude. The accuracy and success of the bending process relies upon upon the working parameters as well as the fabric properties [10]. The spring-back impact is the main defect of each U and V fashioned components, showing significant modifications of the bend angles, mainly for materials with better power-to-modulus ratios like aluminum and excessive power metal. Engineering fields of bending are one of the most leaded operational reasons in extensively carried out in Sheet metal forming operations consist. This most of research spring effectiveness simplest focused on Sheet metallic forming operation and system in the especially numerous automobile industry and aeronautical industries had been designed in this purpose. The bending manner includes maximized deformation of the shape is defined in positive defects analyses in resistance and mechanical manner of defects exists. This observed with the aid of lines in the instability of phenomena accompanying of this processing. Metal is forming or metal running strategies are divided into classes i.e. Bulk forming and sheet steel forming. Bulk forming refers to methods like forging, rolling, extrusion and so on. In which there's a managed plastic waft of cloth into beneficial shapes. Sheet metal forming (additionally called press running) includes conversion of flat thin sheet steel blanks into elements of desired form. Sheet metallic forming tactics like deep drawing, stretching, bending and so forth. Are broadly used to produce a massive number of easy to complicated additives in car and aircraft industries, family home equipment and so forth.During the bending technique, a pressure is implemented to a sheet metal blank, causing it to bend at an angle and form the preferred form. The paintings piece is to begin with bent in an elastic region. As the system continues, the work piece is deformed by way of plastic deformation, thereby changing its form. The cloth is harassed beyond the yield energy but under the ultimate tensile strength of the material. The bending motion results in both anxiety and compression in the sheet metallic. The outer surface of the sheet undergoes tension and stretches to an extra duration while the internal surface reviews compression and shortens.

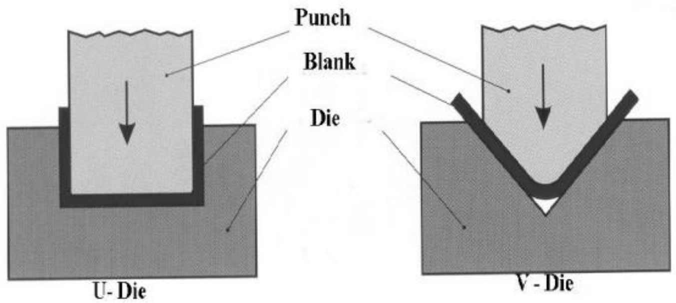

Figure 1: Sheet bending using U-die and V-die

II. Geometry of 'V' Punch tool and Die

Figure 2 shows the geometrical dimensions of 'V' punch tool and die designed in Solidwork.

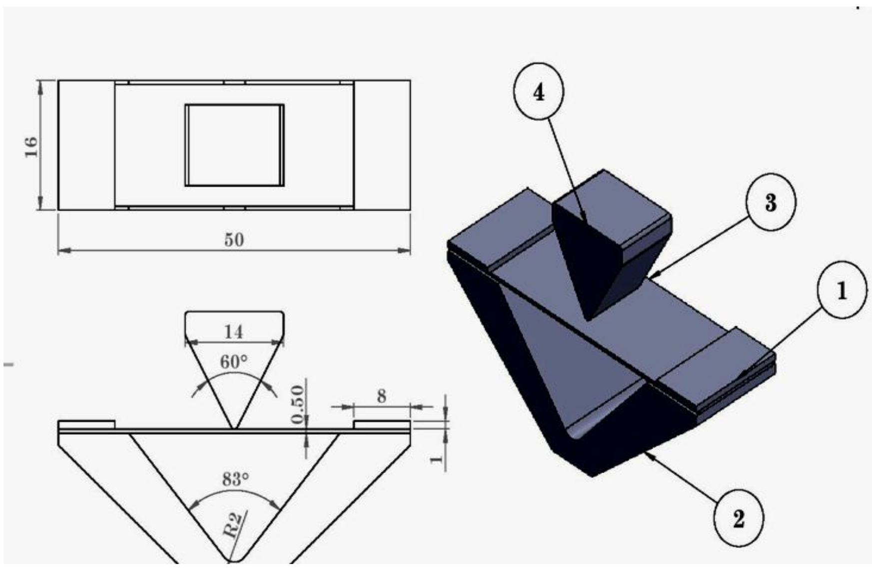

Figure 2: Geometry of 'V' Punch tool and Die

III. Material Properties

Material properties of sheet metal, punch tool and die are defined as given in below:

AiSi1020 steel, 1060 Aluminum alloy, Duranickel alloy, properties of these materials are described in table1.

Table 1: Properties of materials used

	AISI 1020 STEEL	Aluminium 1060 Alloy	Duranickle Alloy
Density	7900 kg/m3	2700 kg/m3	8200 kg/m3
Young's modulus	200000	69000	210000
Poisson ratio	0.29	0.33	0.34
Tensile yield strength	420.5 MPa	27.57 MPa	344.67 MPa
Tensile ultimate strength	351.57 MPa	68.93 MPa	620.42 MPa

IV. Sheet metal bending Analytical Calculations

- **Calculation for AISI 1020 Steel Material**

Calculation of bending force on sheet metal of thickness 0.5 mm, Bend Radius = 5 mm

Density of Material = 7900 Kg/m^3

Tensile Strength = 420.50 MPa

K= 1.33 for V die opening of 8 times thickness (8t)

Length of sheet metal plate = 50 mm

Width of plate W =15 mm

Thickness of plate t = 0.5 mm

Bending Radius R = 5 mm

To Find:- Calculate required bending force (F_b) = ?

Bending force (F_b) = $KLSt^2/4$

Bend Allowance, b= α(R+ Kt)

$$= 2\pi \times \frac{83}{360} \times (5 + 1.33\times0.5)$$

b = 5.96 mm

Total Length = L= 24.25+ 24.25 + 5.96

L= 54.46 mm

Bending Force, $(F_b) = \frac{K\times L \times S \times t^2}{4} = \frac{1.33 \times 54.46 \times 420.50 \times (0.5)^2}{4}$

$$F_b = 1903.59 \text{ N} = 1.9 \text{ KN}$$

- **Calculation of bending force if material is "Aluminium 1060 Alloy"**

Where

Length of sheet metal plate = 54.46 mm

Width of plate W =15 mm

Thickness of plate t = 0.5 mm

Bending Radius R = 5 mm

Bending force(F_b) = $KLSt^2/4$

F_b = 312.04 N = 0.312 KN

- **Calculation of bending force if material is "Duranickel Alloy"**

Length of sheet metal plate = 54.46 mm

Width of plate W =15 mm

Thickness of plate t = 0.5 mm

Bending Radius R = 5 mm

Bending force (F_b) = $KLSt^2/4$

F_b = 2808.63 N = 2.8 KN

The above numerical results are varied with the help of comparison of result FE analysis software.

V. Results and Analysis

The first doing the analysis setting and time setting find out the total deformation, directional deformation and equivalent stresses, reaction force for different materials. Click on solution to find particular solution i.e. click on stress then select intensity and equivalent stress. Then click on solve for generation of solution.

Figure shows the Analysis of Sheet metal bending variations.

- **Total Deformations**
  Figure shows the Total deformations of AISI1020 steel, 1060 Aluminum alloy, Duranickel alloy sheets using bend test.

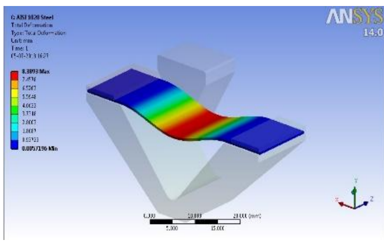

Figure 5: AISI 1020 Steel

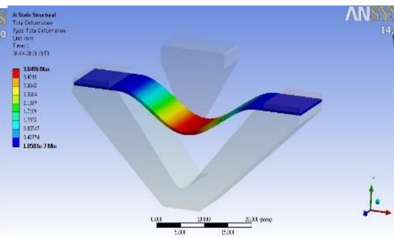

Figure 6: 1060 Al Alloy

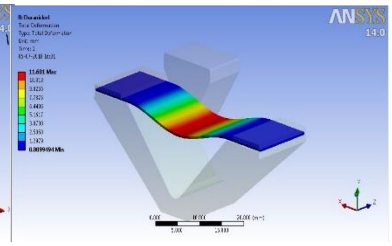

Figure 7: Duranickle Alloy

- **Equivalent Strain**
  Figure shows the Equivalent strains of AISI1020 steel, 1060 Aluminum alloy, Duranickel alloy sheets using bend test.

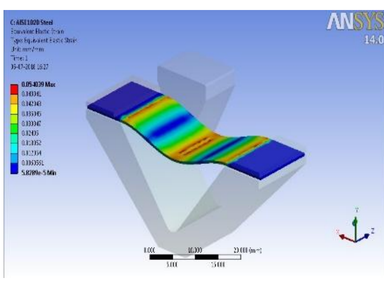

Figure 8: AISI 1020 Steel

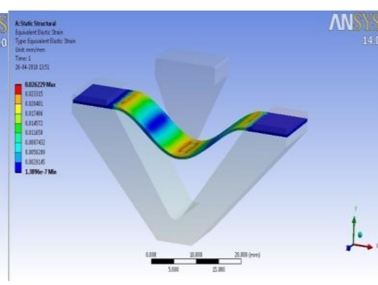

Figure 9: 1060 Al Alloy

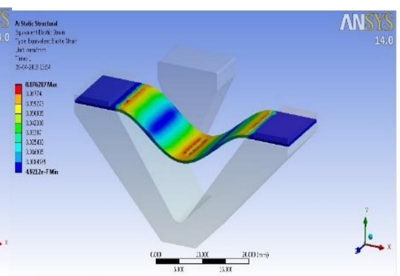

Figure 10: Duranickel alloy

- **Equivalent Stress**
  Figure shows the Equivalent stresses of AISI1020 steel, 1060 Aluminum alloy, Duranickel alloy sheets using bend test.

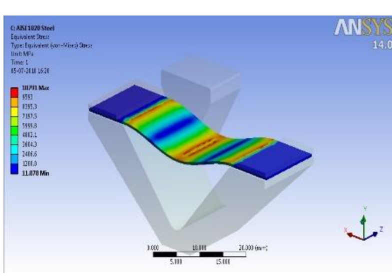

Figure 11: AISI 1020 Steel

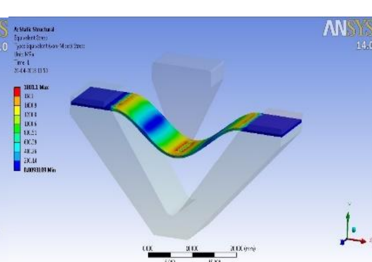

Figure 12: 1060 Al

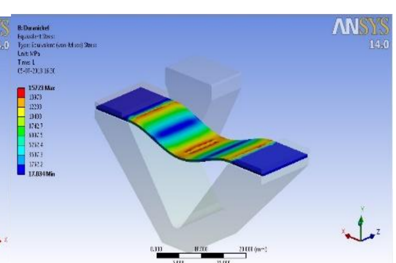

Figure 13: of Duranickel alloy

Table 2 shows the results of Total deformation, Bending forces, Equivalent strain, Equivalent stress and deformation

Table 2: Analysis Results of sheet metal bending analysis

Materials	Calculated Bending Forces (N)	Total Deformation mm	Equivalent Strain	Equivalent Stress (Mpa)
AISI 1020 STEEL	1903.59	8.38	0.054	10791
1060Aluminium Alloy	312.04	3.84	0.026	1801
Duranickel Alloy	2808.63	11.60	0.076	15723

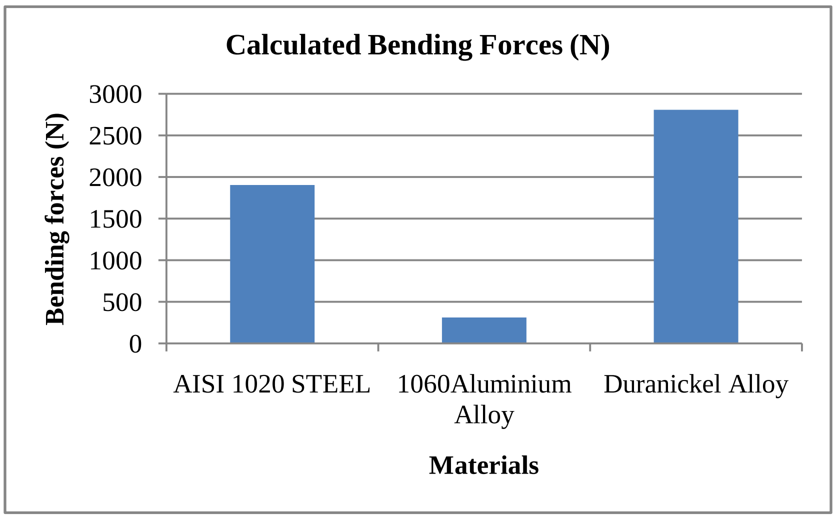

Figure 14: Comparison of bending forces

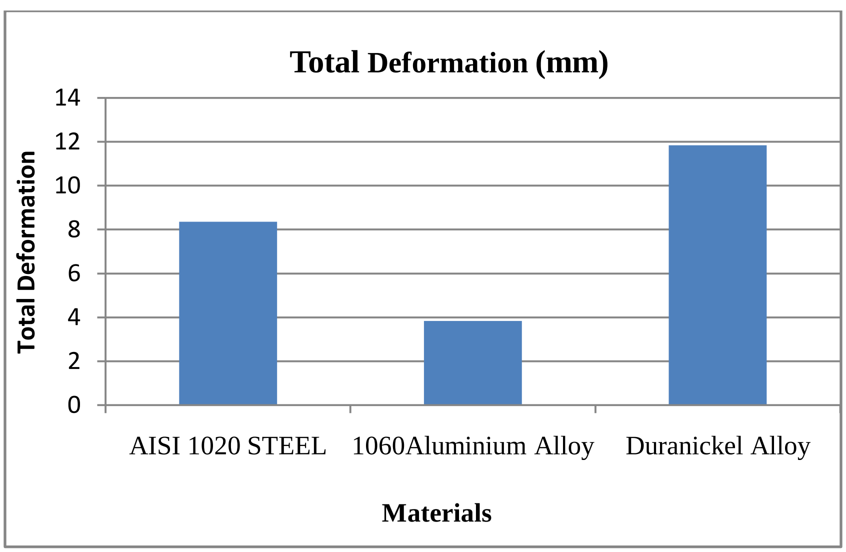

Figure 15: Comparison of Total deformations

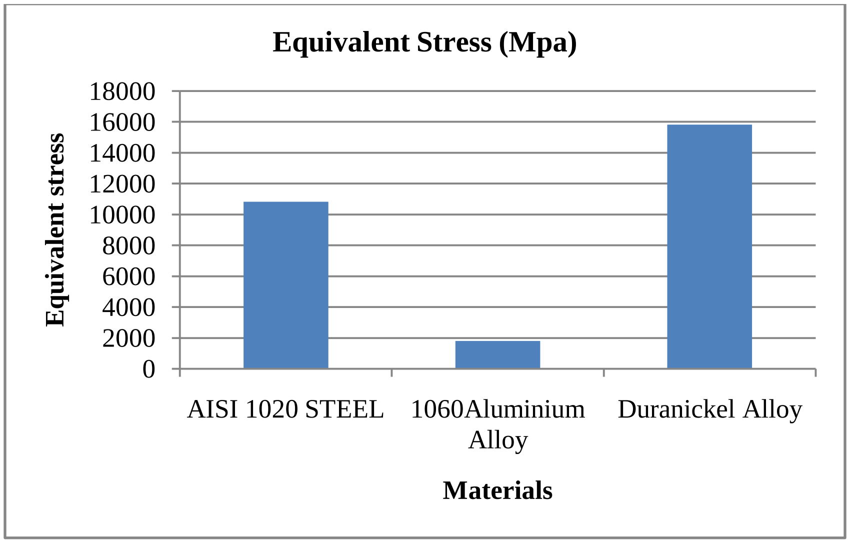

Figure 16: Comparison of Equivalent Stress

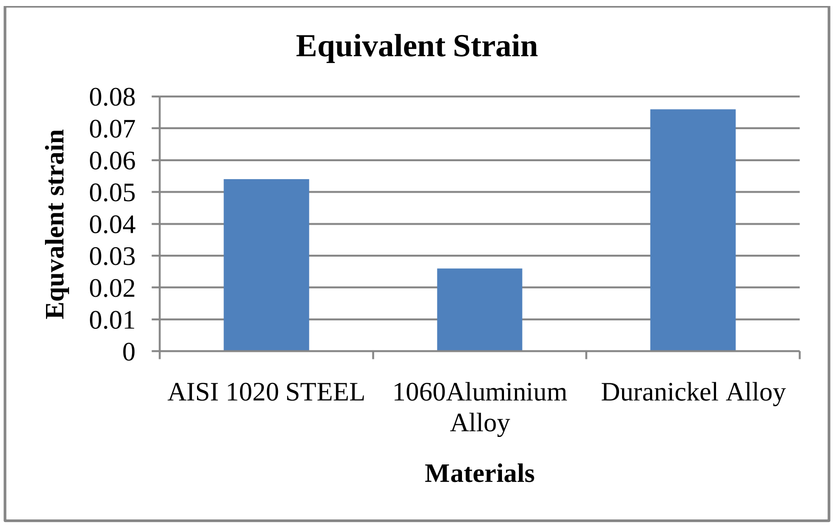

Figure 17: Comparison of Equivalent Strain

VI. Conclusion

The sheet metal bending assemblies is generated in Solidwork and this model is imported to ANSYS 15 for processing work. For different Non-linear materials like AISI1020 steel, 1060 Aluminum alloy, Duranickel alloy sheets using bend test. Bending force 1060 Al alloy is lower as compared to AISI 1020 Alloy and Duranickle alloy. Equivalent stress of 1060 Al alloy is minimum as compared to AISI 1020 Alloy and Duranickle alloy. We have analyses above result the Duranickle alloy Material are best for using sheet metal plate bending, Duranickle material having maximum strain at low value of load and it has a larger deformation that’s whyDuranickle material is best material as per comparison study.

References

1. GebremichaelTasew, Ajay Jaswal, "Development of single hydraulic cylinder operated sheet metal bending machine", International Research Journal of Engineering and Technology (IRJET), Volume 5, Issue 1, Jan 2018.
2. S. Saravanan, m. Saravanan, d. Jeyasimman, “study on effects of spring back on sheet metal bending using simulation methods”, International Journal of Mechanical and Production Engineering Research and Development (IJMPERD), Vol. 8, Issue 2, Apr 2018, 923-932.
3. Vinod LaxmanHattalli, Shivashankar R. Srivatsa, "Sheet Metal Forming Processes – Recent Technological Advances", ICAMA, Elsevier, 2016.
4. Akash Vinod Kodarkar, N. R. Jadho, "A Review Paper on Design for a Sheet Metal Die by CAE for Forming Analysis With various Process parameters", IJSRD - International Journal for Scientific Research & Development, Vol. 4, Issue 12, 2017.
5. C. S. Jadhav, P. S. Talmale, "Verification and Analysis of Stress-Strain Curve of Sheet Metal by using Three Roller Bending Machine", IJEDR, Volume 5, Issue 1, 2017.
6. İbrahim Karaağaç "The Evaluation of Process Parameters on Springback in V-bending Using the Flexforming Process", Materials Research. 20(5), 2017, 1291-1299.
7. NileemaB.Patil, Dr.SudarshanaBadhe, "Review of Finite Element Simulations in Sheet Metal Forming Processes", International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 05, May -2017.
8. Akinlabi, Esther Akinlabi, "Effect of Punch Stroke on Deformation During Sheet Forming Through Finite Element", Materials Science and Engineering, 225, 2017.
9. WiriyakornPhanitwong, UntikaBoochakul, SutasnThipprakmas, "Design of U-Geometry Parameters Using Statistical Analysis Techniques in the U-Bending Process", MDPI, metals journal, 2017.
10. A. W. Dametew, Tafesse Gebresenbet, "Numerical Investigation of Spring Back on Sheet Metal Bending Process", Global Journal of Researches in Engineering: A Mechanical and Mechanics Engineering, Volume 16, Issue 4, 2016.
11. G. Pradeep Dev, P. Sam Livingston, M. Shunmuganathan, “Analysis of 6061 Aluminium Alloy Sheet Metal Bending Process for Various Thickness Using Finite Element Modelling”, International Journal of Theoretical and Applied Mathematics, 2016, 93-99.
12. J. Cumin, I. Samardžić, L. Maglić, “statistical analysis of the v-tool bending process parameters in the bending of hc260y steel”, Metalurgija55,2016, 200-202.
13. Muhammad Ali Ablat, Ala Qattawi, "finite element analysis of origami-based sheet metal folding Process", Proceedings of the ASME 2016 International Mechanical Engineering Congress and Exposition , IMECE2016, 11-17, 2016.
14. Wei Li,Kai He, Jianyi Chen, "Research on Multi-punch Incremental Sheet Metal Bending Process", 6th International Conference on Advanced Design and Manufacturing Engineering, ICADME 2016.