ANALYSIS OF SHEET METAL BENDING ON ANSYS WITH THE USE OF DIFFERENT MATERIALS

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ABSTRACT:

The technique of sheet metal forming is well established and often used. It is essential for survival in the cutthroat manufacturing industry to reduce response times and costs, boost productivity, and raise the calibre of manufactured goods. Using finite element analysis as a simulation tool, we may examine how components, machinery, and structures operate under various loading conditions. An overview of regulating geometry and material nonlinearity has been provided in regard to constrained component reproduction of framing activities. This study describes the bending of sheets of AISI 1020 steel, 1060 aluminium alloy, and duranickel alloy using a bend test using a 'V' shape punch tool. The sheet metal strip experiences permanent distortion as a result of the severe plastic strain. One of the most important issues with the sheet metal bending process is the development of spring back during unloading. This study makes use of finite element analysis and design of experiments to examine the bending behaviour of sheet metal. Numerical simulations using parametric analysis are performed to study the elastoplasticbehaviour. The static mechanical behaviour of metal sheet is investigated for various materials to discover correlations. In order to implement the systematic procedure, a FEM analysis of sheet metal three-point bending is created.

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

I. Introduction

A variety of metallic components for cars, aircraft, buildings, and home appliances are created using deformation processing. This category comprises manufacturing processes that include moulding the material to a product's basic shape using plastics. Examples include forging, rolling, extrusion, sheet metal forming, and hydro forming. In a kind of deformation process known as sheet metal forming, blanks are shaped into the desired shape with a thickness that is much smaller than the other dimensions.Sheet metal forming includes bending, punching, drawing, stretching, and other processes. The best of multiple bending techniques is chosen to manufacture the sheet metal: V-die bending. Frequently occurring sheet metal forming failures include issues including puckering, wrinkling, and shape distortion. They are renowned for having a high thickness to surface area ratio. No one test can reliably forecast a material's formability under all conditions since sheet metal forming processes vary so much in terms of type, scope, and speed. specified processes need the work material's forming characteristics to fall within a specified range in order to be successfully completed. The effectiveness of forming operations as a whole is influenced by a variety of parameters, including stretching, elongation, anisotropy, grain size, and others. Another important factor that affects the creation of sheet metal is sheet metal anisotropy, or directionality. Anisotropy is obtained during the thermo-mechanical processing of the sheet. The formability of the same sheet metal might vary greatly in various worlds depending on the elements of the forming system. It's interesting to contrast this with a typical mechanical property of sheet metal, which depends just on the sheet metal and not on system elements such as sheet thickness, manufacturing circumstances, surface polish, and sheet metal characteristics, among others.

During the bending process, a force is applied to a sheet of metal, causing it to bend at an angle and take the desired form. The work item is first bent in an elastic zone. Plastic deformation causes the work item to become warped over time, changing its shape. Beyond its yield strength, the material has been stretched, but not quite to its maximum tensile strength. The bending process causes the sheet metal to be both squeezed and tensioned. The outside surface of the sheet is tensed and lengthens, while the inner surface is compressed and contracts. As you go closer to the sheet's centre, the tensile and compressive stresses decrease.

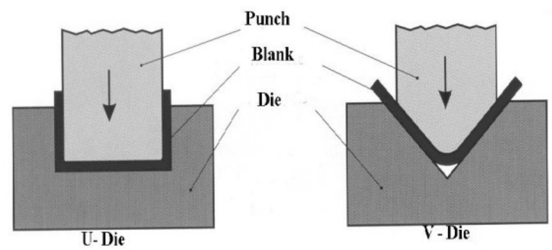
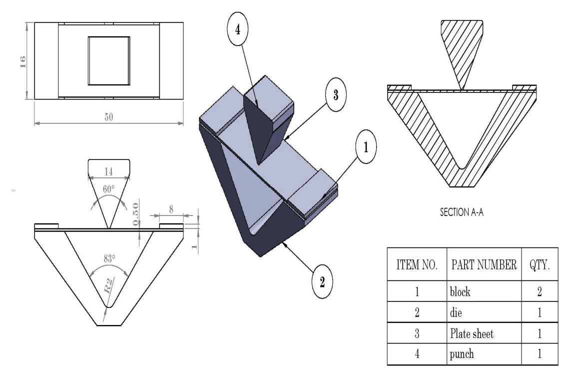


Fig 1: Sheet bending using U-die and V-die

II. Geometry of 'V' Punch tool and Die

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



ITEM NO.	PART NUMBER	QTY.
1	block	2
2	die	1
3	Plate sheet	1
4	punch	1

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

III. Material Properties

The following are the material qualities of sheet metal, punch tools, and dies:

The characteristics of AiSi1020 steel, 1060 Aluminum alloy, and Duranickel alloy are listed in table 1.

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. Modelling Geometry of Punch Tool and Die

The 'V' Punch tool, sheet metal, and die design configuration were modelled using Solidworks. Import the.igs file into Ansys next to assess the design geometry. The die component of the sheet metal bending assembly is fixed. The sheet metal plate is fastened using the die. The die is entirely constrained. In this work, transient structural analysis is used to determine the bending stresses in sheet metal plates. Figures display the nomenclature for sheet metal plate bending view assembly.

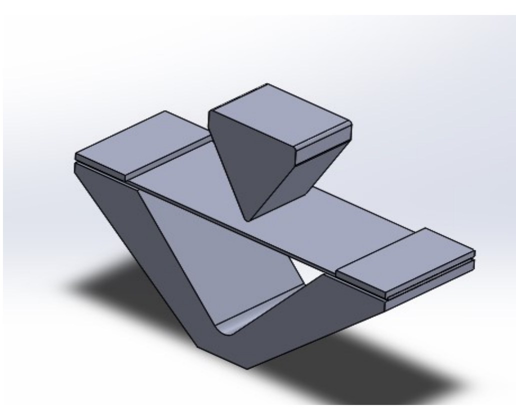


Fig 3: Sheet Metal Plate Bending View Assembly

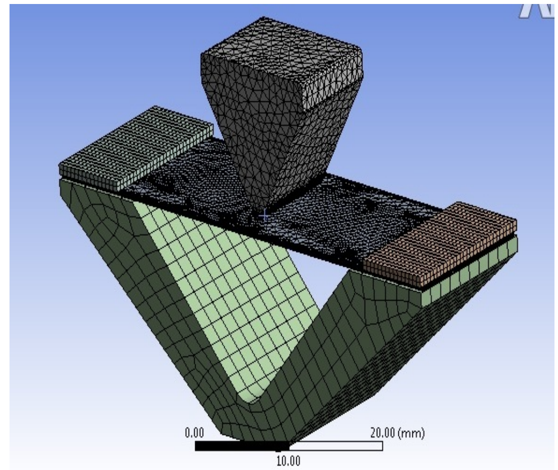


Fig 4: Meshed view Model of Sheet metal Assembly

V. Results and Analysis

Set up the analysis and timer to start calculating the reaction force, equivalent stresses, total deformation, and direction of deformation for different materials. Click on it, for instance, stress, and then choose intensity and similar stress to learn more about that response. Then, click on solve to provide a solution.
Figure shows the Analysis of Sheet metal bending variations.

- **Total Deformations**

  The figure shows the total deformations that resulted from applying the bend test to sheets made of AISI1020 steel, 1060 aluminium alloy, and duranickel alloy.

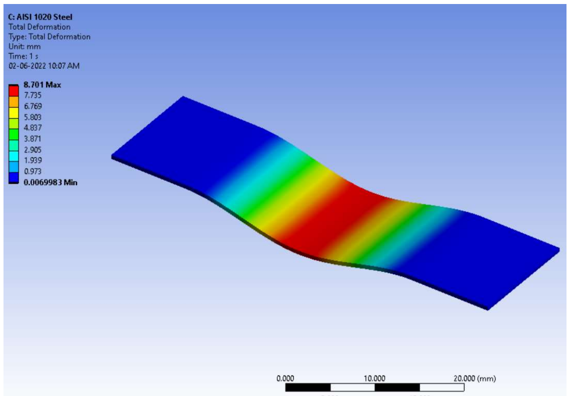


Fig 5: Total deformation of AISI 1020 Steel

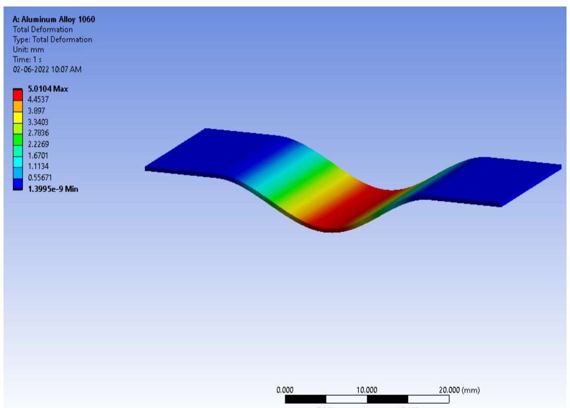


Fig 6: Total deformation of 1060 Al Alloy

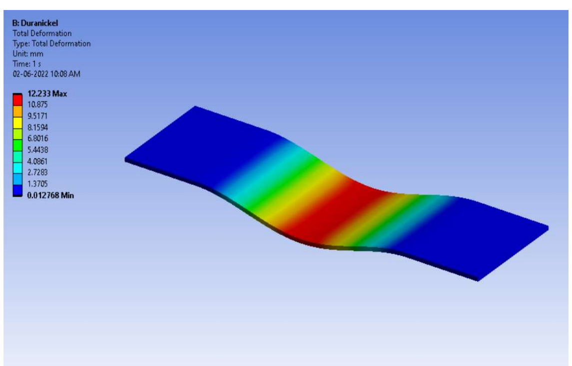


Fig 7: Total deformation of Duranickle Alloy

- **Equivalent Strain**

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

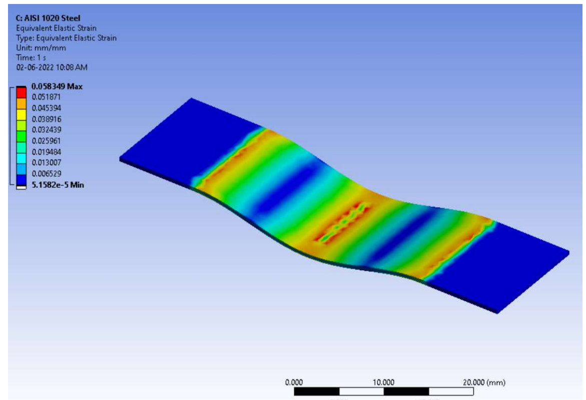


Fig 8: Equivalent strain of AISI 1020 Steel

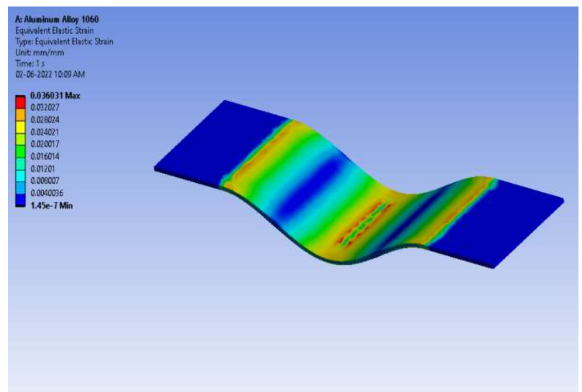


Fig 9: Equivalent strain of 1060 Al Alloy

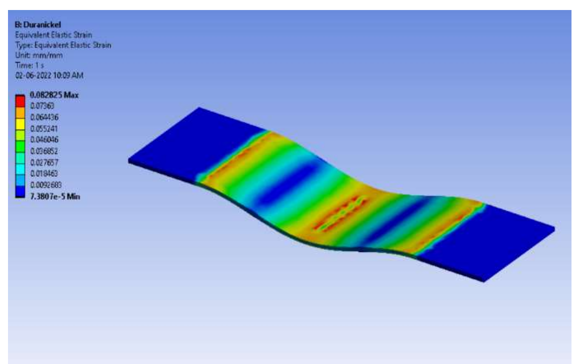


Fig 10: Equivalent strain of Duranickel alloy

- **Equivalent Stress**

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

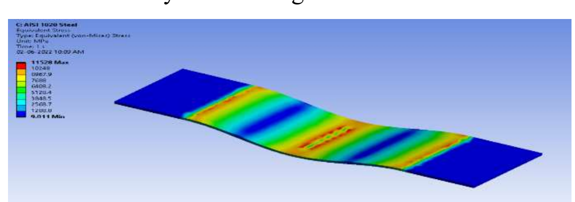


Fig 11: Equivalent stress of AISI 1020 Steel

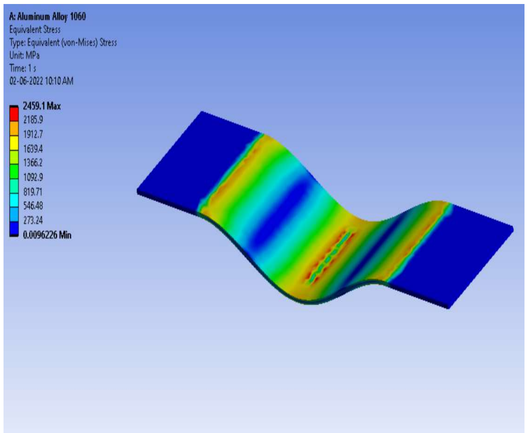


Fig 12: Equivalent stress of 1060 Al

Total deformation, Bending forces, Equivalent strain, Equivalent stress, and deformation findings are shown in Table 2.

Table 2: Analysis Results of sheet metal bending analysis

Materials	**Calculated Bending Forces (N)**	**Total Deformation mm**	**Equivalent Strain**	**Equivalent Stress (Mpa)**	**Directional Deformation mm**
AISI 1020 STEEL	1903.59	8.35	0.054	10822	0.00354
1060Aluminium Alloy	312.04	3.84	0.026	1801	0.00159
Duranickel Alloy	2808.63	11.84	0.076	15824	0.00547

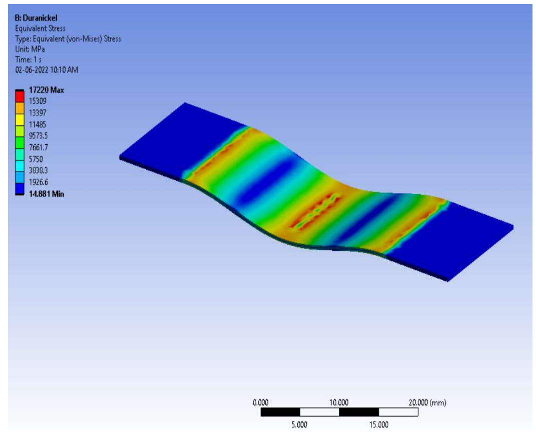


Fig 13: Equivalent stress of Duranickel alloy

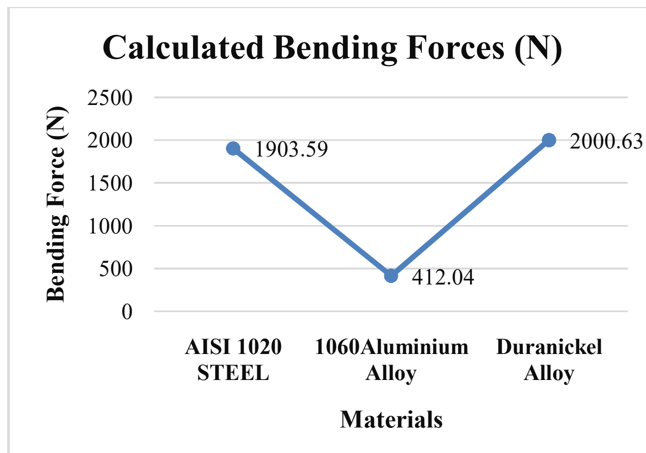


Fig 14: Comparison of bending forces

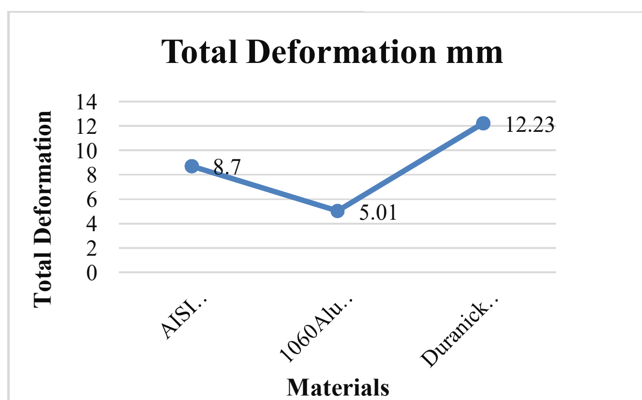


Fig 15: Comparison of Total deformations

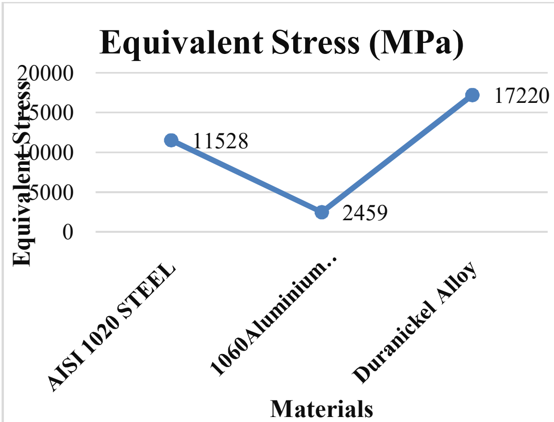


Fig 16: Comparison of Equivalent Stress

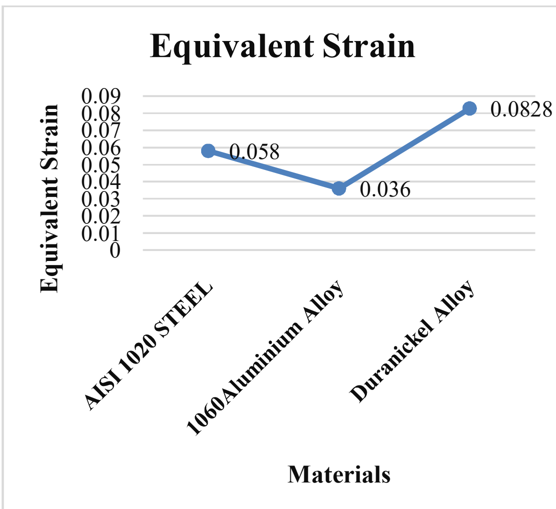


Fig 17: Comparison of Equivalent Strain

V. Conclusion

The transition zone variation criteria for V-shape bending are the main topic of this study for sheets and plates. Given a bending sheet, there are two distinct regions of deformation: one caused by punch loading and the other unaffected by punch loading. However, given our current understanding of bending sheets, we often overlook the fact that deformation areas cannot be changed into non-deformation areas. In our opinion, there is no distortion in the non-deformation zone, but there is a significant amount of distortion in the deformation region's breadth direction. The focus of this research is the region that exists between the deformation zone and the non-deformation zone. In the transition zone, distortion takes place, and its value changes slowly and with very tiny values rather of being constant or fluctuating with large values. In this research, I use finite element analysis to investigate the transition zone of bending sheets and plates in terms of location, interval, and distortion value. The ANSYS Finite Element application is used to simulate the bending of thin sheets and plates.

The sheet metal bending assembly's CAD model is made in Solidworks and then put into ANSYS 15 for processing. For a variety of non-linear materials, including AISI 1020 steel, 1060 aluminium alloy, and Duranickel alloy sheets, the bend test is utilized. The bending force of 1060 Al alloy is less than that of AISI 1020 Alloy and Duranickle Alloy. The equivalent stress of 1060 Al alloy is the lowest when compared to AISI 1020 Alloy and Duranickle alloy. The analysis of the Duranickle alloy has been done, and the findings are shown above. Duranickle material is the best material in a comparison study because it has the most deformation and the most strain at low load.

References

1. Khan Muhammad Idrees, Xi Chen (2022). Analysis on the Transition Zone of Deformation in Sheet & Plate Bending Processes While Using FEA. North American Academic Research, 5(3), 152-163, 2022. doi: https://doi.org/10.5281/zenodo.6383187.

2. Gavrilescu, I.; Boazu, D.; Stan, F. "Estimating of Bending Force and Curvature of the Bending Plate in a Three-Roller Bending System Using Finite Element Simulation and Analytical Modeling". Materials 2021, 14, 1204. https://doi.org/10.3390/ ma14051204.
3. 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.
4. 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.
5. VinodLaxmanHattalli, Shivashankar R. Srivatsa, "Sheet Metal Forming Processes – Recent Technological Advances", ICAMA, Elsevier, 2016.
6. AkashVinodKodarkar, 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.
7. 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.
8. İbrahim Karaağaç "The Evaluation of Process Parameters on Springback in V-bending Using the Flexforming Process", Materials Research. 20(5), 2017, 1291-1299.
9. 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.
10. Akinlabi, Esther Akinlabi, "Effect of Punch Stroke on Deformation During Sheet Forming Through Finite Element", Materials Science and Engineering, 225, 2017.
11. WiriyakornPhanitwong, UntikaBoochakul, SutasnThipprakmas, "Design of U-Geometry Parameters Using Statistical Analysis Techniques in the U-Bending Process", MDPI , metals journal, 2017.
12. A. W. Dametew, TafesseGebresenbet, "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.
13. 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.
14. 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.
15. Muhammad Ali Ablat, AlaQattawi, "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.

16. 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.