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Deep Drawing Analysis of Sheet Metal with Different Materials by Using Ansys

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Abstract: *The goal of this research is to identify the components that influence a drawing process and analyse it by adjusting the Die radius while maintaining the Friction, Punch radius, and Blank Thickness constant. Punches, blank thicknesses of the same geometry, and dies of varied geometries were designed in Solidworks software and analysed in ansys in this research. Also, using finite element analysis, the simulation influence of the major process variation, namely die radius, is investigated. The simulated findings were quite similar to the analytical model's results. The hydro forming deep drawing approach, according to finite element simulations, offers a more uniform thickness distribution than traditional deep drawing and reduces the danger of ripping throughout the operation.*
Various forms of load given to the punch tool, as well as optimal deformation and stresses in the metal sheet The materials utilised were structural steel, aluminium alloy, and magnesium alloy.
Keywords: *Deep drawing,FEM, Aluminum alloy, Magnesium alloy, Punch tool.*

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I. Introduction

Deep drawing is a process frequently used in the industrial sector for shaping sheet metal into cup or box-like structures under tensile and compressive pressures without affecting the sheet thickness of the sheet metal. Sheet metal deep drawing is used to create a wide range of goods, including cooking pots and pans, containers, sinks, and car components like panels and gas tanks. The formability of a blank during the deep drawing process is governed by process parameters such as blank holder force, lubrication, punch and die radius, die–punch clearance, as well as the mechanical properties and thickness of the sheet metal and the shape of the component. Deep drawing is a low-cost sheet metal shaping technology used in the fabrication of a wide range of industrial components. Complex geometrical drawn pieces, on the other hand, are difficult to make due to the many modes and conditions of the material flow. Wrinkling and tearing are two of the most typical problems associated with the forming process, and both have an influence on the cost and quality of the components. Due to the lack of theoretical techniques in the literature, the trial and error method is used to minimise or eliminate deep drawing mistakes, or inclusive is used in the early stages of the manufacturing process, resulting in higher costs and longer production times. The inquiry includes the use of previously published analytical methodologies, simulation utilising computer software based on the Finite Element Method (FEM), and experimental methods. The thickness profile on the flanges of a deep drawing component was measured before and after the approach was adopted, utilising data from the FEM model, simulation, and experiment. The results revealed that by combining both the analytical and FEM approaches, it was possible to establish the extent to which the sheet metal blank shape influenced minimising or removing the wrinkle defect, and that this knowledge could be used as a beneficial design tool.

II. Finite Element Analysis

The purpose of finite element analysis is to discover a simple solution to a difficult issue. Finite element analysis has shown to be an effective approach for solving a broad variety of engineering problems numerically. The area of study of dynamics, stability, fracture mechanics, heat flux, fluid flow, magnetic flux, seepage, and other flow issues includes deformation and stress analysis of automobile, aviation, building, defence, missile, and bridge structures. Complex issues may now be represented using relative cases thanks to advancements in computer technology and CAD systems. Before the first prototype is produced, many different configurations may be tested on a computer. The fundamentals of engineering must be understood in order toidealise a given structure for the desired behaviour. It is critical to have shown understanding of the usual issue area, modelling approaches, data transmission and integration, and computational components of the finite element method. The solution area in the finite element technique is made up of numerous tiny, linked subregions called finite elements.

III. Material Properties

Material properties of bending punch tool and die tool is described as given in below:
Die tool and metal sheet is made from Structural steel, Aluminum alloy and magnesium alloy, properties of these material are described in table 1.

Table 1: Properties of used Material

Material Properties	Aluminum Alloy	Structural Steel	Magnesium Alloy
Density	2770 kg/m^3	7850 kg/m^3	1800 kg/m^3
Youings Modulus	71000 Mpa	200000 Mpa	45000 Mpa
Poisson ratio	0.33	0.3	0.35
Tensile yield strength	280 Mpa	250 Mpa	193 Mpa
Tensile ultimate Strength	310 Mpa	460 Mpa	255 Mpa

IV. Modelling of Punch tool and Die

Figure show the design and geometry of punch tool and die and applied boundary conditions on it.

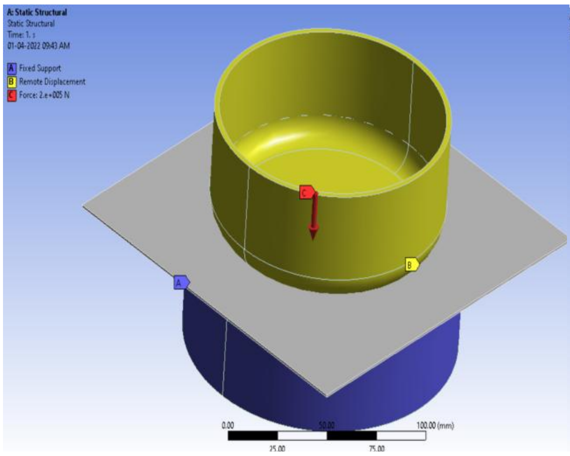

Figure 1: Deigned model of punch tool and die

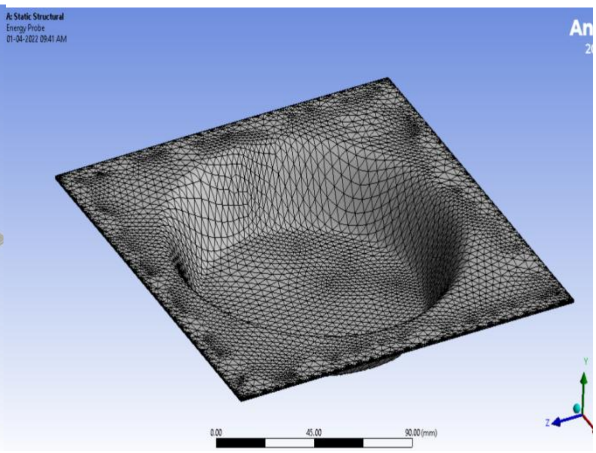

Figure 2: Meshed view of Punch tool and die

V. Results and Analysis

The sheet metal formation using deep drawing process is carried out in number of iterations. The formation of sheet metal along with resulting stresses is represented as shown in the following figures. Axisymmetric approach is used to analyze the deep drawing process of sheet metal formation with contact elements between punch, sheet metal interface and sheet metal and die interface. Displacement convergence is used to simulate the problem. The simulation is carried out with number of steps for better convergence of the problem for deflection, stresses and contact pressure.

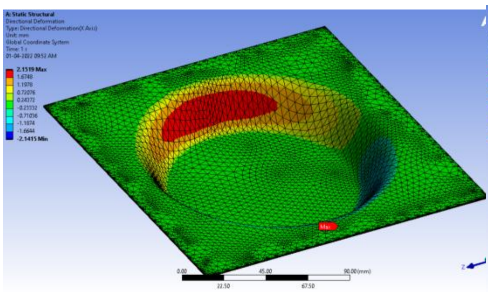

Figure 3: Directional deformation of Aluminium alloy

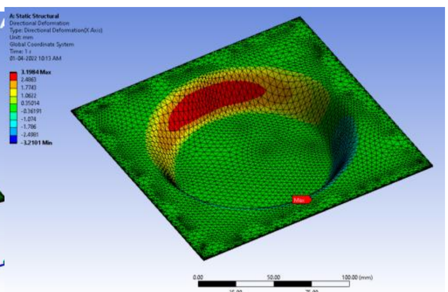

Figure 4: Directional deformation of Magnesium Alloy

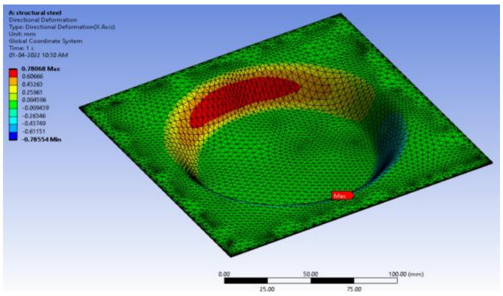

Figure5: Directional deformation of Structural steel

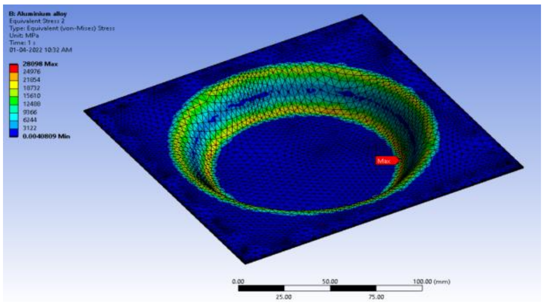

Figure 6: Equivalent stress of Aluminum alloy

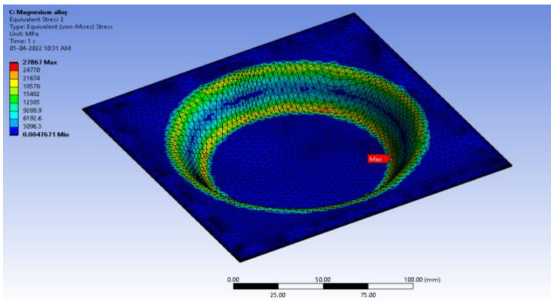

Figure 7: Equivalent stress of Magnesium Alloy

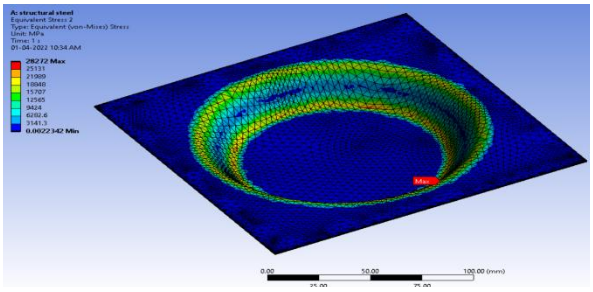

Figure 8: Equivalent stress of Structural steel

As per above study The figures 9to 11 shows slow deformation process of sheet metal with the punch movement. From figure shows equivalent stress generated in sheet metal. Results of materials used to design punch and die tool are described below.

Table 2: Results of Structural Steel with respect to various loads

Forces	Structural Steel		
	Equivalent Stress	**Total deformation (mm)**	**Directional deformation (mm)**
200 KN	28272	23.31	0.78
225 KN	32691.75	27.31	0.914
250 KN	36324.17	30.34	1.016
275 KN	39956.59	33.38	1.117
300 KN	43589.01	36.41	1.219

Table 3: Table: Results of Aluminum Alloy with respect to various loads

Forces	Aluminum Alloy		
	Equivalent Stress	**Total deformation (mm)**	**Directional Deformation(mm)**
200 KN	28098	59.47	2.15
225 KN	32047.69	69.69	2.42
250 KN	35608.49	77.43	2.68
275 KN	39169.34	85.17	2.95
300 KN	42730.19	92.92	3.22

Table 4: Table: Results of Magnesium Alloy with respect to various loads

Forces	**Magnesium Alloy**		
	Equivalent Stress	**Total Deformation (mm)**	**Directional Deformation (mm)**
200 KN	27867	90.59	3.19
225 KN	31970.52	106.19	3.71
250 KN	35522.8	117.98	4.13
275 KN	39075.08	129.78	4.54
300 KN	42627.36	141.58	4.95

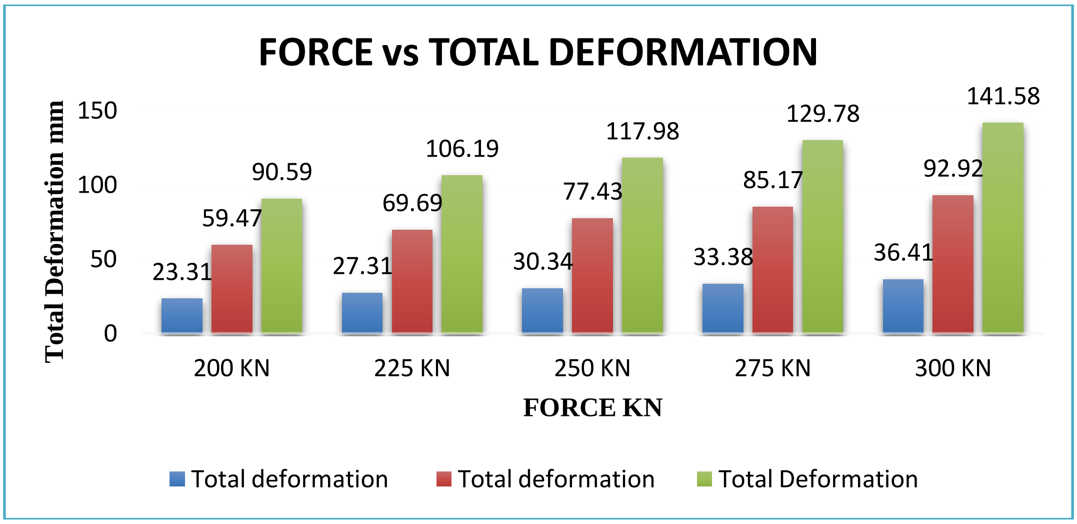

Figure 9: Comparison between Forces and Total deformation

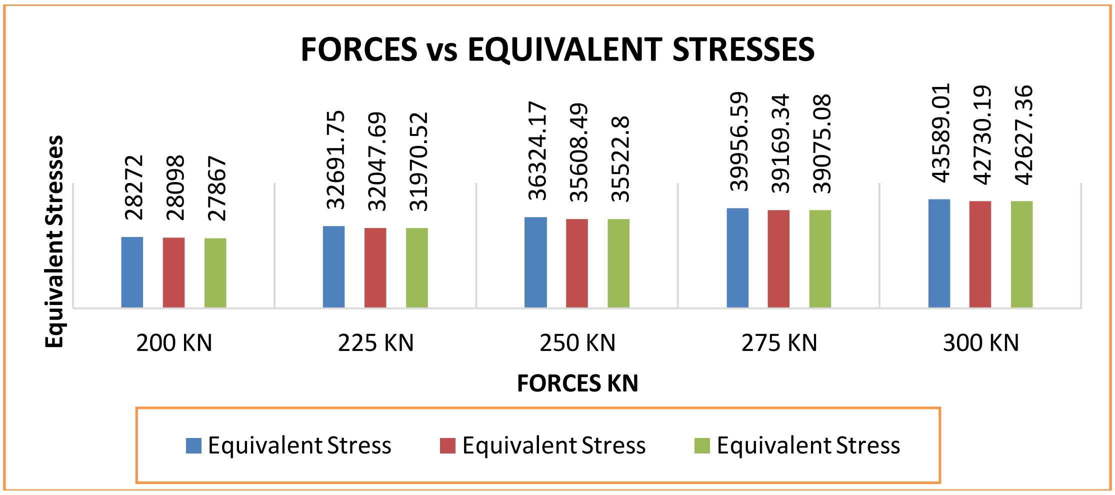

Figure10: Comparison between Forces and Equivalent Stresses

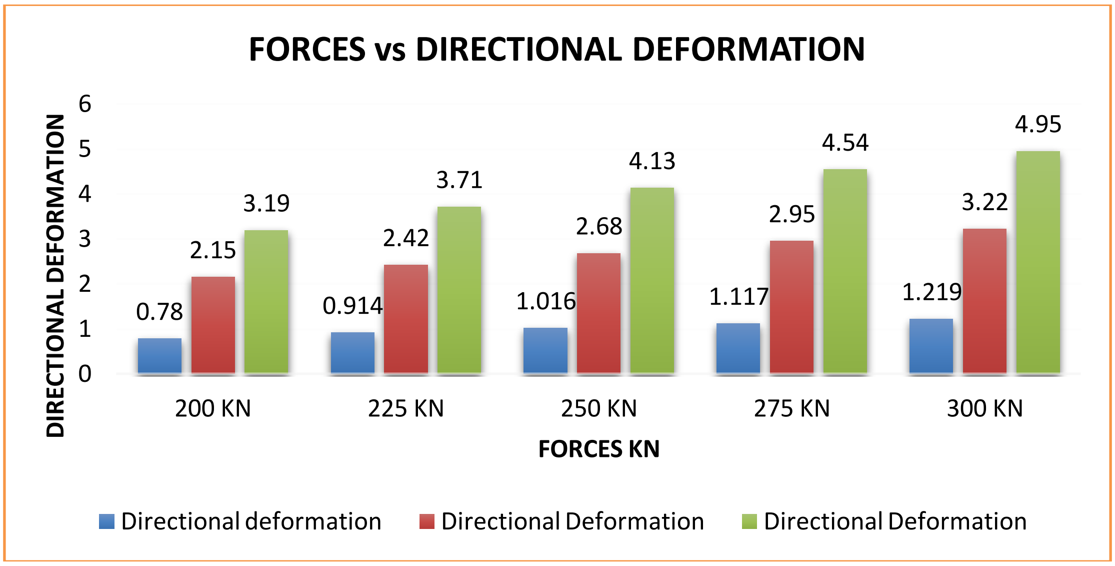

Figure11: Comparison between Forces and directional deformation

VI. Conclusion

The deep drawing forming process is simulated using Finite element software, and an analysis is done to calculate the load requirements when the deep drawing forming process is increased. A summary of the results is provided below. The punch, sheet, and fixed die are initially modelled in accordance with the specifications. Because of its plastic properties, the element may have a significant deflection influence. Sheet metal forming load requirements have been studied. The results show that as the depth of the drawing process increases, so do the load requirements. A finite element simulation may be used to determine areas of thinning and potential failure sites. High-stress zones are the most likely to fail. Finite element simulation assists in the avoidance of prototype fabrication as well as the verification of necessary load calculations.

According to the study, magnesium alloy deforms more than other materials, but structural steel deforms less than other materials. In addition, structural steel has a larger equivalent stress than other materials. As a consequence, high deformation materials are used in the deep drawing process, which is why magnesium alloy is the best deep drawing material. It is also less stressed than other materials.

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