A Review of finite Element Analysis For Deep Drawing Process

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Abstract- *Deep drawing is a method of shaping sheet metal in which a punch is used to pull a sheet metal blank from the outside into a forming die. As a result, it is a process in which the shape changes but the material remains constant. The process is known as "deep drawing" when the depth of the drawn part is higher than its diameter. This is accomplished by passing the part through a sequence of dies that alter its shape. There is a radial drawing stress and a tangential compressive stress in the flange area due to the material retention feature. This is the location of the sheet metal in the die shoulder area. Compressive stresses (also known as "hoop stresses") generate flange wrinkles (wrinkles of the first order). Wrinkles can be avoided by using a blank holder, whose purpose it is to help control the flow of material into the radius of the die.*

The entire drawing load is made up of the ideal forming load plus an extra component to account for friction where the flanges touch and bending and unbending forces at the die radius. The forming load is transferred from the punch radius to the deformation region via the drawn portion wall (sheet metal flange).

I. INTRODUCTION

The global demand for metal containers is currently at 410 billion units per year. There are 320 billion drink cans and 75 billion food cans. As is generally known, the cost of processed metal accounts for between 50 and 70 percent of the entire cost of the majority of food and drink containers. From the manufacturer's perspective, a reduction in material consumption is essential to cost reductions. The amount of material needed can be reduced by reducing the wall thickness of the containers while keeping adequate strength to allow the container to perform as intended without danger of failure. The designer must determine what material specs and attributes are appropriate for the food or drink being packaged, in addition to achieving these requirements. Traditionally, this approach, like the bulk of metal forming procedures, has been evaluated empirically or by trial-and-error techniques. Because dies, blank holders, and punches must be created, these processes are expensive and time-consuming.

In the wall of the drawn part that is touching the punch, there is no hoop strain, so the plane strain condition is met. In reality, most of the time the strain condition is just about flat. Due to tensile forces acting on the part wall, there is a lot of wall thinning, which makes the thickness of the part wall uneven. The part wall thickness is thinnest at the punch radius, where the part wall loses contact with the punch.

Predictions about the punch force, blank holder force, thickness distribution in different sections of the metal, and lubrication requirements can be made using finite element analysis and statistical approaches. This allows engineers to respond more swiftly to market changes and can significantly reduce production costs. It also allows for the production of superior containers in less time. This allows us to learn more about how different materials interact at their contact points, as well as how to deal with specific materials, which is equally beneficial.

II. LITERATURE REVIEW

Iordan, I Li et. al. (2015) Common shapes for aviation sheet metal structures include square cups with a circular arc at the bottom. Aluminum alloy plates are utilized for deep drawing of this form of rectangular cup, which results in a substantially thinner wall thickness around the bottom circular arc. In this research, locally thickened plates were employed for deep drawing aluminum alloy rectangular cups with a short radius at the bottom circular arc.

Chen, D. C et. al. (2019) The final profile shape of a sheet steel geometry was confirmed using behavior numerical simulations, as was the deep drawing method. ANSYS software turned into employed to evaluate sheet metal forming designs. Due to the symmetry of the geometry and the loading scenarios, a nonlinear dynamic specific numerical model was developed using two separate designs: a three-dimensional quarter model and a two-dimensional axisymmetric finite detail model.

Chandraet. Al. (2017) Find the best clean form design that allows for consistent trimming of the flange on cups of arbitrary shape (cups without ears). As a result of the sheet's planar anisotropy and non-uniform material glide, it develops a flange (or earing) that is not uniform in thickness. Drawing is a sheet metal forming technique used to create a one-of-a-kind, field-fashioned, and intricately curved and concave cup; it has been assessed that this method is most effective in a global context during mass manufacturing.

Reddy, P. V., et. Al. (2016) The problem of making a round cup out of a thin plate without a clean holder was investigated, and a novel method for deep drawing was offered as a solution. Punch, die, and die-punch all make up what is called the "die meeting" in this technique. Using DEFORM, a 2D axisymmetric finite element model turned into created. Researchers looked at how the clearance ratio between the punch and the die (die-punch) affected the load, thickness distribution, and stress distribution during cup wrinkling, as well as the influence of die geometry (half-cone angle).

U. Haribabuet. Al. (2018) the deep drawing method for sheet metal and shape optimization for such components using finite element analysis were briefly discussed. Throughout the development of the plan, simulation-based design techniques were used. A thorough method simulation and optimization were performed within the parameters of the current inquiry utilizing the same strategy. In order to quantify the strain and stress that each unique forming technique contributed to the final product, this study used computer simulations of the numerous forming procedures.

A. S., Abdelmaguidet. Al. (2007) performing finite element analysis on sheet metal fabrications prior to deep drawing in flywheel manufacture. metal sheet for deep drawing: stress-pressure and anisotropic conduct, In order to reap the advantages of deep drawing, it is required to examine the strain-pressure and anisotropy behavior of the target sheet metal. Various tests were conducted to test this behavior, using a brass or aluminum pattern as a specimen and a bi-axial tester.

K. M. Krishna et. Al. (2014) An analysis of the deep drawing process using different punch and die geometries. This painting provides a study of the depths of deep drawing simulations and finite element analysis (FEA). The obtained result enables the identification of excellent draw ratios in deep drawing.

Atal et. Al .(2013) By simulating followed by evaluation using a finite detail approach, it is possible to investigate to investigate typical problems encountered in deep drawing systems, such as wrinkling and fracture, and to determine how sensitive these problems are to changes in input parameters. Otherwise, it would be necessary to conduct exquisite sensible experimentation, which is an expensive and time-consuming process.

III. THE DEEP DRAWING PROCESS

Deep drawing is the process of forcing a round piece of sheet metal, known as a "blank," through a hollow chamber, known as a "die," with a normal amount of force from a "punch," to form a hollow shell. You can regulate and direct the flow of blank material by applying force to the blank holder (BHF). Figure 1 shows the key components of the deep drawing process.

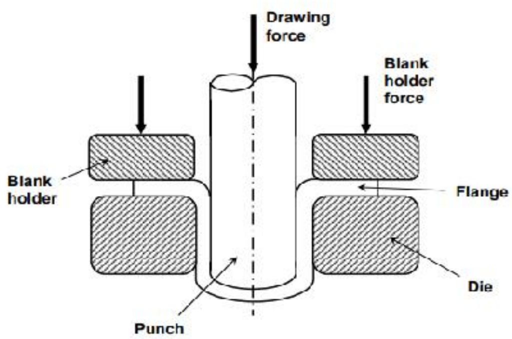

Figure 1 Elements of the deep drawing process

In the radial direction, the blank is stressed by pulling, and in the tangential direction, it is stressed by pushing. Controlling these stresses, as well as the applied load and the contact between the blank and the die or punch, is necessary to avoid failure, which can happen in three main ways.

In deep drawing, there are three main ways that the process can go wrong: wrinkling, cracking, and earing. When the blank holder force is low, wrinkles form in the flange part before the metal flows into the die. Because of this, the compressive stresses can be stronger than the pressure of the blank holder and cause buckling, which looks like wrinkles.

Finite Element Analysis

The finite detail method arose from study into space systems. However, because this theory is so generic, it may be applied to solve a wide range of boundary fee problems in engineering. When there are boundary criteria that must be met in a body problem, individuals look for a solution inside that area or region. This is known as a price boundary headache.

For static wing evaluation, rocket and missile structure assessment, dynamic analysis, and reaction to random and periodic masses in aviation systems, the finite detail technique is the ideal instrument. In the disciplines of stress awareness, pressure analysis of stress vessels, and dynamic analysis of mechanical links, the finite detail technique may be useful in the mechanical design process.

The finite element approach is used specifically for the three most prevalent forms of boundary value problems: propagation (or short) problems, Eigen value problems, and equilibrium of regular kingdom (or time independent) problems. It is demonstrated in equilibrium that the distribution of displacement or strain in a solid mechanics problem is the same over the whole problem space. By calculating the heat transfer coefficient, it may be able to obtain a temperature or heat flow distribution that is consistent across the country. Static mechanics and structural concerns are employed to determine mode shapes, buckling masses, and plant frequencies. The equilibrium of laminar flows can be found if the problem is in fluid mechanics, and the characteristics of a resonant circuit can be found if the problem is in electrical. The way the body responds to a constant force over time in propagation or transient situations is extremely close to stable mechanics.

The finite detail method has demonstrated its worth in civil engineering for static analysis of trusses, frames, and bridges. The main purpose of the dynamic investigation is to establish the structure's inherent frequencies, modes, and responses to periodic masses. The finite element technique is used in nuclear engineering to characterize the static and dynamic behavior of its components, such as containment structures, dynamic reactor aspect containment systems, and nuclear pressure vessels. To study the effect on skulls, a finite detail method, which is also used in biomedical engineering, is used. The finite detail technique can be applied in the broader issue of geomechanics, which includes excavations, underground openings, and dynamic assessments of dam reservoir structures.

IV. CONCLUSION

The research community is becoming interested in employing various optimization techniques to improve the deep drawing process. Optimization techniques provide a systematic procedure for determining the process parameters required to achieve a certain goal. Due to the complexity of the deep drawing process, closed form equations based on theoretical investigation may be difficult to manage using traditional mathematical programming techniques or may be unsuitable for practical applications. Most research on the optimization of the deep drawing process work uses either experimental or finite element modeling to verify the proposed optimization technique.

Based on the process parameters considered in the optimization of the deep drawing process, five key subjects of research are identified. The initial line of research focuses on the optimization of blank holder force in order to prevent wrinkling and breakage. The second line focuses on the deep drawing blank holder mechanism's design parameters, which comprise the die, punch, and blank holder. The third research line is concerned with locating the appropriate blank shape. The lubrication system and type of lubricant are examined in the fourth line. Lubrication is a vital part of the deep drawing process since it helps to reduce the amount of energy required and prevents breakage.

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