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Structural Analysis of Vee-Cap Sheet Metal Component

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Abstract: *In this work, analysis of draw component i.e Vee-Cap used in AC motor and other machines is carried out. 3D modeling of the draw component is carried out in Solid Works software. ANSYS 16 is employed for the structural analysis of the sheet metal component considered for present study. Angles $0^0$and 3^0 at the corner of the draw angle are considered for analysis of the component in order to check the stress distribution at the bottom fillet, which is the most critical part of the component. The displacement of the component is also analyzed to check the plastic strain behavior of the component. From the structural analysis it is clear that the von-mises stress distribution is maximum at 0^0 and reduced for 3^0. Whereas, for displacement and plastic strain of the component reduces by increasing the clearance angle from $0^0$to 3^0.*

Keywords: *Vee-Cap, Plastic Strain, von-mises, Displacement, Sheet Metal*

I. Introduction

Design and development of Progressive tools for the sheet metal component is one important phase in sheet metal manufacturing. Sheet metal press working process by progressive tools is a highly complex process that is vulnerable to various uncertainties such as variation in progressive tools geometry, strip layout, die shear, material properties, component and press working equipment position error and process parameters related to its manufacturer. These uncertainties in combinations can induce heavy manufacturing losses through premature die failure, final part geometric distortion and production risk [10-12]. All station work simultaneously at different points along the work strip, which advances on station at each stroke of ram. Thus a complete part is produced with each stroke. Progressive dies generally include blanking and piercing operations but a complicated progressive die can do the operation of bending, forming, curling and heading also .Each workstation performs one or more distinct die operation, but the scrip must move from the first through each succeeding station to produce a complete part .One or more idle station may be incorporated in the die ,not to perform work on the metal but to locate the strip, to facilitate inter station strip travel, to provide maximum size die sections or to simplify their construction [13-14].

II. Literature Review

Murat Tahir Altinbalik et al., used progressive dies that have amount of advantage especially for mass production for comparing conventional deep drawing processes. Progressive dies, which needs have experience to be designed can be easily machined with new developed CAD-CAM technologies, and a progressive die designed for a certain part, which is used in building sector and then manufactured. A commercial steel sheet was chosen as a test material which in widespread used in automotive and kitchenware industry [1–3]. Progressive draw dies provides 4 times more production compared to conventional deep drawing dies. Thus, they are better in terms of energy consumption and workmanship cost. A design of compound die by combining the blanking, piercing, drawing operation [4–6]. Compound die design is applied to dies in which two or more cutting operations, typically piercing, blanking and drawing are performed. In the same single station and completed during the single press cycle.

As we have seen from the literature review, it becomes clear for us that a lot of work is carried out in sheet metal stamping of bending and forming shapes [7]. Even, though these tools are employed for draw operation, but no work is reported on draw operations of Vee-Cap component due its complexity. Hence we are motivated from this fact and we are using Vee-Cap component for analysis using commercial code ANSYS 16 software package which takes huge time to obtain the results as reported in earlier work [8,9].

III. Model of THE Component

The modeling of Vee-CAP component is modeled by using Solid Edge v19 and structural analysis using ANSYS 16. The component is shown in Figure 1.

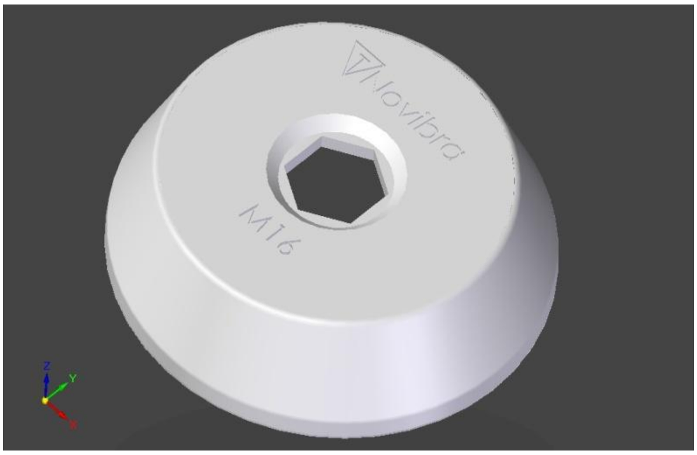

Figure 1: Model of Component (Vee-CAP)

Novibra RA and EF uses the rubber profile in shear and compression, obtaining good vertical flexibility with the advantage of horizontal stability. For normal speeds of approx. 1500 rpm, the Novibra RA and EF type provides a degree of isolation of 75% - 85%. For better isolation, the alternative Novibra RAEM or Novibra M can be chosen. Fitted as standard with an integral fail-safe design device with resilient stop, making Novibra RA and EF ideal for use in mobile or marine applications. The Novibra RA/EF mounts can accommodate occasional shock loads to 5 g reference to the weight in hardness 60 degree IRH. The mount will withstand shock loads up to 2 g without plastic deformation. Material is High Carbon steel (non-linear material) with thickness of component 3 mm, young's modulus 210000 MPa, yield stress 346 MPa, Ultimate stress 620 MPa and density 7850 kg/m^3. Analysis is performed on the component which is using the non-linear materials and for various angles of clearance of component as shown below in Figure 2.

IV. Results And Discussions

The structural and thermal combined analysis of the Vee-Cap component is presented in this section. Figure 3 shows displacement distribution of component. It is observed that the maximum displacement developed is 8.33mm at bottom fillet at zero deg clearance. Figure 4 shows Von-Mises Stress distribution of component. It is observed that the maximum Von-Mises Stress developed is 350 MPa at bottom fillet region at zero deg clearance. Figure 5 shows Plastic strain distribution of component. It is observed that the maximum Plastic strain developed is 1.75% at bottom fillet at zero deg clearance. Figure 6 shows displacement distribution of component. It is observed that the maximum displacement developed is 6.85mm at bottom fillet at 3 deg clearance which is less than zero deg clearance. Figure 7 shows Von-Mises Stress distribution of component. It is observed that the maximum Von-Mises Stress developed is 287 MPa at bottom fillet region at 3 deg which is less than zero deg clearance. Figure 8 shows Plastic strain distribution of component. It is observed that the maximum Plastic strain developed is 1.44% at bottom fillet at 3 deg which is less than zero deg clearance.

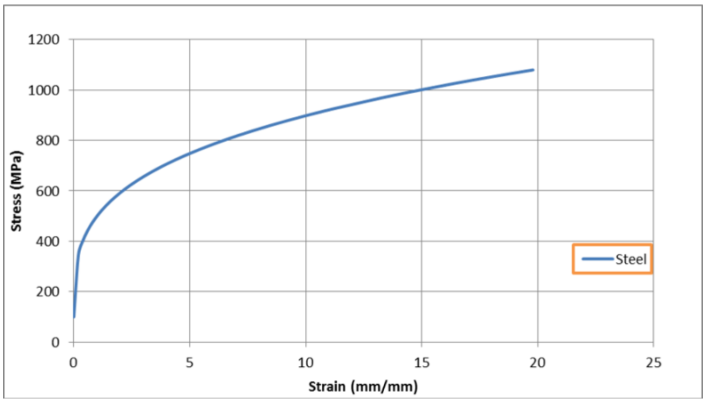

Figure 2: Non-linear material properties considered for the analysis

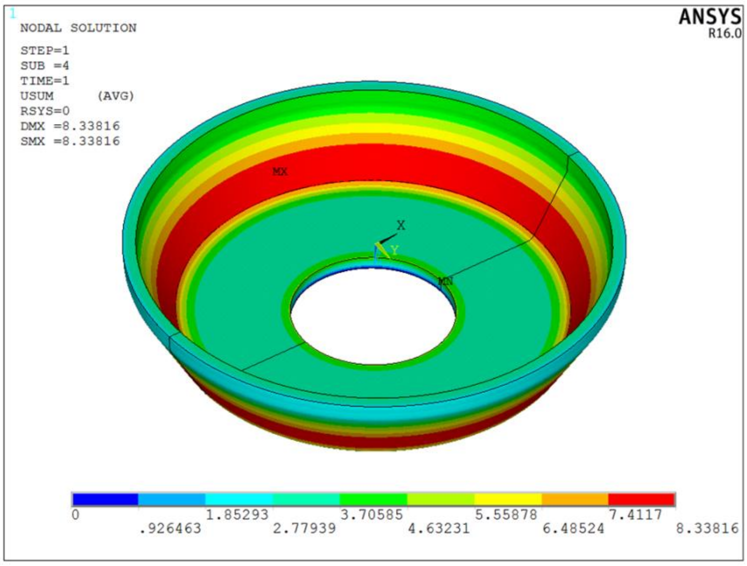

Figure 3: Displacement distribution of component at zero deg

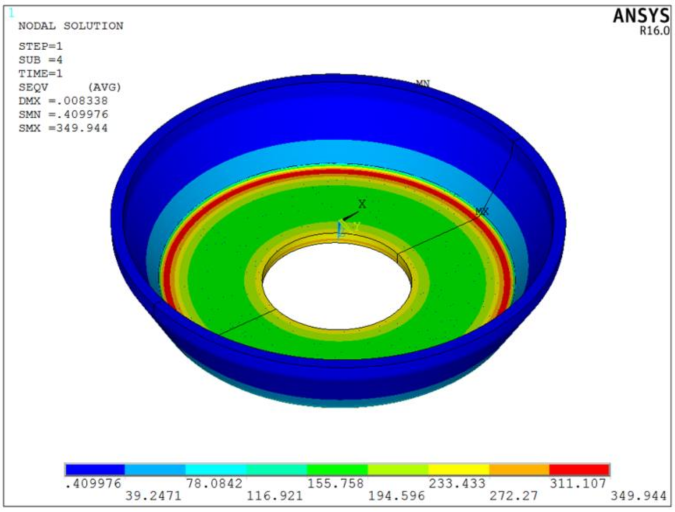

Figure 4: Von-Mises Stress distribution on component at zero deg.

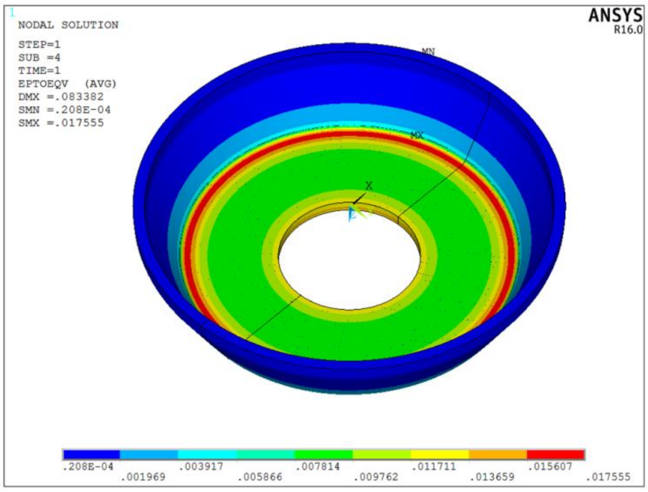

Figure 5: Plastic strain distribution on component at zero deg.

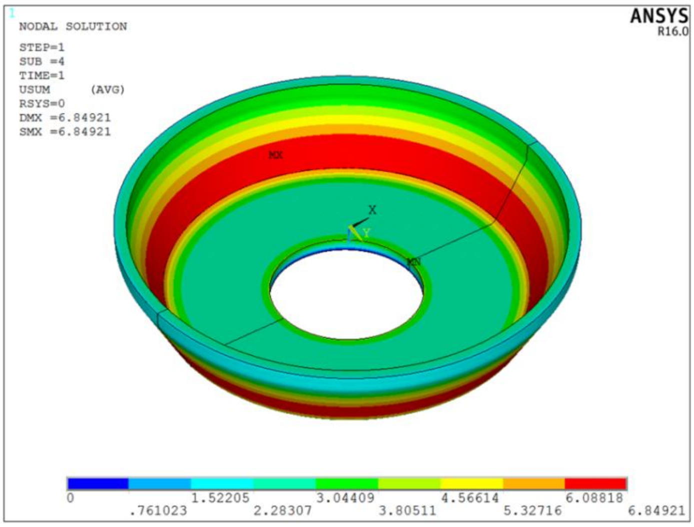

Figure 6: Displacement distribution of component at 3 deg

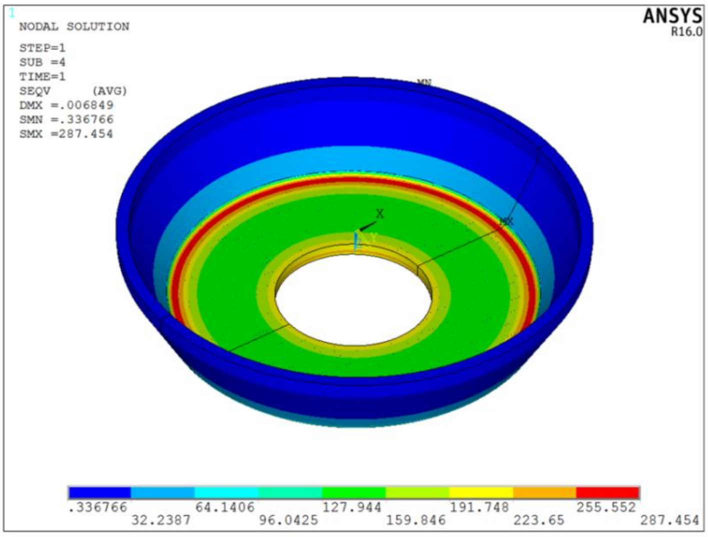

Figure 7: Von-Mises Stress distribution on component at 3 deg.

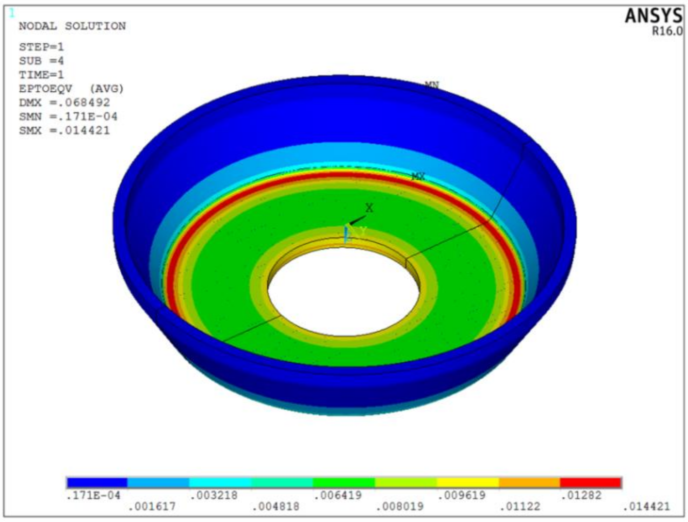

Figure 8: Plastic strain distribution on component at 3 deg.

V. Conclusion

From the Analysis we observed that, increasing the clearance angle the Von-Mises Stress distribution and plastic strain are reduced for the component. The induced plastic strain is more for zero deg clearance die i.e. 1.81% shows that, component is failing due to excessive plastic deformation. The displacement of the component is also analyzed to check the plastic strain behavior of the component. From the structural analysis it is clear that the von-mises stress distribution sis maximum at 0^0 and reduced for 3^0. Whereas, for displacement and plastic strain of the component reduces by increasing the clearance angle from $0^0$to 3^0.

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