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Analysis of Von Mises Stress and Equivalent Plastic Strain of Different Materials in Deep Drawing Process Using Abaqus

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ABSTRACT

The aim of this analysis is to determine the Von- mises stress and equivalent plastic strain of the materials AA2060, C95510, and C95900. Due to energy savings in the sheet metal forming industry, demand for lightweight materials is growing. Structured sheet metal is a sturdy and lightweight material. However, for the forming phase, the deepdrawingprocesslimitsforformedsheetmetalsshouldbe investigated. For the simulation method, ABAQUS 6.14 is used. It aids in the solution of complex computational problems. Abaqus can conduct pre-processing, post- processing, and processing stage monitoring. Deep drawingis primarily used in aerospace defense components such as closed end cases, sleeves, and other similar products. Deep drawing is also used in the manufacturing of carparts.

KEYWORDS

Equivalent Plastic Strain, Sheet Metals, Active Energy.

Introduction

The deep drawing technique was invented in the 1700s. The deep drawing method is commonly used in sheet metal forming. This deep drawing process is mainly used in production of cars in industries, aerospace industries and also used in daily life kitchen appliances. Plastic deformation is a common occurrence in sheet metals.

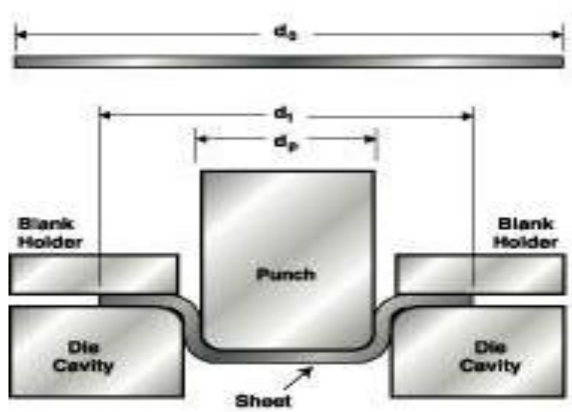

Fig. 1. Assembly of deep drawing

towards the die then the required shape will be formed. This sheet metal forming process they are consider lot of factors like lubrication, punch force required for the sheet metal, die clearance, temperature, friction, speed of the punch, blankholding force, punch clearance and limiting drawing ratio. It is important to produce defect-free cups and to reduce the sheet metal product's manufacturing costs. During the deep drawing phase, temperature, punch power, die, and punch clearance are all important parameters to remember. Deep drawing is a forming technique that requires a combination of compressive and tensile forces. A flat sheet metal blank is shaped into a hollow body with one side open in this process. There are three types of deep drawing processes in general. They are deep drawing with instruments, active means, and active energy.

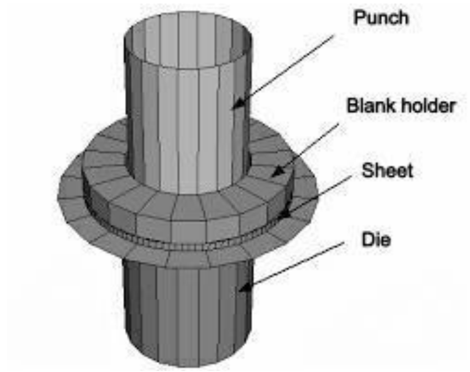

Fig. 2. Simulation modelling of deep drawing

Defects in Deep Drawing Cups

In the deep drawing process, complex operations and other things can go wrong during the drawing procedure, resulting indefects.

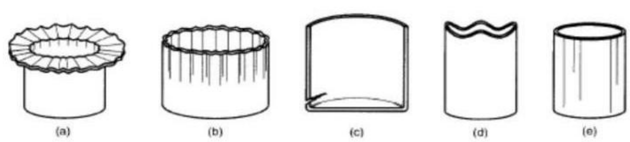

Fig. 3. Defects in deep drawing

a. Wrinkling in the flange: On the flange, this is similar to ups and downs or waviness. The flange is held in the cup wall region if it is drawn into the diehole.
b. Wrinkling in the wall: During the stamping process, the blank's flange is subjected to radial drawing stress and tangential compressive stress, which can causewrinkles.
c. Tearing: It's a crack at the base of the cup caused by high tensiletension.
d. Earing: Earing are peaks and valleys in the height of the walls of drawncups.
e. Surface scratches: Scratches are caused by the use of rough punches and dies, as well as inadequatelubrication.

Modelling in Finite Element Analysis

All finite element models that are analyzed from this study and investigationsof the die, punch, and blank holder are modelled via analytically rigid surfaces, where the blank is described as a deformable body, are analyzed using ABAQUS/CAEpre-processor.

Material Properties

Aluminium of grade AA2060, C95510, C95900.The mechanical properties is shown below in the table.

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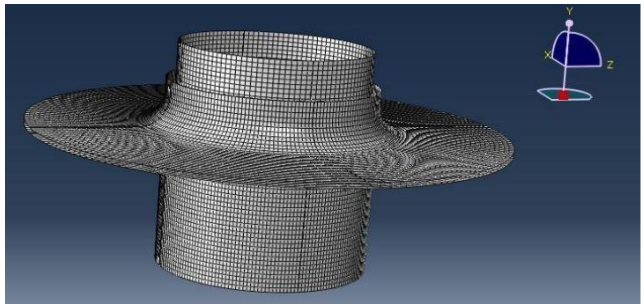

Fig. 4. 3D model of deep drawing cup using ABAQUS

Table 1. Mechanical properties of AA2060

S.No.	Property	Value
1	Density	$2.7*10^{-6}$kg/mm^3
2	Young's modulus	$70*10^3$MPa
3	Poisson ratio	0.33
4	Yield Strength	35Mpa

Table 2. Mechanical properties of C95510

S.No.	Property	Value
1	Density	$7.5*10^{-6}$kg/mm^3
2	Young's modulus	$110*10^3$MPa
3	Poisson ratio	0.32
4	Yield Strength	386Mpa

Table 3. Mechanical properties of C95900

S.No.	Property	Value
1	Density	$7.0*10^{-6}$kg/mm^3
2	Young's modulus	$97*10^3$Mpa
3	Poisson ratio	0.34
4	Yield Strength	345Mpa

Contact and Boundary Condition

Sheet metal with a thickness of 1mm can be chosen. The sheet metal is 80mm in diameter.

For dies and sheet metal, the coefficient of friction is 0.05.

For sheet metal and holder, the coefficient of friction is 0.08. For punch and sheet metal, the coefficient of friction is 0.1.

Kinematic contact conditions help the contact between the sheet and the punch and die, as well as the blank holder. The initialstepsofthearrangementsproducedtheconditionusedby master-slave surface sets. The master surface refers to the rigid body'ssurface,whilethesurfacereferstothedeformablebody's surface. This document also includes the friction coefficientsof all contact surfaces. The loading and unloading force, which determinesthemovementofthepunchandblankdisplacement, as well as the degree of freedom, are defined by the boundary conditionsthatarecharacterizedforeachphase.Thevirtualtrial and error process can be used to replace the experimental trial and error process. In this simulation of the deep drawing process, the effects of various process parameters on the deep drawing process are more precisely calculated. Precision numerical descriptions of instruments, as well as accurate descriptions of material behavior, contact behavior, and other process variables, are required for finite element simulations to beaccurate.

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Result and Discussion

AA2060 at Velocity 200mm/s

Table 4

S. No.	Velocity of punch (mm/ s)	Height of the cup after punch force removed	Von-misesstress(MPa)		Equivalent plastic strainPEEQ	
			Max	Min	Max	Min
1	200	30	87.77	1.71	0.0827	0.0239

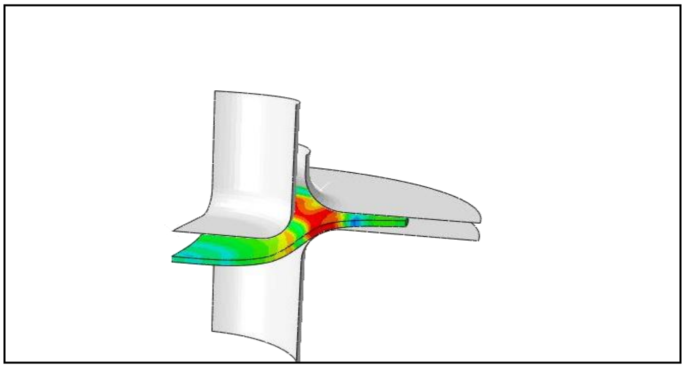

Fig. 5. Simulation of AA2060

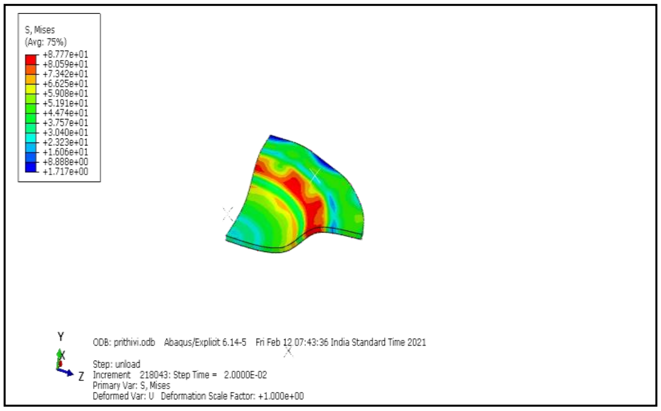

Fig. 6. Von mises stress distribution

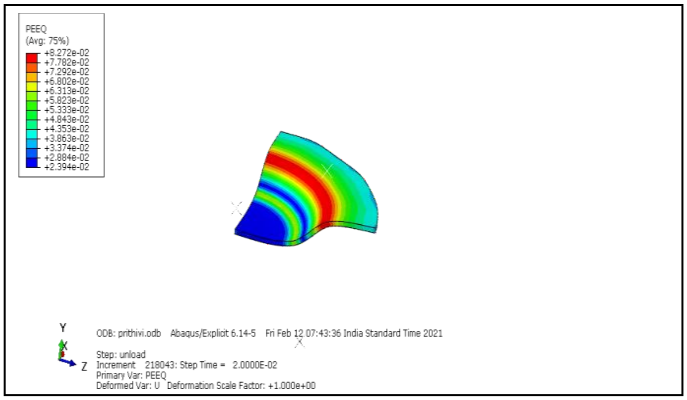

Fig. 7. Equivalent plastic strain

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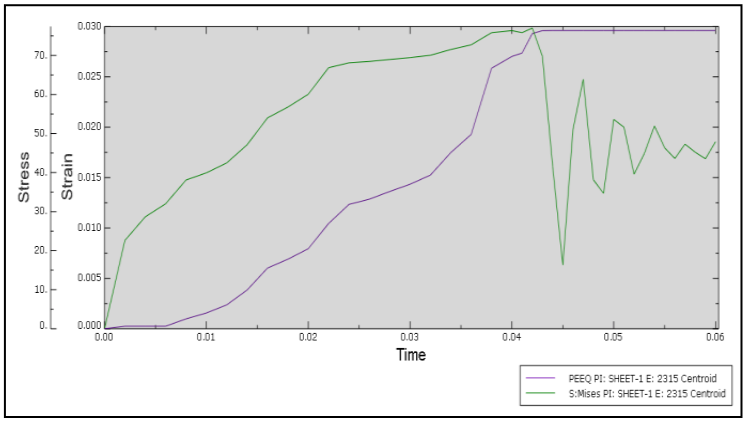

Fig. 8. PEEQ, Von-mises stress vs Time

C95510 at Velocity 200mm/s

Table 5

S. No.	**Velocity ofpunch (mm/s)**	**Height of the cup after punch force removed**	**Von-mises stress(MPa)**		**Equivalent plastic strainPEEQ**	
			Max	**Min**	**Max**	**Min**
1	200	30	576.3	454.6	0.0396	0.0057

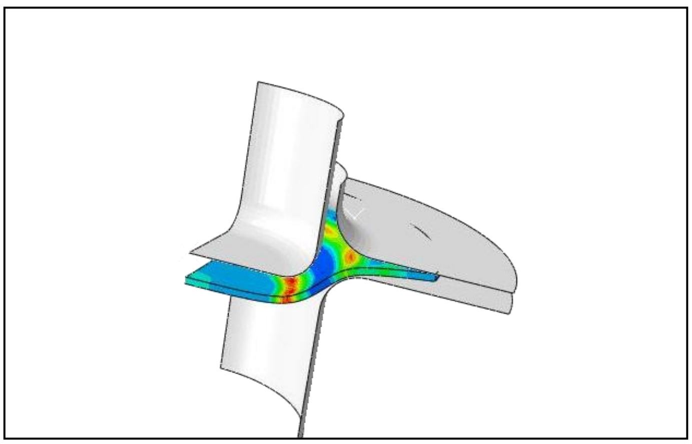

Fig. 9. Simulation of C95510

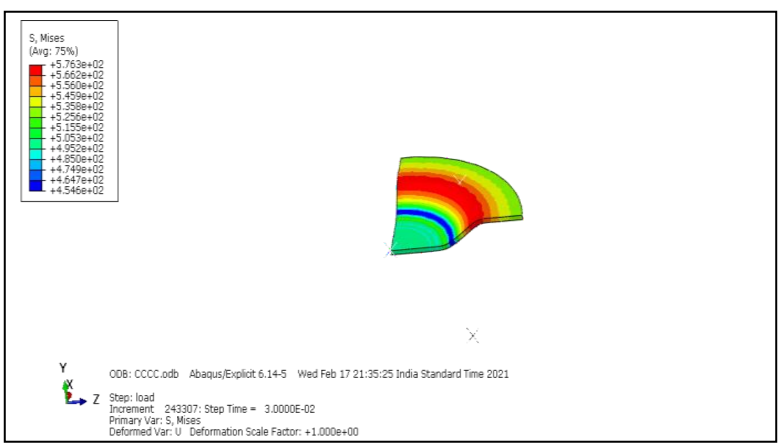

Fig. 10. Von–mises stress distribution

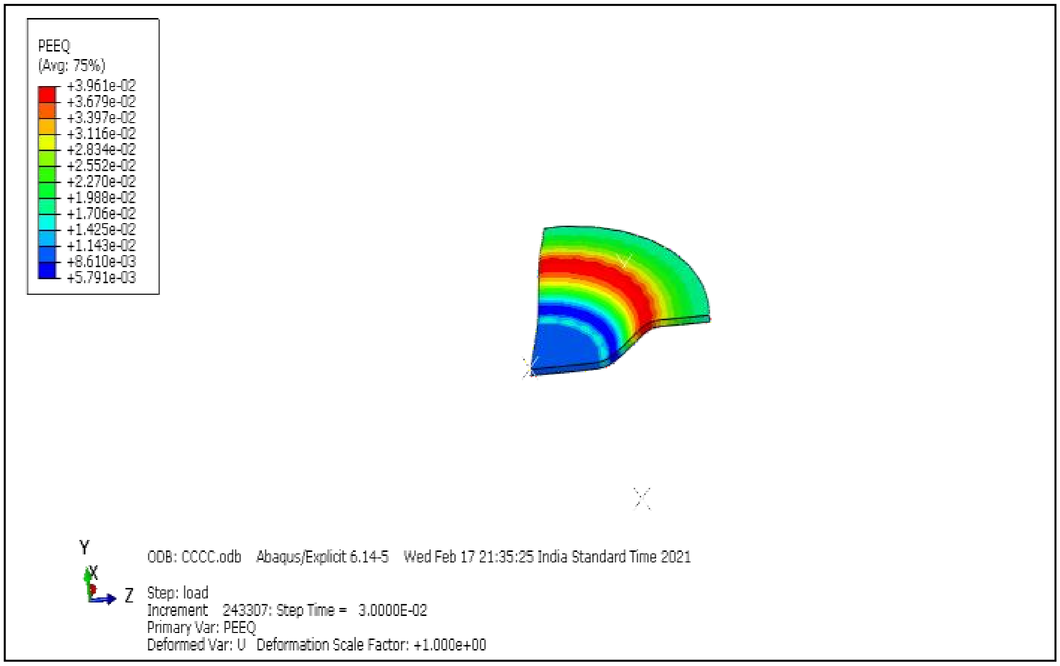

Fig. 11. Equivalent plastic strain

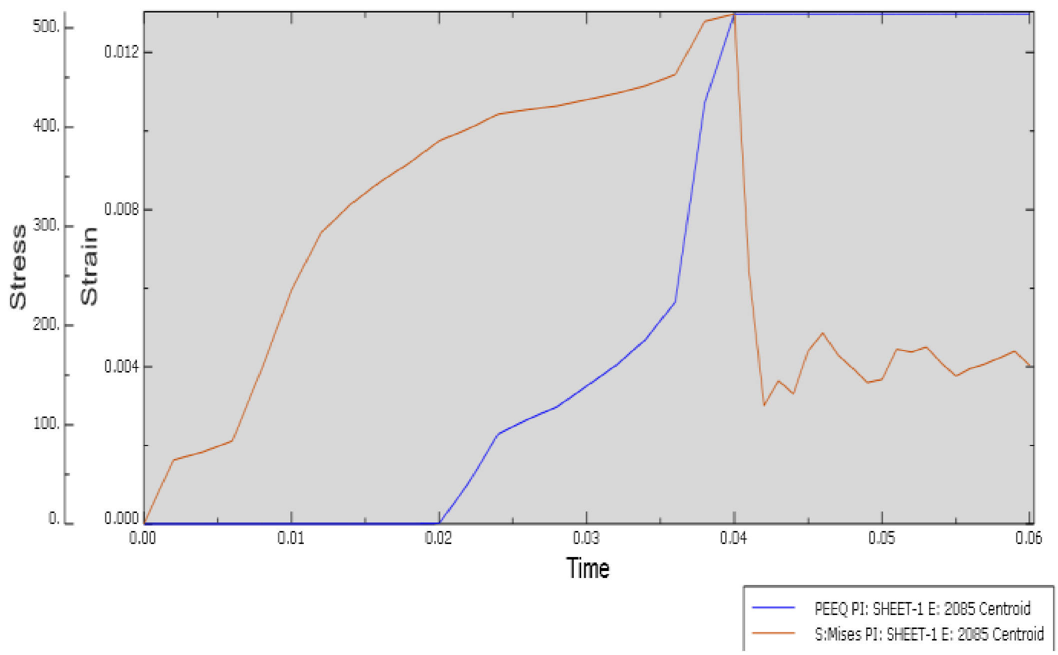

Fig. 12. PEEQ, Von-mises stress vs Time

C95900 at Velocity 200mm/s

Table 6

S.No.	Velocity ofpunch (mm/s)	Height of the cup after punch force removed	Von-mises stress(MPa)		Equivalent plasticstrainPEEQ	
			Max	**Min**	**Max**	**Min**
1	200	30	399.7	9.033	0.0754	0.0153

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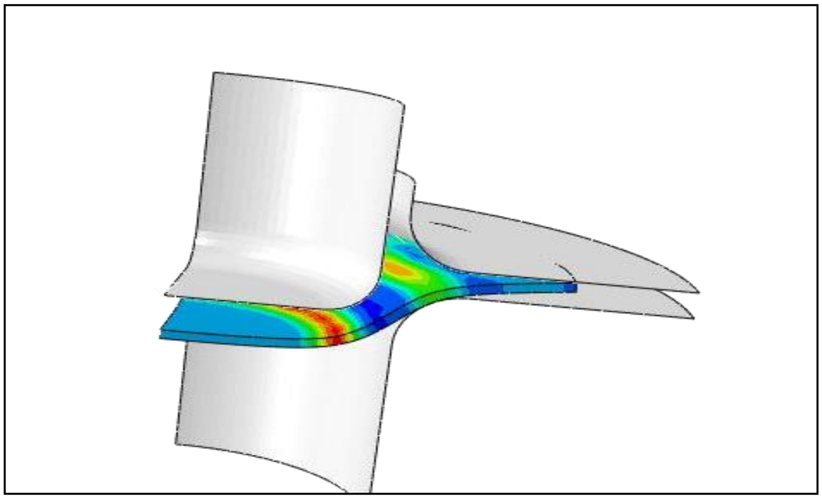

Fig. 13. Simulation of C95900

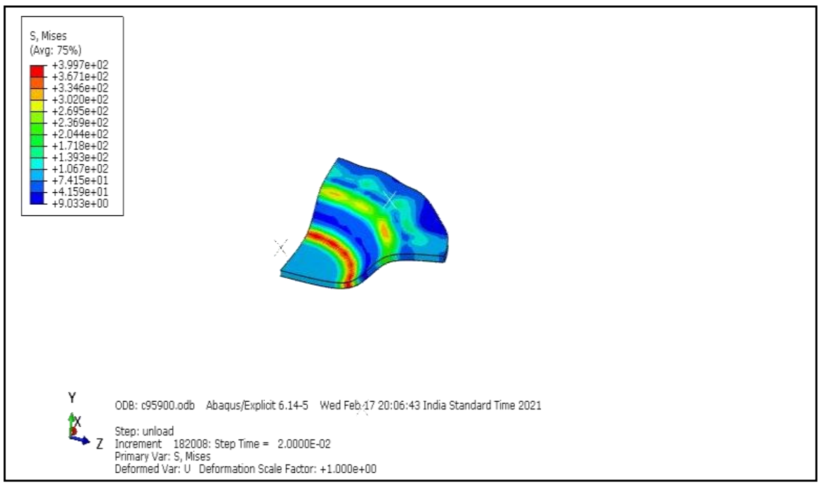

Fig. 14. Von-mises stress distribution

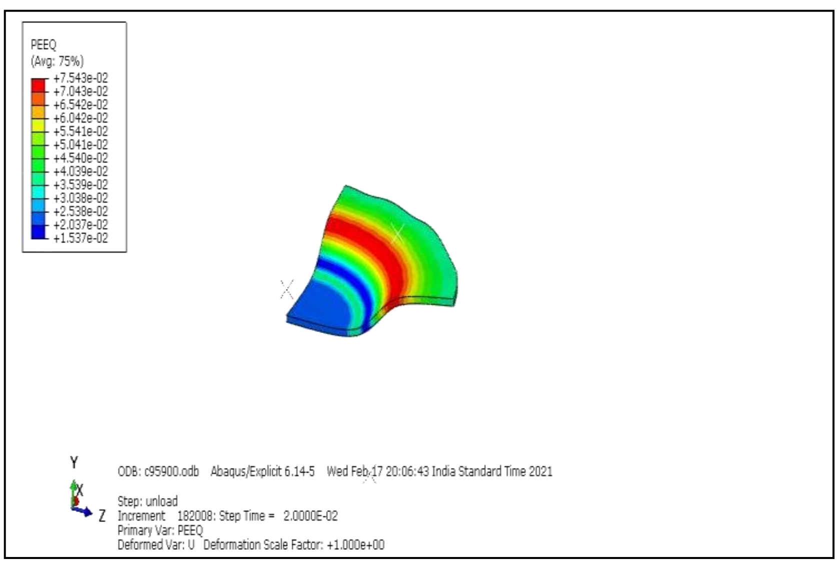

Fig. 15. Equivalent plastic strain distribution

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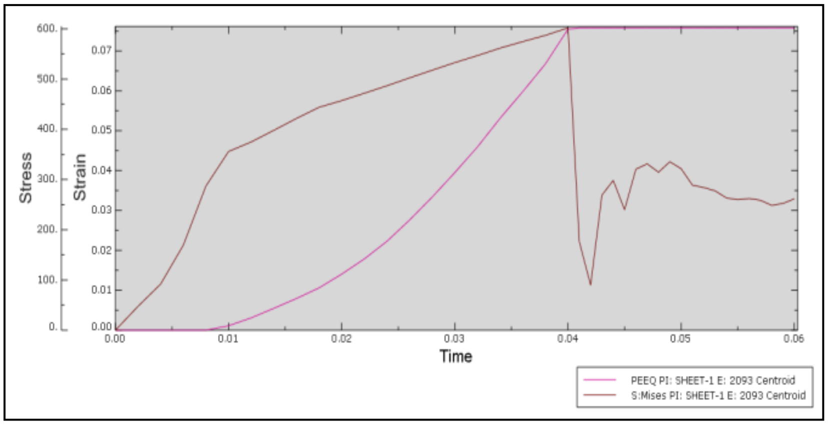
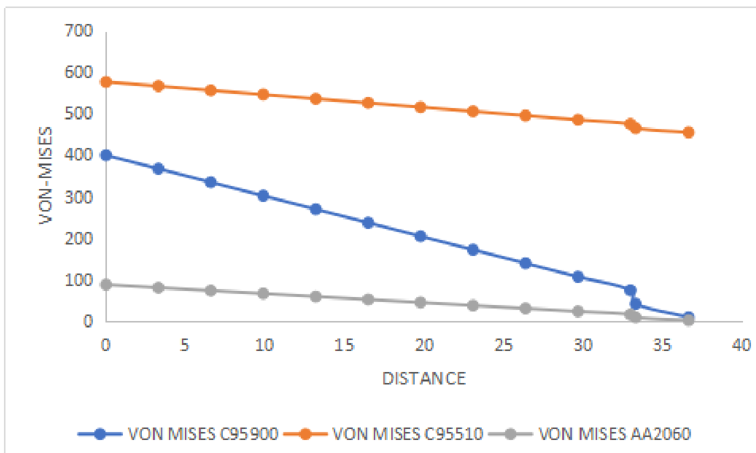
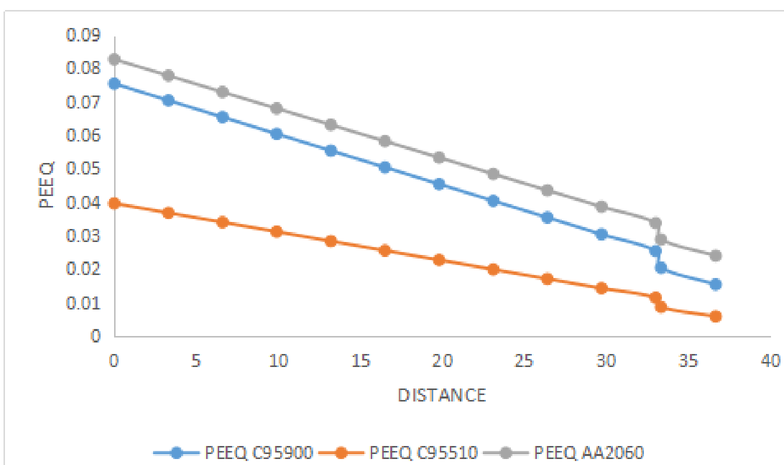


Fig. 16. PEEQ, Von-mises stress vs Time

Comparison ofResults





Conclusion

ThestudyofdeepdrawingsofAA2060,C95510, and C95900 yielded the following conclusions. Cracking, wrinkling, tearing, and necking arenot visible in the deep drawing components of AA2060, C95510, and C95900 at a thickness of 1mm. The velocity of punch for all components will be 0.70 m/sand coefficient of friction willbethe von-mises stress distribution is morein C95510 when compared with AA2060 and C95900.The equivalent plastic strain is more in AA2060 when compared with C95510 and C95900.

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