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CONTOUR PRESENTATION OF PLASTIC STRAIN OF A SQUARE ALUMINIUM SHEET BLANK IN CONDITIONS OF IMPLEMENTATION OF A SHALLOW DRAWING PROCESS

Abstract: *The results of a computer simulation of a square part drawing process obtained by means of the LS-DYNA software environment are presented in the article. A calculated area of plastic strain of the square aluminium sheet blank is visually displayed on the entire time range of the drawing process modeling.*

Key words: *drawing, a sheet blank, a die, plastic strain.*

Language: *English*

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Introduction

Features of drawing processes of sheet blanks, researched by means of a computer simulation, are presented in the works [1 – 11]. The following recommendations were given: with the thickness of the round sheet blank up to 2.5 mm, wrinkles on a flange are formed, which are eliminated when using of a blank holder; a radius chamfer on the edges of a working part of a punch is calculated by the formula 1.5*s* (where *s* is the thickness of the sheet blank before processing by pressure, mm); a degree of plastic strain of the sheet blank when drawing by a reversible method is less than when the direct method and etc. A drawing analysis of the square sheet blanks shows an occurrence of the most deformed local volumes of material in the mates area of side walls of the part. Removing of excess material on the square sheet blank will eliminate a curvature of the side walls of the part and get the most rational cutting of metal. This research is aimed at a visual display of the deformation process of the square metal sheet blank on the entire time range of the shallow drawing process.

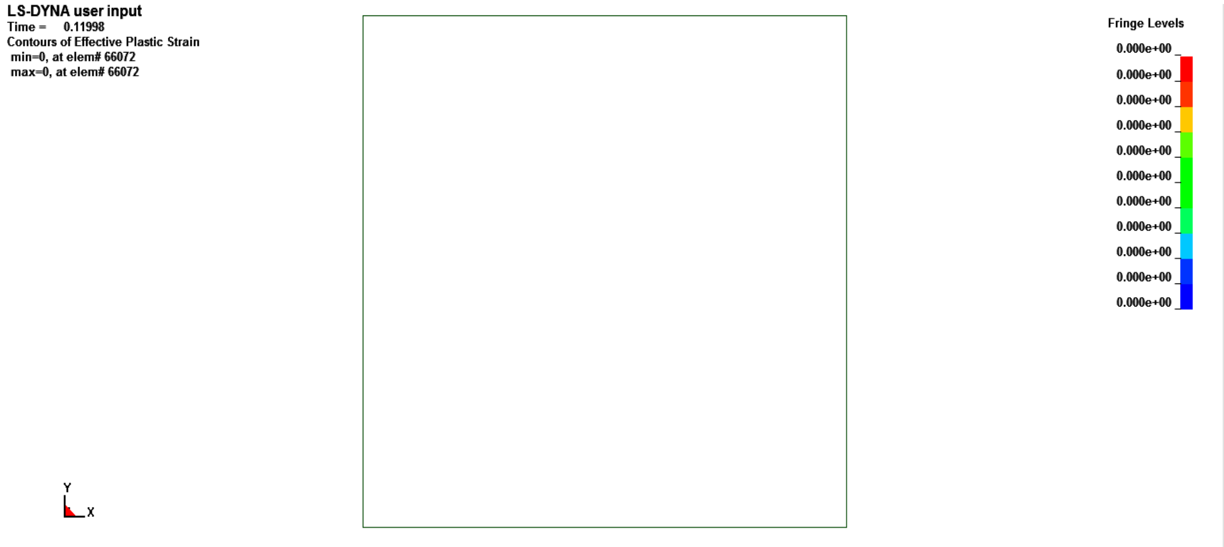
Materials and methods

The drawing process of a computer model of the sheet blank by means of the models of the forming and auxiliary parts of a drawing die was researched. The solid models of the square sheet blank (the dimensions: 100×100×2 mm), the punch (the dimensions: 54×54×40 mm, the radius chamfer on the edges of 3 mm), the die with a square hole (the dimensions of the hole: 60×60×40 mm, the radius chamfer on the edges of 5 mm) and the blank holder with the square hole (the dimensions: 120×120×2 mm) was built in the KOMPAS software environment. All solid models were split into finite elements and initial conditions of performing of the drawing process were set in the Ansys Workbench software environment. By the sheet blanks were given the properties of 2024 aluminium alloy; by the forming and auxiliary parts of the drawing die were given the properties of an absolutely solid body. The drawing force was taken by the value of 15 kN. The model of the square sheet blank was deformed in a cold state at an ambient temperature. All technological information was loaded into the LS-DYNA software environment for a subsequent mathematical calculation of the shallow drawing process of the square sheet blank.

Results and discussion

The results of the computer simulation are presented by plastic strain contours on the processed solid model of the square part. The contours distribution is shown in the top view. Thus, it is possible to judge about plastic strain of the sheet blank only on the internal forming surfaces and the flange surfaces. The models of the die, the punch and the blank holder when the simulation of the drawing process were hidden. The contours of the coefficient of plastic strain of material have a color spectrum that corresponds to the certain value of the parameter on a special scale (located on the right). The calculated values of the coefficient of plastic strain of the square sheet blank were recorded every 0.01 s of modeling of the drawing process by the direct method.

The computer simulation of drawing of the square sheet blank into the die hole to the depth of 30 mm lasted 0.25 s under the specified conditions. Boundaries of excess material located in the flange areas of the square sheet blank along the *X* and *Y* coordinate axes are observed at 0.16 s of the drawing process. Gradual punching by the punch of the sheet blank into the square hole of the die is accompanied by a displacement of material in the middle of the each side of the square. This leads to a profile concavity of the side walls of the aluminium part when viewed from the main view. The concavity radius will be defined as the distance from a side face of the sheet blank before plastic deformation to the outer surface of the formed side wall of the square part. The coefficient of plastic strain of material reaches the value of 0.35 in the mates areas of the side walls of the square part. The other elements of the square part have in 2.5 times less plastic strain after drawing. The most uniform plastic strain occurs on the area of the blank when formation of the bottom.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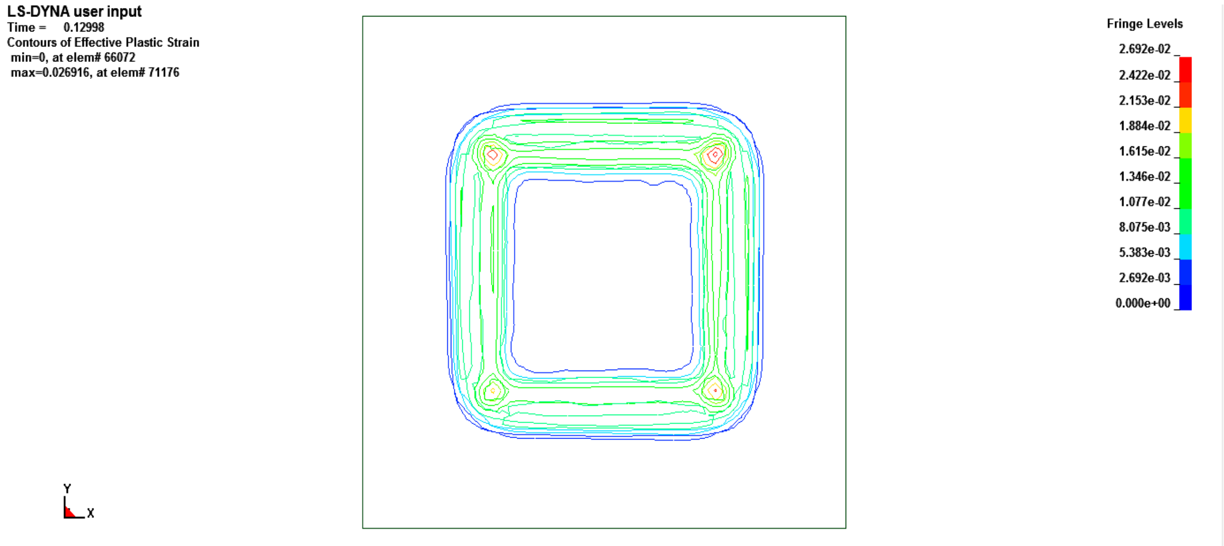
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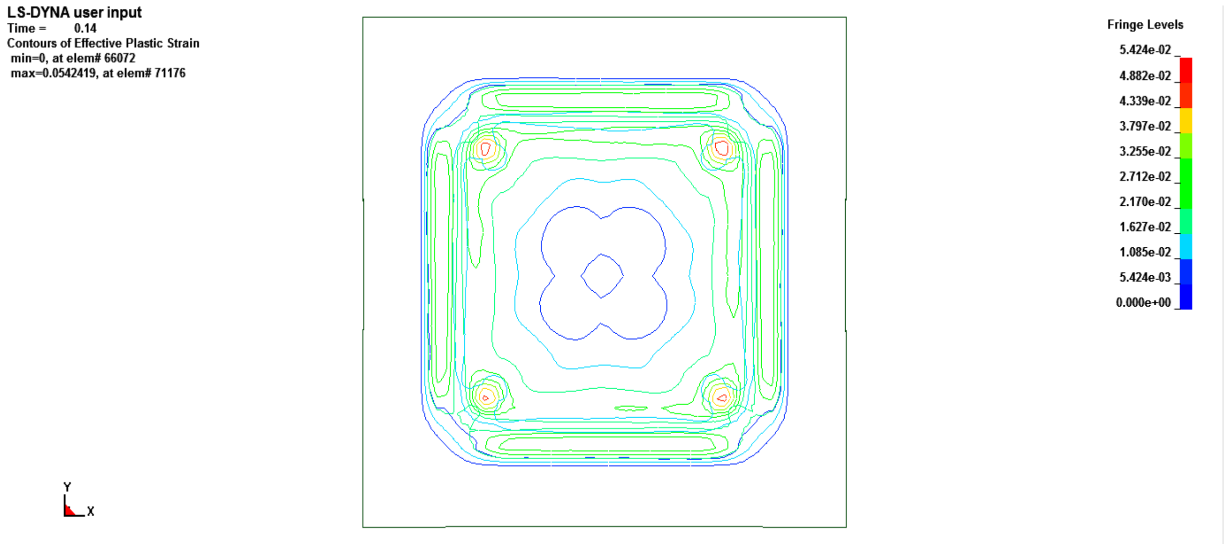
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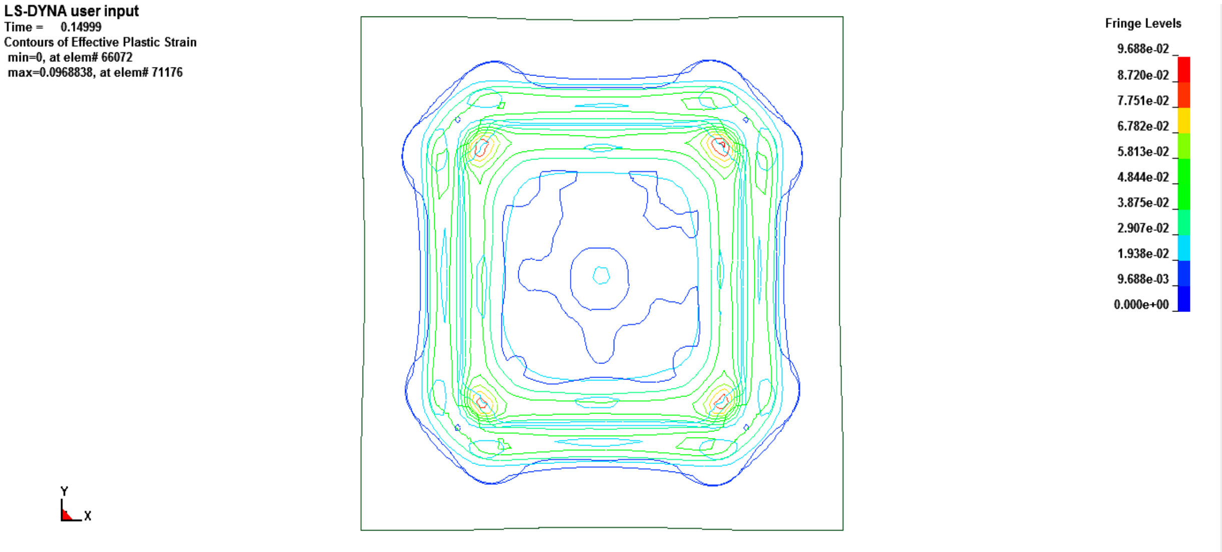
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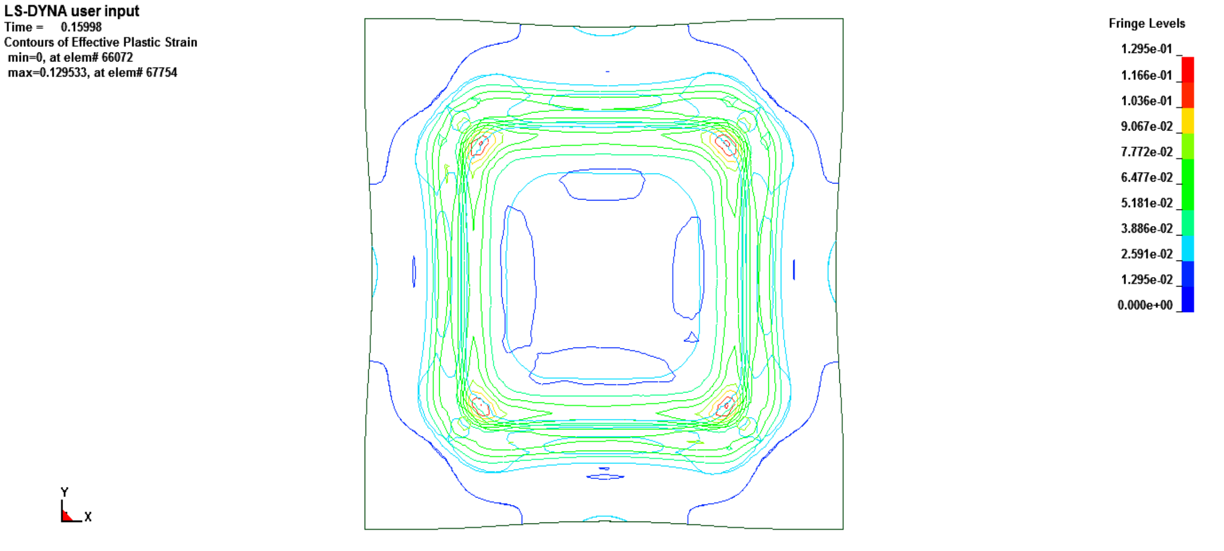
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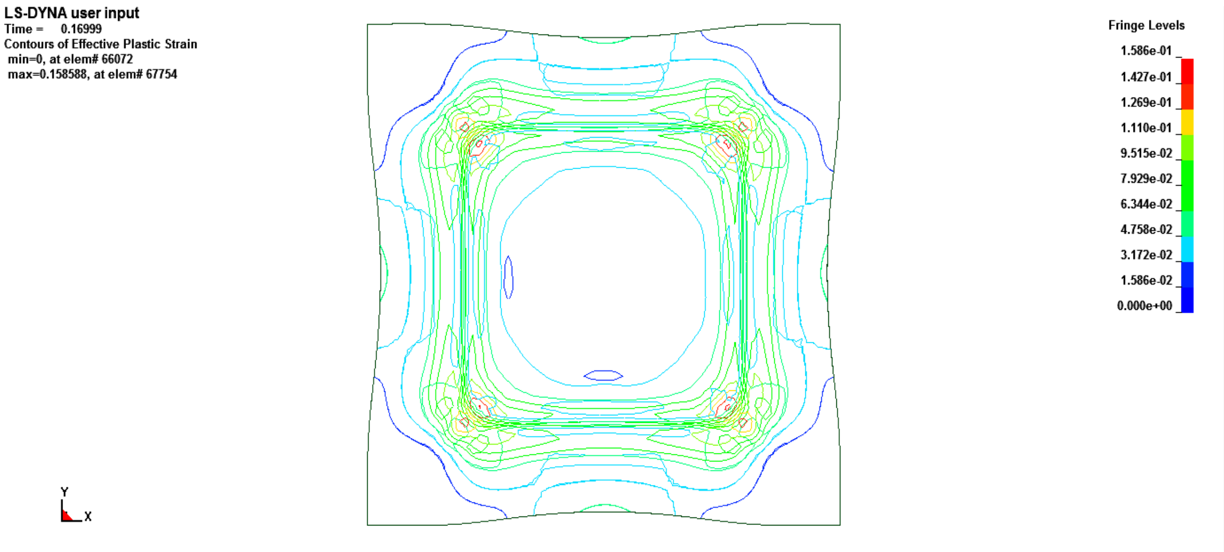
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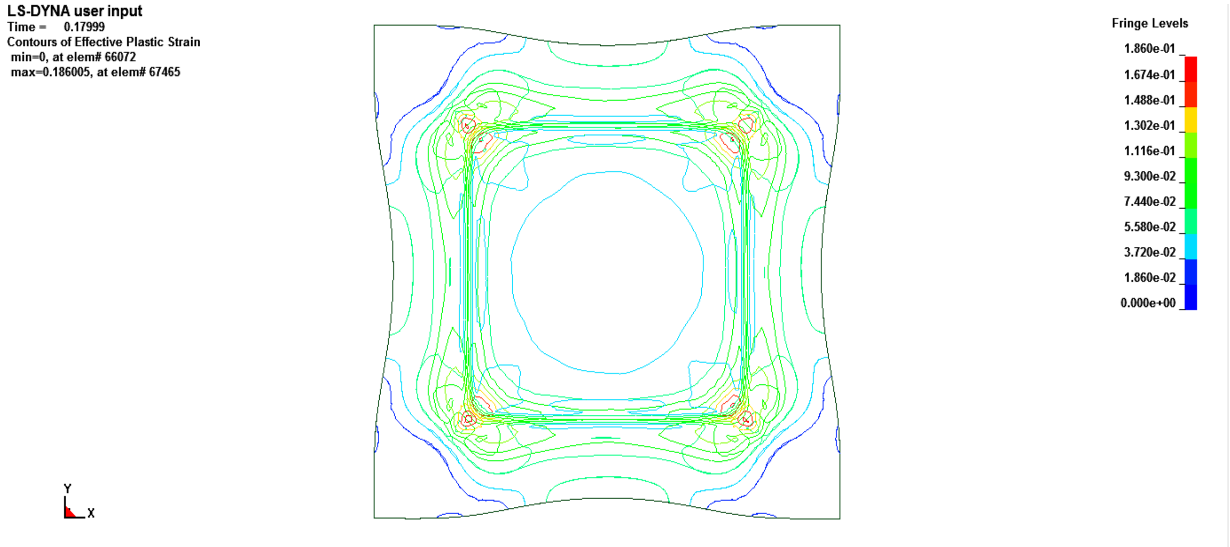

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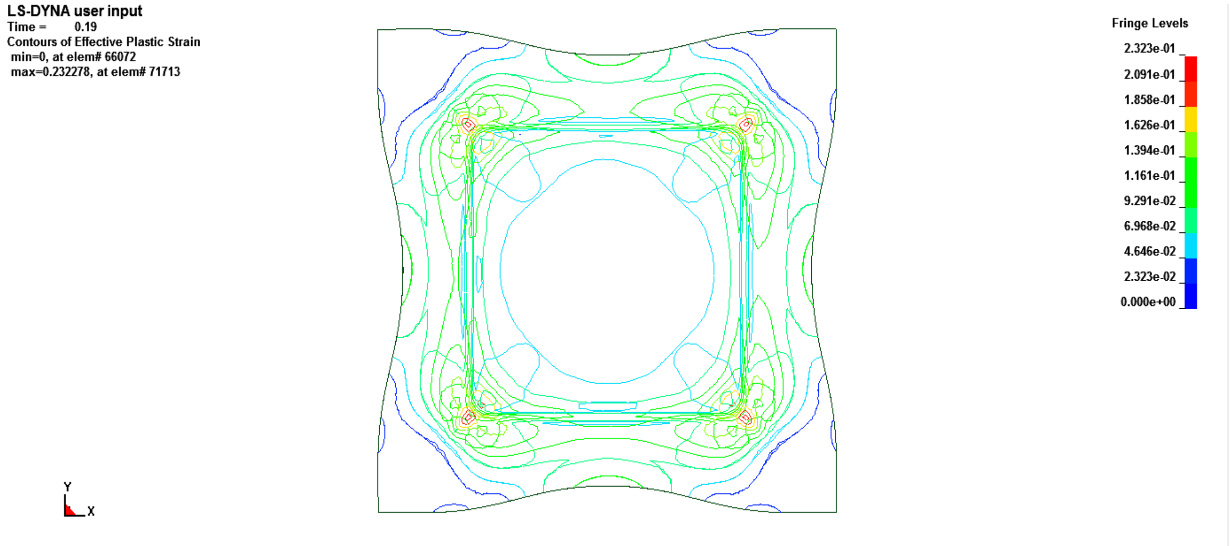

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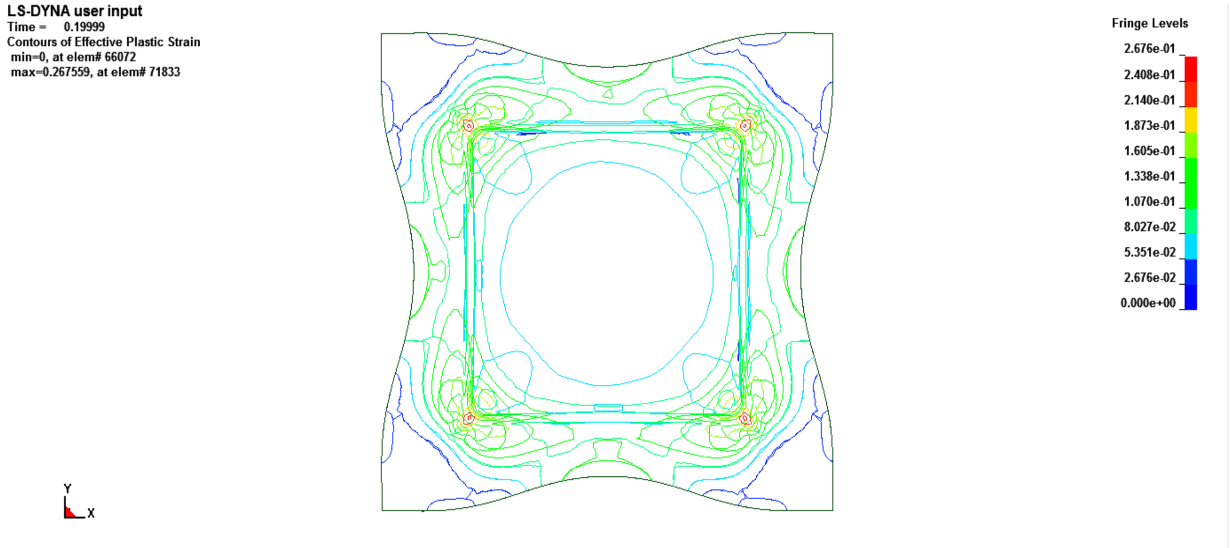

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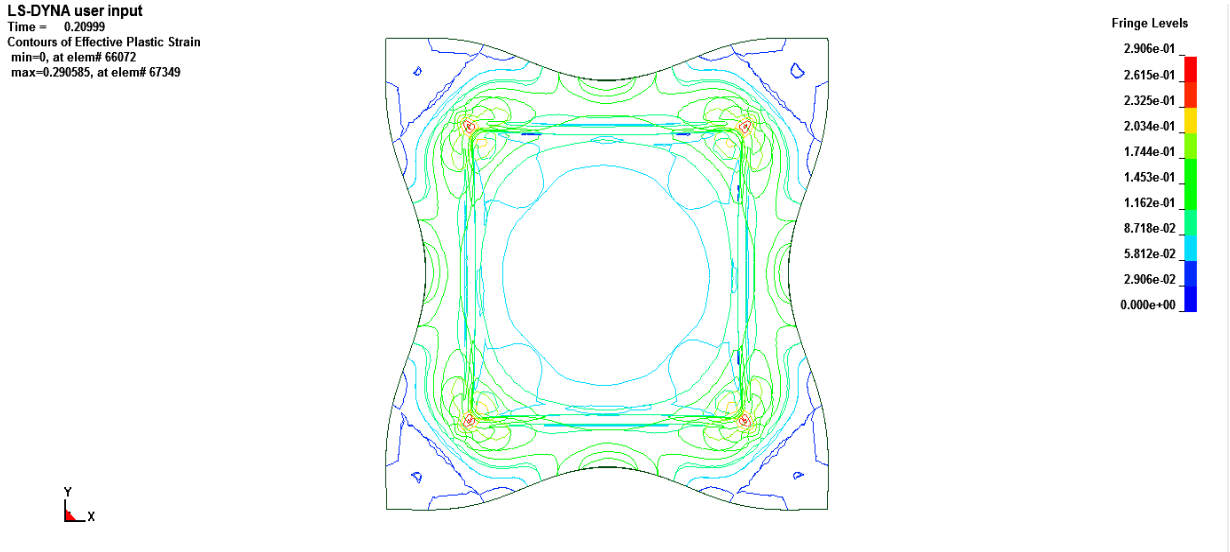

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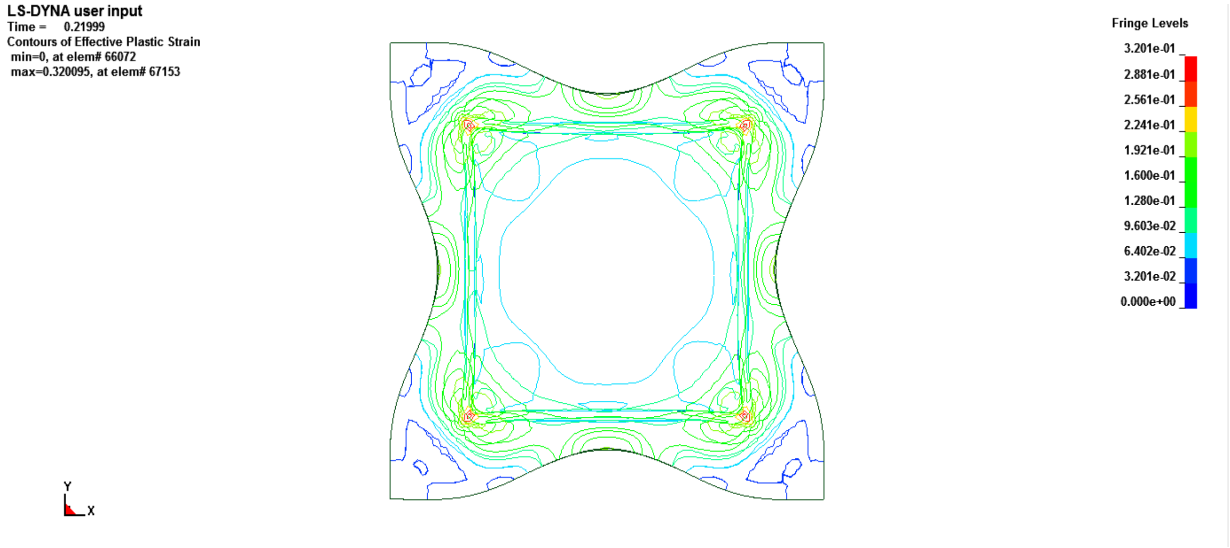

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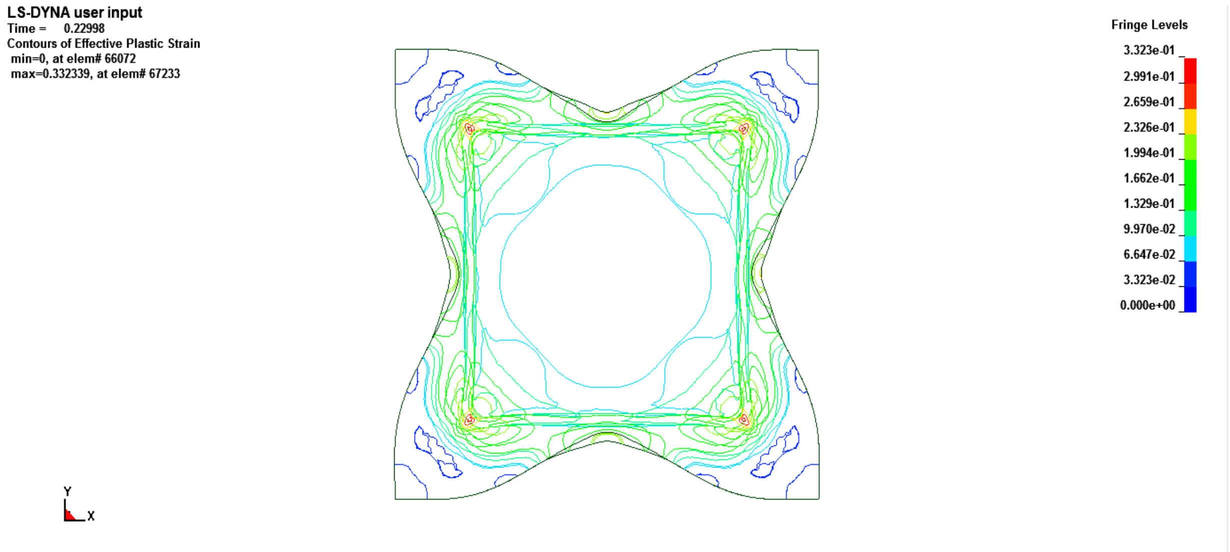

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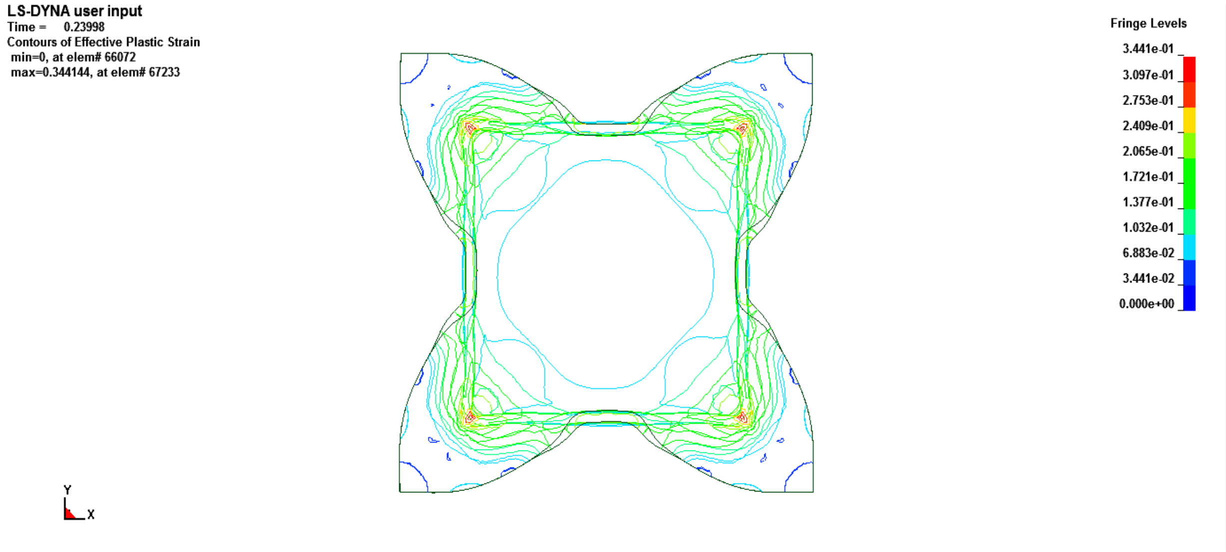

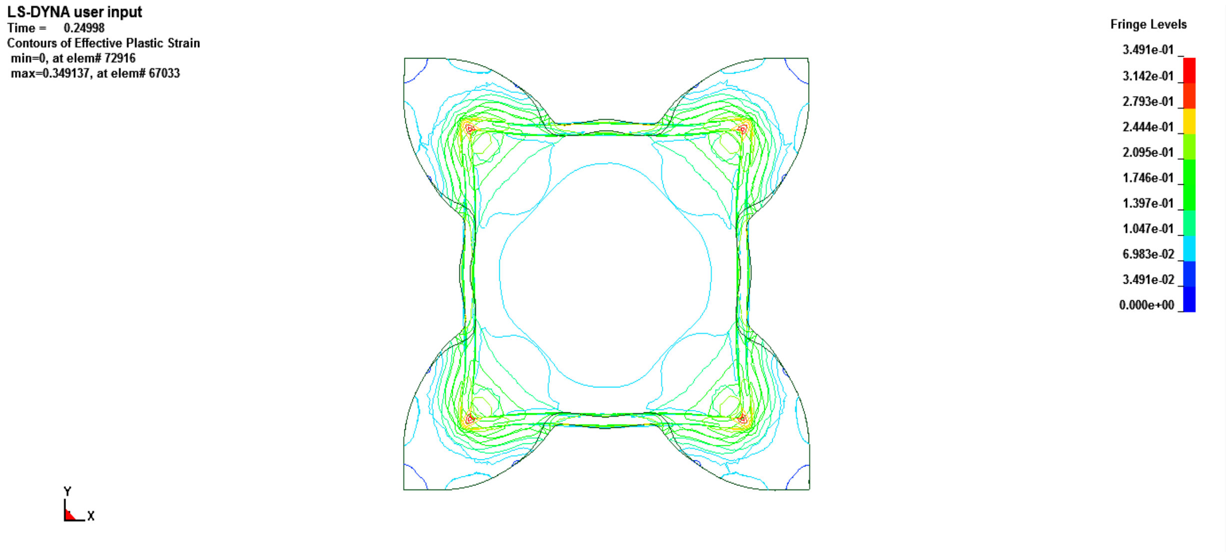

Conclusion

The radius chamfers on the punch edges provide decreasing of local concentrations of material stress. This allows to reduce a possibility of mates break of the walls of the square part, which is made of less durable metal alloy than steel. A choice of the overall dimensions of the forming parts of the drawing die and removing of the calculated excess flange of the sheet blank will reduce deviations of a shape when serial manufacturing of the square thin-walled parts in the production conditions.

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