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A Study of Ability of a Rectangular Shell Deep Drawing by Finite Element Program

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Abstract

This study was the use of the finite element method in the deep drawing process of a rectangular shell cup. The aim was to analyse the equivalent strain in the workpiece and to find out what happened to the disc blank sheet before the forming by stamping. The rectangular shell cup was 24x30x20 mm. and made of 2mm.thick SUS 403 and SUS 304 stainless steel. There were 3 types of blank sheets: 1) square sheet 2) 45 degree angled edge cutting sheet 3) circular sheet. It was found out that the drawing up with the use of 3 types of blank sheet made of SUS 304 stainless steel had no risk in the workpiece. For the stamping of the rectangular shell that used a square sheet made of SUS 403 stainless steel, it was found out that there was no risk in the work piece, but with the use of 45 degree angled edge cutting sheet or round sheet, the work piece had a risk to be damaged.

Keywords: *rectangular shell, Finite element*

1. INTRODUCTION

Deep drawing is very important to component manufacturing of parts of a product in industries. The problem of the rectangular shell cup deep drawing process was the equal amount of flow in each side, resulting in making mould in an actual production process. Therefore, finite element process plays a role in analyzing the ability of a rectangular shell deep drawing process and it well known that using steel sheet in deep drawing process requires an awareness of the factors that have an effect with finished workpieces to prevent the damage that may happen with workpieces during the deep drawing process There are the factors or variable that have an influence on ability in drawing. During the deep drawing, the punch will be stamped on the blank sheet through the die opening. This process will make the bending and unbending in the die. The metal between the punch will have tensile stress along the line of the punch and the hoop compression stress. The metal on the shell wall will receive axial tension. At the bottom of the shell the metal will have tensile stress on both axial lines. This stress has an effect to the force in drawing and damage that will be

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happened in deep drawing such as wrinkles and tears that can absolutely damage the workpiece.

Finite element calculation is an important tool that predicts the result of the problem that we are interested in without an actual try out. It can save both time and money and also help in analysis to choose the suitable condition or solve the problems efficiently. With these advantages, the finite element method is used in engineering widely. The achievement and worthiness of this research will be a part that makes the entrepreneurs to believe in using technology to develop the competitiveness. As the moulding industry in country has been growing quickly, so it is necessary to use finite element program in problem analysis before design and make the moulds to decrease an error and the design time of mould production. It makes the entrepreneurs ability to produce quality workpieces on time and decrease the money for editing and trying out the mould.

2. METHODOLOGY

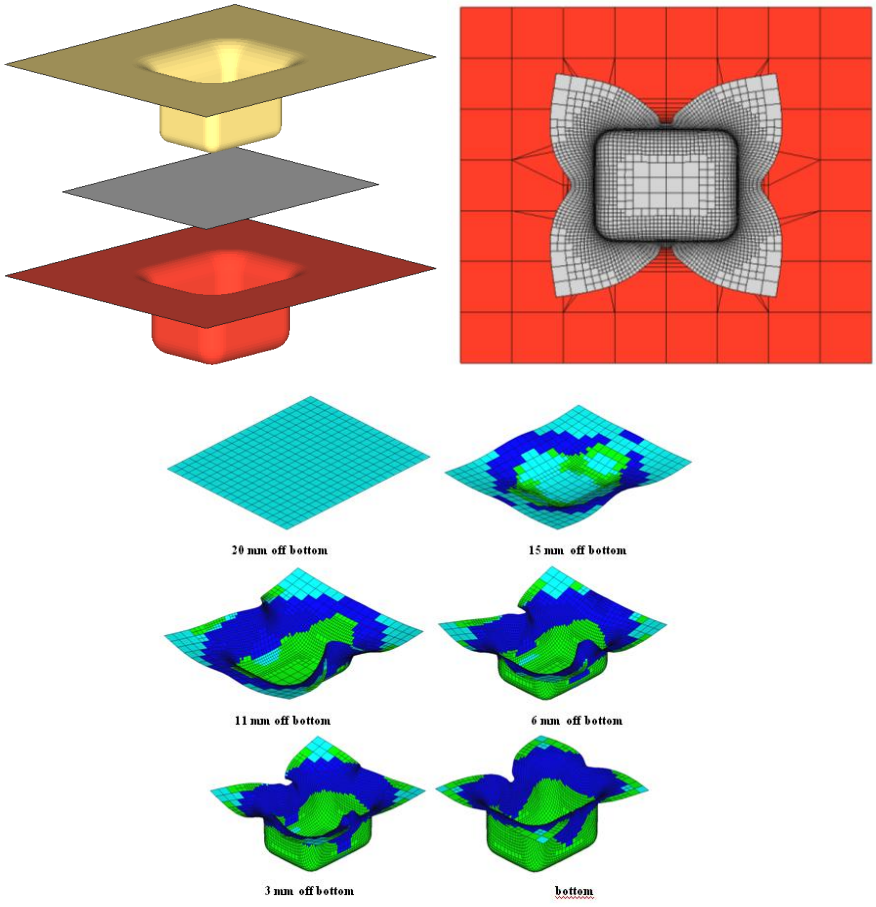
The process of this research started with the consultation to the entrepreneur of a small enterprise who runs business about making the mould. They had a question about drawing a rectangular shell made of 2 mm. thick SUS403 and SUS304 stainless steel. The question was which type of sheet can decrease the damage on the surface of workpiece during draw up a rectangular shell. Normally, there were 3 types of blank sheets: 1) square sheet 2) 45 degree angled edge cutting sheet 3) circular sheet. Therefore, the researchers suggested the use of finite element program in deep drawing simulation that would make it easier to choose the type of sheet before stamp the rectangular shell. The researchers chose a box of 24 x 30 x 20 mm. and 2 mm. thick It was the size the entrepreneur wanted. The material was SUS 403 and SUS 304 stainless steel. The punch and die was set steady at 5 mm. in radius. The first step of create the model requires the data related to set finite element program such as qualities of workpiece that use in drawing up a rectangular shell.

The steps of programming the finite element simulation were: first, design the models of drawing: the upper die, lower die and blank sheet. Second, design a formability step model. Third, create blank final shape model. Forth, create thinning model. Finally, report the simulation (Forming Limit Diagram).

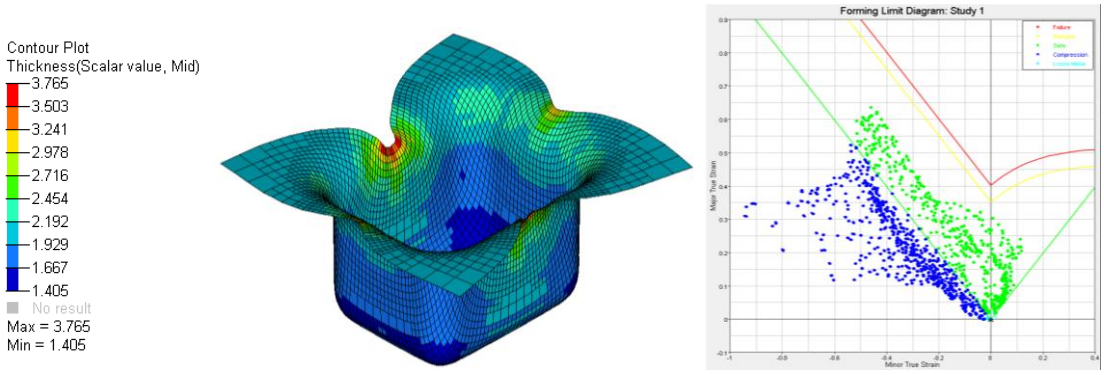
3. RESULTS

The results revealed the ability of a rectangular shell deep drawing simulation by using finite element program in order to obtain the analysis results of equivalent strain that happened in workpiece. It showed that the more stress in the area the more chance to be damaged (torn) in that area. In the simulation, the radius of punch and die was set at 5mm. The material was 2 mm. thick SUS 403 and SUS 304 stainless steel. There were 3 types of blank sheets in this study: 1) square sheet 2) 45 degree angled edge cutting sheet 3) circular sheet which was used in drawing. The rectangular shell size was 20x30x20mm. The results were showed in the table below.

1. The simulation results of drawing with the use of square sheet made of 2 mm. thick SUS 304 stainless steel.The radius of punch and die was set steadyat 5 mm. It was found that there was no risk in the workpiece while drawing.



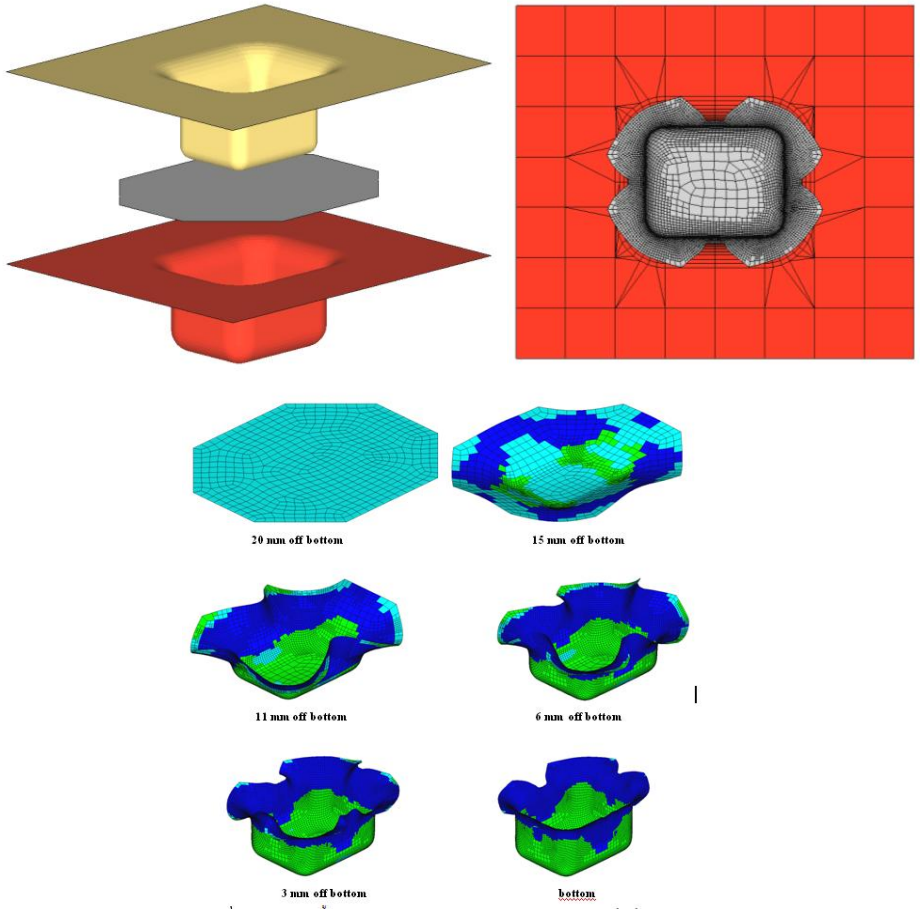
Upper Die Model , Lower Die Model and Blank Model , Blank Final Shape Model , Formability Step Model



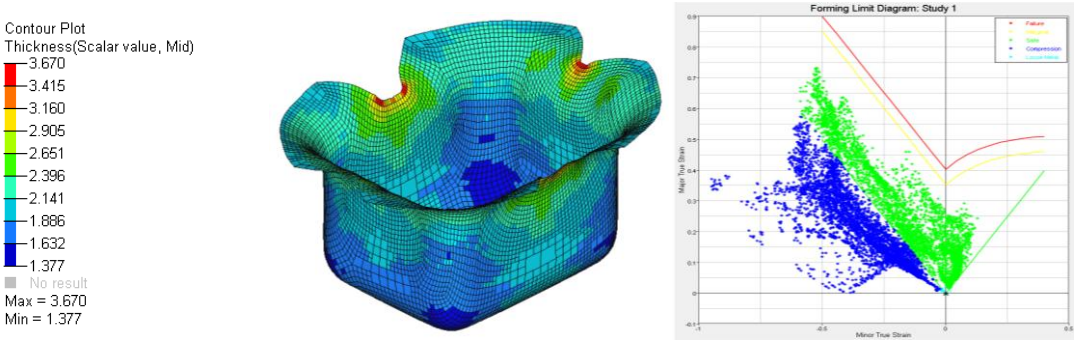
Thinning Model , Forming Limit Diagram

Figure 1. The results of a square blank sheet SUS 304 stainless steel deep drawing

2. The simulation results of drawing with the use of 45 degree angled edge cutting sheet made of 2 mm. thick SUS 304 stainless steel. The radius of punch and die was set steady at 5 mm. It was found that there was no risk in the workpiece while drawing.



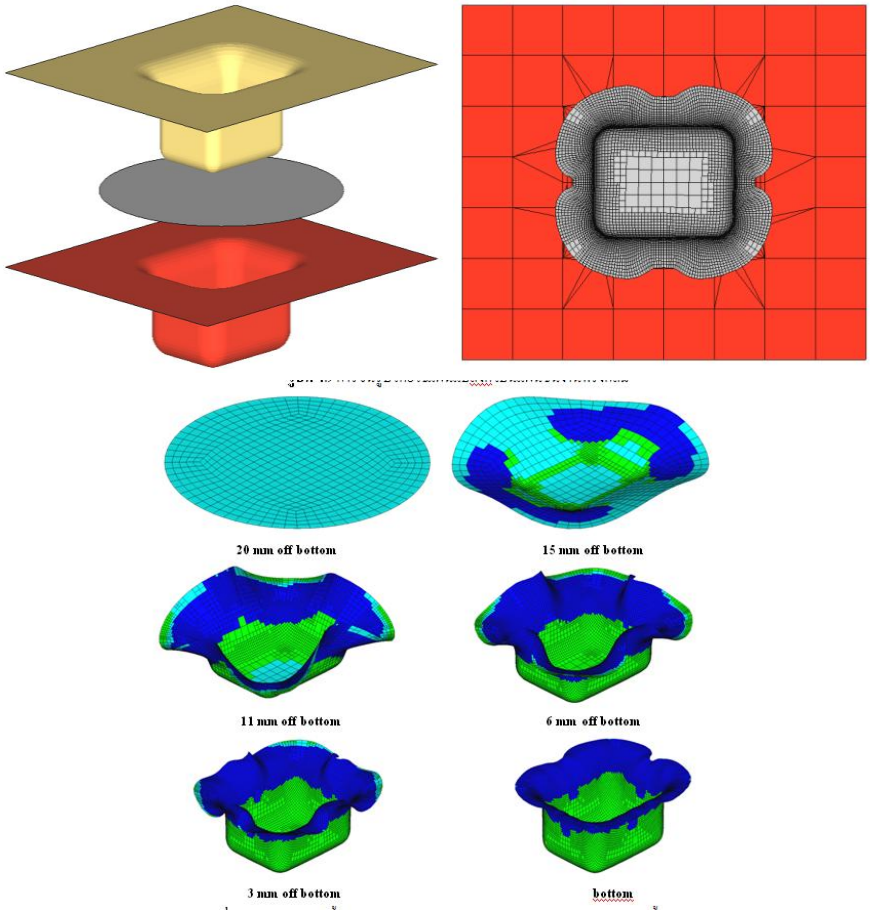
Upper Die Model , Lower Die Model and Blank Model , Blank Final Shape Model , Formability Step Model



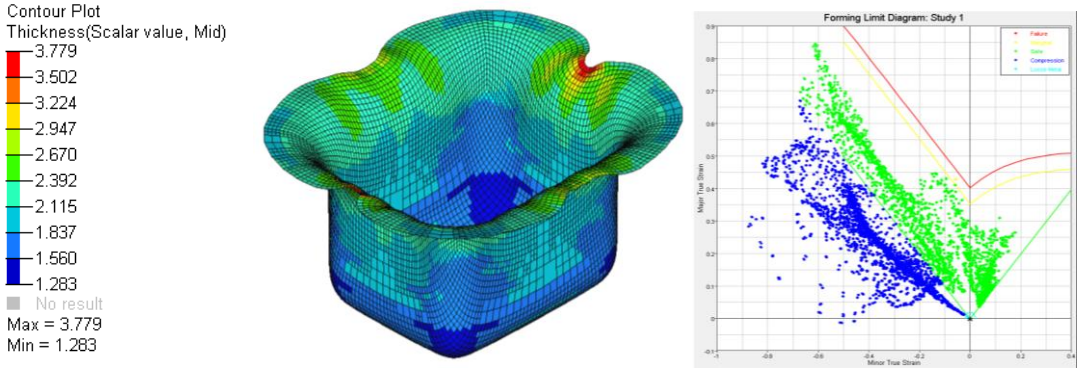
Thinning Model , Forming Limit Diagram

Figure 2. The results of a 45 degree angled edge cutting SUS 304 stainless steel deep drawing

3. The simulation results of drawing with the use of circular sheet made of 2 mm. thick SUS 304 stainless steel. The radius of punch and die was set steady at 5 mm. It was found that there was no risk in the workpiece while drawing.



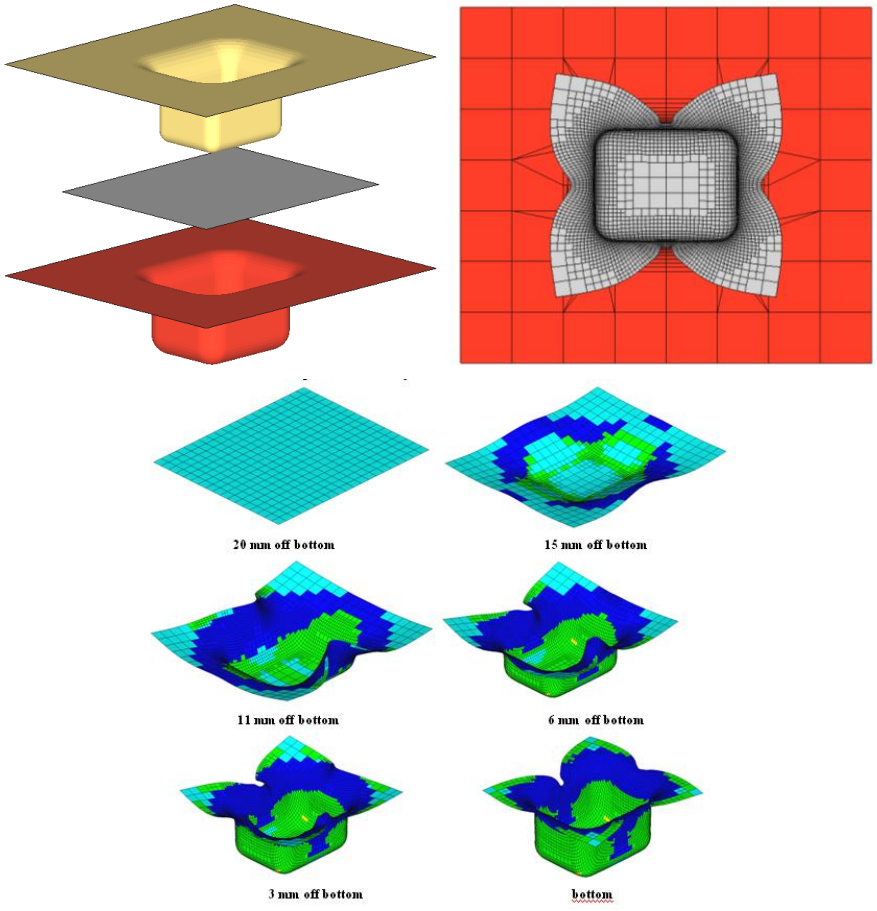
Upper Die Model , Lower Die Model and Blank Model ， Blank Final Shape Model ， Formability Step Model



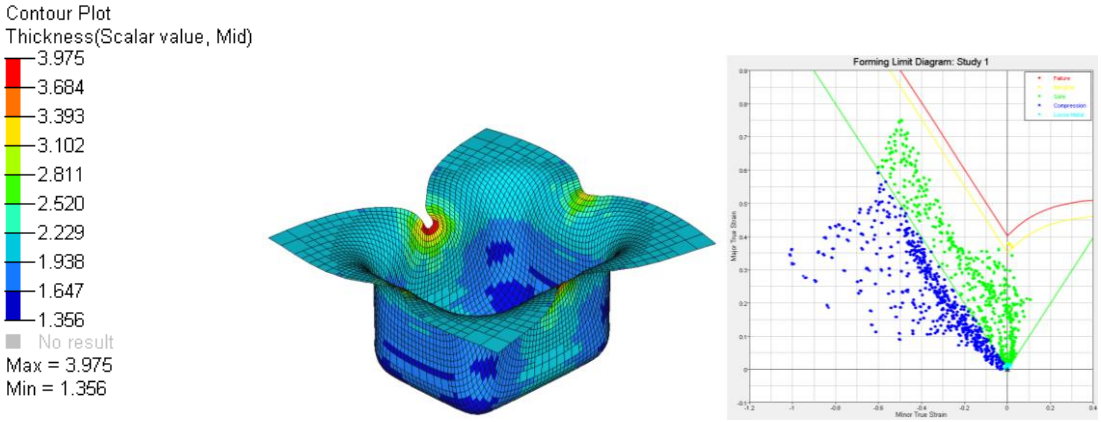
Thinning Model , Forming Limit Diagram

Figure 3. The results of a circular blank sheet SUS 304 stainless steel deep drawing

4. The simulation results of drawing with the use of square sheet made of 2 mm. thick SUS 403 stainless steel. The radius of punch and die was set steady at 5 mm. It was found that there was no risk in the workpiece while drawing.
5.



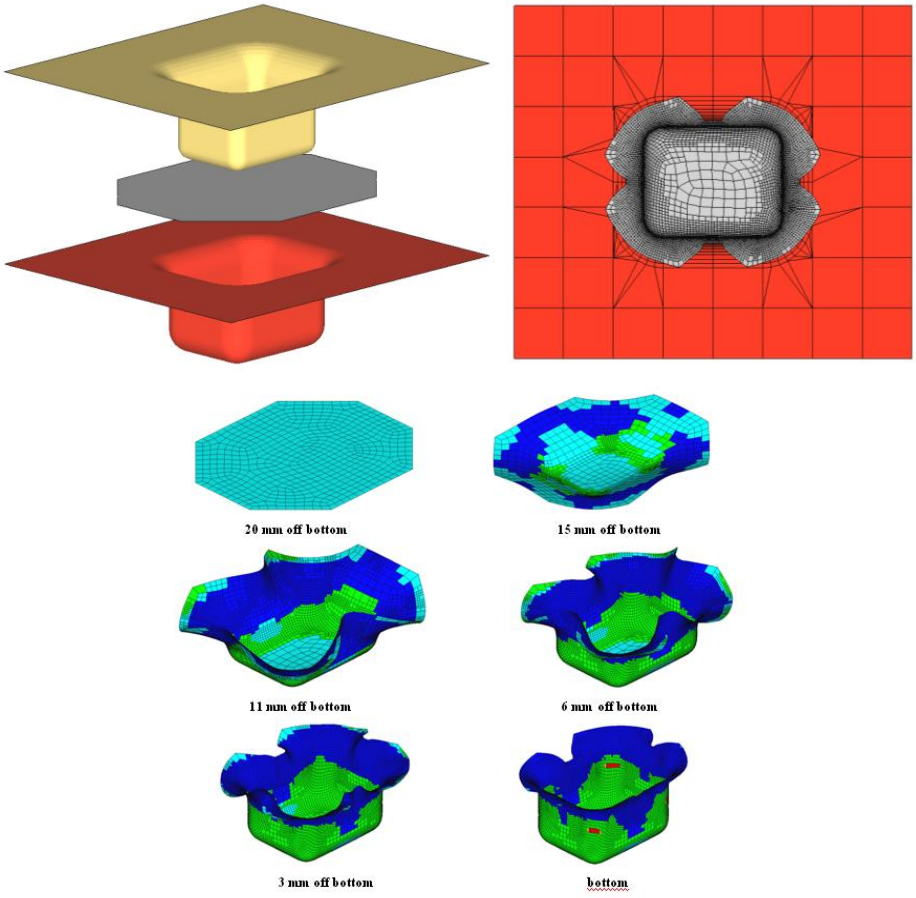
Upper Die Model , Lower Die Model and Blank Model ， Blank Final Shape Model ， Formability Step Model



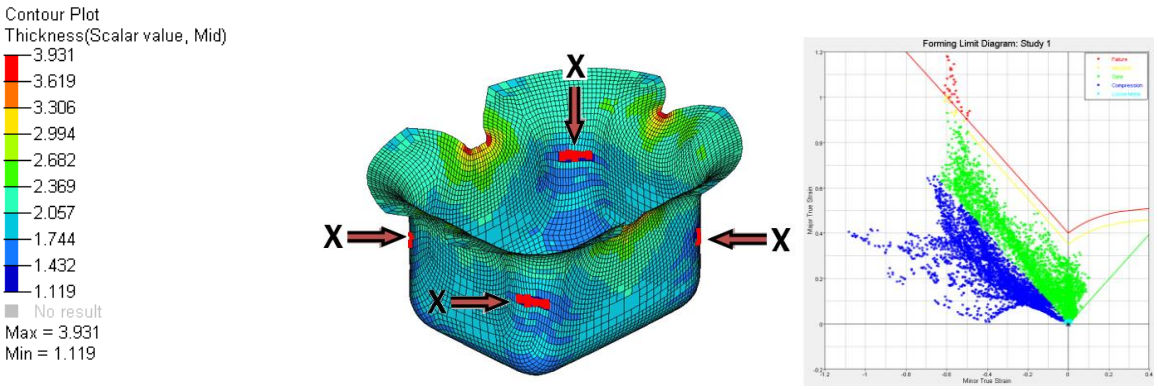
Thinning Model , Forming Limit Diagram

Figure 4. The results of a square blank sheet SUS 403 stainless steel deep drawing

6. The simulation results of drawing with the use of 45 degree angled edge cutting sheet made of 2 mm. thick SUS 403 stainless steel. The radius of punch and die was set steady at 5 mm. It was found that there was a chance that the workpiece would be damaged while drawing drawing in the curve area.



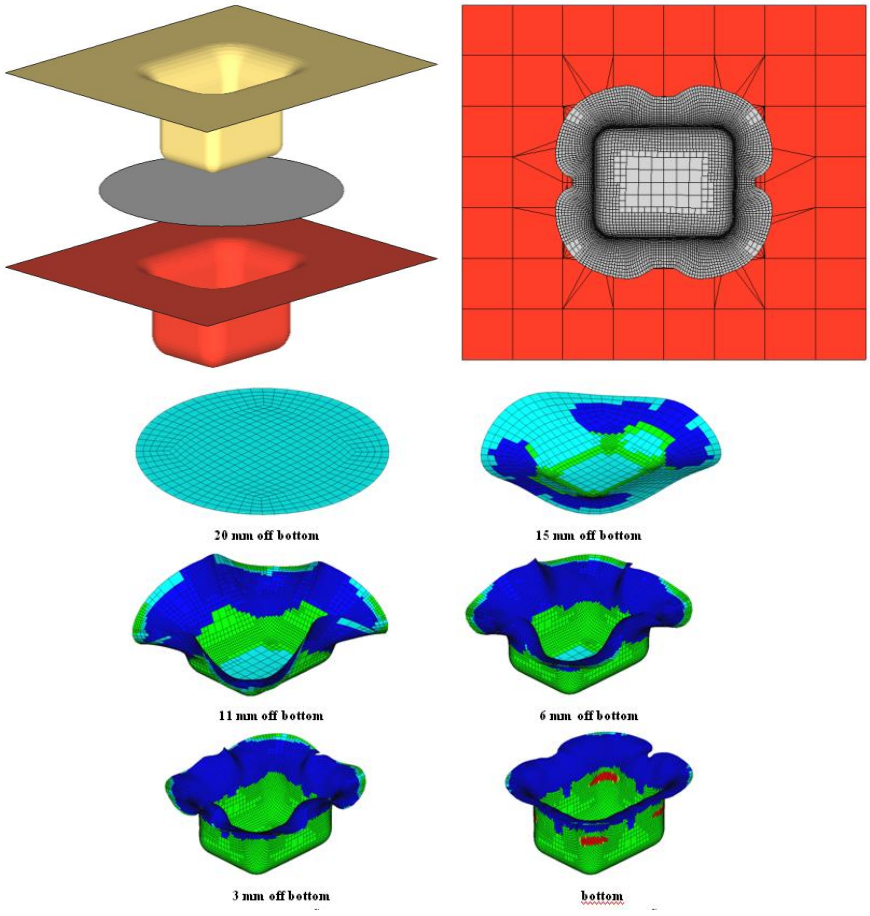
Upper Die Model , Lower Die Model and Blank Model , Blank Final Shape Model , Formability Step Model



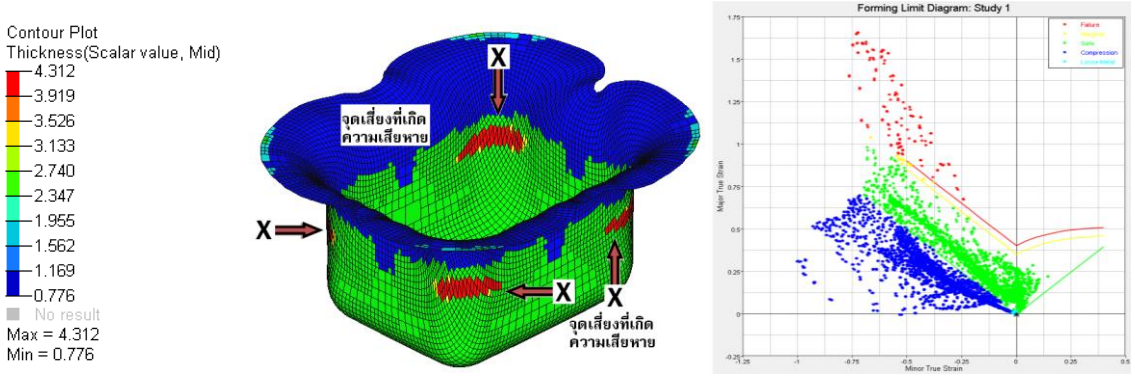
Thinning Model , Forming Limit Diagram

Figure 5. The results of a 45 degree angled edge cutting SUS 403 stainless steel deep drawing

6. The simulation results of drawing with the use of circularsheet made of 2 mm. thick SUS 403 stainless steel. The radius of punch and die was set steady at 5 mm. It was found that there was a chance that the workpiece would be damaged while drawing in the curve area.



Upper Die Model , Lower Die Model and Blank Model , Blank Final Shape Model , Formability Step Model



Thinning Model , Forming Limit Diagram

Figure 6. The results of a circular blank sheet SUS 403 stainless steel deep drawing

4. DISCUSSION

The rectangular shell deep drawing process usually has problems with flow in solid that not equal in each side which has an effect to real manufacture. This research started with the problems of entrepreneur who run business about making steel mould. They had to make the 24x30x20 mm and 2-mm. thick rectangular shell made from SUS 403 and SUS 304 stainless steel. There was no problems with making the mould but the problems was the type of blank sheet able to decrease the damage on workpieces surface during deep drawing process. There were 3 types of blank sheets before draw up: 1) square sheet 2) 45 degree angled edge cutting sheet 3) circular sheet. The researcher used finite element program to help in forming simulation, so it easier to choose the type of blank sheet before stamping a rectangular shell. The shell size was chosen by the entrepreneur. The radius of punch and die was set at 5 mm. The first step was to acquire the related information in order to set finite element program.

The results of the simulation on the ability of a rectangular shell deep drawing process by finite element program to obtain the analysis results of equivalent strain that happen in workpieces, showed the blank sheet model after forming. The researchers found that there was no risk that the workpieces would be damaged in using 3 types of blank sheet stampd a rectangular shell that made from SUS304 stainless steels. For using SUS 403 stainless steel sheet, there was no risk that the workpiece would be damaged when use the square sheets, but there were the risks that the workpiece would be damaged on radius of curvature area in stamping with 45 degree angled edge cutting sheet and round sheet. Thus, the researchers concluded that the best type of blank sheet for stainless was a square sheet.

5. CONCLUSION

This research is considered as adoption of deep drawing simulation technology by use finite element program to design deep draw mould. This research makes us understand the advantage of technology or using computer in computer-aided engineering (CAE). After the researchers have considered the results of simulation to obtain the workpiece which the customers want, they found that this method can decrease the risk and manufacture time. Especially, it can help us know that which type of blank sheet that can decrease the damage on workpiece surface during deep drawing process. Normally, there are 3 types of blank sheets before draw up: 1) square sheet 2) 45 degree angled edge cutting sheet 3) circular sheet. The researcher found that the appropriate sheet for deep drawing a 24x30x20 square cup stainless steel, SUS403 and SUS304 stainless steel, should be a square sheet because there is no risk that the workpiece will be damaged after forming.

ACKNOWLEDGEMENT

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