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Analysis of Process parameters by using Fluid Assisted Blank Holding System [FAB] for the steel 2062

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ABSTRACT: The capability of a deep drawing process majorly affects the output characteristics of the sheet metal component. Numerous approaches are employed to enhance the process capability of the deep drawing process. However the use of hydraulic pressure to attain the desired process characteristics has rarely been attempted. The current study therefore aims at developing a hydraulic pressure based Fluid Assisted Blank Holding system and analyzing the effect of process parameters viz. Punch force and Blank Holding force on the response parameters like Major strain, Minor strain average surface roughness and thickness reduction in deep drawing of MS alloy ,2062 by using a sophisticated photogrammetric measurement system ARGUS. The results indicate that the developed FAB system can be successfully implemented to generate wrinkle free surface for the deep drawn cup with reduction in the number of draws as compared to conventional mechanical blank holder.

Keywords: Fluid assisted Deep drawing Process, Fluid pressure, Wrinkle free surface, MS 2062.

1. INTRODUCTION

Sheet Metal deep drawing forming is one of the most widely used manufacturing process. The objective is to maximize the formability so that one can produce the deep drawing Cup with minimum no of draws. Similarity it also required maximize the depth of draw for given Quality of Sheet material. Deep drawing is process is simple no steady state forming process making the component of various shapes and sizes. The process looks like very simple it has several parameters determines the outcome and the analysis of process will be complicated.

The parameters involved in this process are Punch Radius, Blank Holding force, material properties, and stress -strain curve anisotropy Lubrication etc. To produce the good quality cup right combination of the parameters will be selected in deep drawing process. The maximum drawing is affected by material properties and stress needed radially draw the metal in to cavity. The drawing force and pressure are supplied by the punch.

During This Century Several Fluid pressure assisted blank holding in deep drawing processes have been established Distinguished amongst these contain hydroforming [1-5], hydro mechanical draw- ing [6-8], drawing alongside hydraulic counter force [9-13], aqua draw [14], deep drawing by hydrodynamic lubrication [15], & the outspread extrusion method A British patent describes a hydraulic method for producing annular cup objects A evaluation of some current hydro-mechanical deep drawing methods can be create in orientation The existing method is an adding to this list [5].

There are several methods for providing the power and drive for the drawing cups.in V Conservative deep drawing method it was achieved through advancement of punch stroke. In the FAB assisted process the power and energy are supplied by punch power and hydraulic force on the circumference of the blank with modified version as shown in fig 01.

The Fluid assisted blank holding system performs the contributing to the external applied force to deform the component to from the cup. Another important function is oiling the die circle in the process where the metal movements and by developing the punch force and blank holding force on the circumference of the blank due this condition extraordinary pressure liquid of enlarged viscosity, thereby cultivating the lubrication of drawing method.

The aim of this effort is Development of FAB system for the deep drawing method for uniform thinness circulation and strain rate. The purpose of this study to produce the wrinkle free surface and good surface finish by using FAB.

2. METHODOLOGY

2.1 Experimental Setup

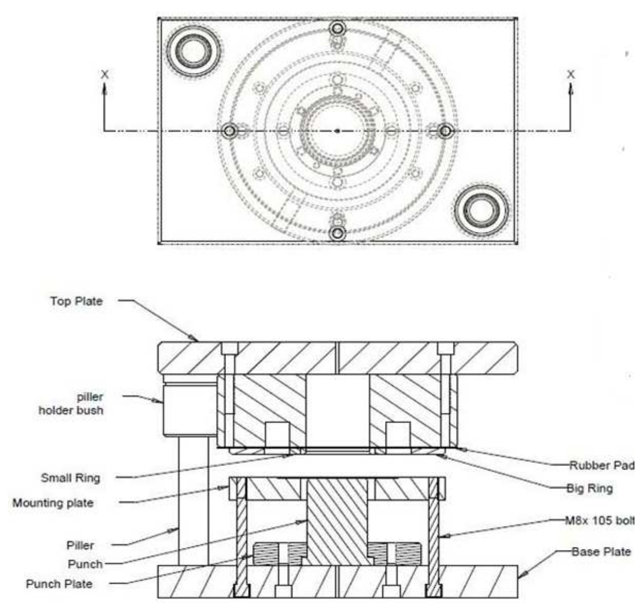

Figure 1: Fluid Assisted Blank Holding System

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2.2 Material Selection

For the conduction of Experiment on Fluid assisted Blank Holding System alloy steel 2062 of 1mm thickness are used having following Table 01 chemical composition.

Table 1: Chemical Composition of MS 2062 A

Element	C	Mn	S	P	Si	C.E.	Fe
% Present	0.20	1.5	0.045	0.045	0.4	0.39	Remaining

2.3 Experimental Set up along with Press Machine

Figure 1 shows the schematic of Fluid assisted blank holding system developed for the deep drawing process. The actual experimental set up as indicated in the figure 2 consists of FAB system mounted on the hydraulic power press, BEMCO with 100T magnitude, outward hydraulic power pack pressure range 0 to 100 Bar for blank holding. The precise process parameters values of punch force have been achieved by setting the frequency of closing and opening of hydraulic valve as 1 kHz. Blank holder of drawing tool is controlled by two cylinders with possibilities to regulate pressure during deep drawing process.

Figure 2: Press Machine

The initial step of research work series has been decided for the conduction of investigation work. Dual parameters blank holding force and Punch selected as contributing factors with 3 levels have been nominated for the material M S 5062.

2.4 Design of Experiment

Investigational statistics for deep drawing method is accompanied on Press In individual reading punch force and blank holding pressure are designated as contributing factors with range and 3 levels. Design of experimentation method is used full factorial method. By full factorial method total 9 turns and for better accurateness 3 duplicates are taken, hence total 27 runs are there [16]

2.5 ARGUS Method

ARGUS is a self-directed actual time ground universal Reconnaissance Imaging Method. It is an off line strain quantity method. It is an optical photogrammetry technique. The optimization of sheet metal forming methods, considering the correct material best and instrument optimization, is a significant factor for effectiveness; mainly in the Research the optical 3D forming analysis system ARGUS backings such optimization processes with precise results of the forming circulation of components.

Figure 3: ARGUS SET UP IIT Bombay

As a outcome of which the ARGUS arrangement deliver full-arena evidence about 3D coordinates of the module's surface, Form variation (major and minor strain), Thickness reduction, Forming Limit Diagram (FLD) [16]

2.5.1 Steps involved in Argus Method

A) Co-ordinate Determination and Scale bar Setting

Generally the working source of the ARGUS system is based on photogrammetry, too called remote recognizing. This method allows one to compute a three-dimensional geometry on the basis of a set of two-dimensional pictures. Because the ARGUS system works in grey measures, the photographs must be in black and white. The position of three-dimensional points of a body is determined by using a triangulation of directional bright bundles.

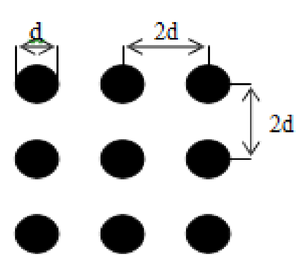

Figure 4: Grid Pattern

B) Taking Pictures

Taking the digital photographs can be regarded as the most

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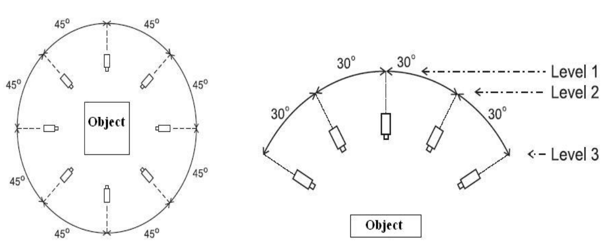
important step in obtaining good measurement results. Pictures of a low quality have a considerable negative influence on the computation of the grid. If for instance certain areas of the image are under or over exposed, the dots have insufficient contrast and so the computation may fail in that area, leaving gaps in the computed grid. The ARGUS system is equipped with a Baumer TXG50i having 2352 x 1728 pixels resolution. This camera is fixed onto a stand as shown in Fig. 03 This setup is adequate for small or medium size objects.

Figure 5: Loading and Fixing of cup on Rotating

C) Camera Positions

The camera positions must be chosen so that every image contains at least five bar-coded markers and that every etched dot is visible in at least three images taken from different directions. However, in practice it is wise to take more images in order to improve the precision and reliability of the calculated object-points. An effective method is to first create a basic set of pictures and then refine the image set as needed. The basic set can be constructed as shown in Fig. 6



(a) Top View (b) Side View

Figure 6: Camera positions for taking pictures of the object: (a) top view, (b) side view

D) Processing of Photogrammetric Data

In the processing stage two steps can be distinguished. First the computation of the ellipses and bundles is done and then the computation of the 3D-points and grid. The former step is the most important, because it converts the photographic data to geometrical data, which is crucial for the outcome of the further computations. In this step the software tries to recognize the ellipses and bar coded markers and from them computes the three-dimensional camera positions. In the latter step the recognized ellipses are converted to 3D-points which subsequently are used to generate the grid. The grid consists of elements that are created by using the 3D-points as nodes for each element. For both these steps some useful tips will be given to improve the computational results.

E) Computing ellipses and bundles

Directly after the pictures are uploaded the ARGUS program automatically starts with the determination of ellipses and markers in all of the pictures. After that choose ‘Compute Ellipses and Bundle’ from the project menu, after step one it may be necessary to ‘clean up’ some of the processed data and redo step one. This ‘cleaning up’ must be done in the ‘Project Mode’ and consists of two actions: ignoring images of poor quality and deleting or renumbering unidentified markers. Ignoring images of poor quality can be done easily by looking in the root of the image-group.

Sample Reading of Strain Measurement

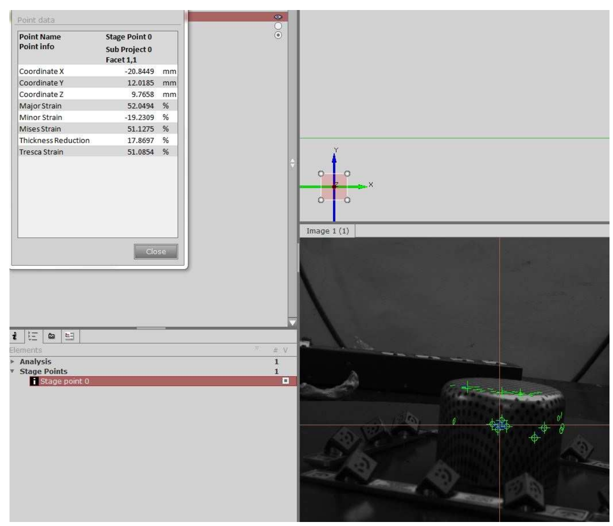


Figure 7: Sample Reading of Strain Measurement

The following Table Shows the DOE table and Experimental reading Taken on ARGUS method at IIT Mumbai

Table 2: DOE of Mild Steel

Punch Force	B.H.P	Major Strain (%)	Minor Strain (%)	Thickness Reduction (%)	Strain Deformation rate	Ra(μm)	Thickness mm [Micrometer]
14	10	54.1465	-18.5243	18.4682	0.357984236	0.957	0.8813

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16	8	54.6682	-18.241	17.7852	0.364546	0.874	0.873
12	8	49.2358	-15.4928	15.0463	0.294220909	1.387	0.8679
12	10	52.6845	-17.0652	17.0126	0.335335096	1.155	0.8701
14	8	52.9817	-17.2365	17.5268	0.334372381	0.969	0.8691
14	10	54.00423	-18.4963	18.0025	0.355394755	0.966	0.8841
12	10	52.4951	-17.6581	17.3215	0.335661244	1.155	0.8721
16	12	56.5423	-20.0143	20.0012	0.402929474	0.625	0.8715
12	12	54.0135	-16.5148	15.54682	0.345726961	1.093	0.8749
14	8	51.4561	-16.0165	17.0026	0.319775355	1.055	0.8672
12	12	53.9091	-15.6562	15.4963	0.342686207	0.983	0.8781
16	12	56.87	-20.0015	20.025	0.406727513	0.571	0.8751
14	10	53.3468	-18.04562	18.4985	0.349962843	0.941	0.883
12	12	53.0012	-16.4982	15.4982	0.339021463	1.065	0.8771
16	10	56.4236	-19.0256	19.5621	0.390928497	0.778	0.8759
12	8	49.3482	-15.50012	15.02365	0.293431312	1.333	0.8681
16	10	56.7452	-18.9886	20.2382	0.394446875	0.557	0.8765
12	8	51.2367	-15.6582	14.9802	0.305456164	1.253	0.8701
14	8	52.4263	-17.7002	18.3452	0.332353081	0.974	0.8654
16	8	54.9865	-18.3416	18.3654	0.368482915	0.816	0.8798
16	10	55.9986	-20.05636	19.6351	0.396119583	0.764	0.8765
16	12	57.6572	-20.8752	20.1012	0.415515344	0.521	0.8731
14	12	56.0013	-19.5472	18.9872	0.387428205	0.897	0.867
16	8	52.981	-18.514	18.465	0.359271357	0.791	0.88
12	10	52.8768	-17.0063	17.6582	0.337599517	1.267	0.8721
14	12	56.8762	-19.7852	19.6852	0.397209326	0.929	0.8846
14	12	56.5042	-19.8024	19.8621	0.39333299	0.901	0.8656

3. RESULT AND DISCUSSION

Factorial Regression: Major Strain (%) versus Punch Force, B.H.P

α to enter = 0.15, α to remove = 0.15

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	2	74.242	37.1210	70.80	0.000
Linear	2	74.242	37.1210	70.80	0.000
Punch Force	1	58.221	58.2210	111.04	0.000
B.H.P	1	16.021	16.0210	30.55	0.000
Error	24	12.584	0.5243		
Lack-of-Fit	6	1.583	0.2639	0.43	0.848
Pure Error	18	11.001	0.6111		

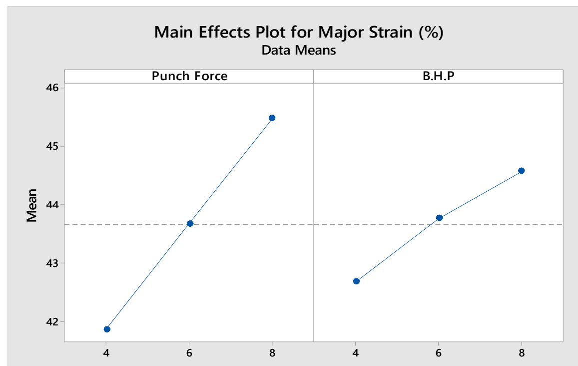

Figure 8: Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.724109	85.51%	84.30%	80.94%

The significance of p-value is, to determine the null hypothesis in a hypothesis test. In regular practice industries are considering the confidence level as 95 %. The 5% rejection defines the P-values. The theory behind p-value expresses that, when P-value is less than 0.05 then hypothesis testing defines the alternate hypothesis.

In above ANOVA the P-value is less than 0.05, describes the input parameters are Good in Fit.

Lack of Fit" which is exactly opposite to Goodness of Fit, In case of "Major Strain" the "Lack of Fit" obtained as 0.848 that indicate null hypothesis that means the model is fit.

R-square represents the relationship between one or additional forecaster variables. In general, the value of R2 is higher, the goodness of fits is observed. Response parameter "Major Strain" analyze the R2 as 85.51, defines a model is Fit.

R-Square adjacent is significant since it gives the increasing R2 value for any model when a new term/factor is added. For "Major Strain" we obtained the value of R-Square (adjacent) is 84.30%.

R-Square predicted is mainly used in regression investigation to specify how well the model forecasts responses for new observations, whereas R-Square indicates in what way fine the model fits the data. The predicted R-Square in "Major Strain" is observed as 80.94%.

The figure shows, Main effect of Punch Force and BHP on Major Strain, describes the inclination of line.

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Inclination of input parameters levels defines the significant effect of Punch Force and BHP on "Major Strain"

Factorial Regression: Minor Strain (%) versus Punch Force, B.H.P

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	2	60.621	30.3107	66.76	0.000
Linear	2	60.621	30.3107	66.76	0.000
Punch Force	1	15.006	15.0065	33.05	0.000
B.H.P	1	45.615	45.6148	100.46	0.000
Error	24	10.897	0.4540		
Lack-of-Fit	6	7.760	1.2934	7.42	0.000
Pure Error	18	3.137	0.1743		
Total	26	71.518			

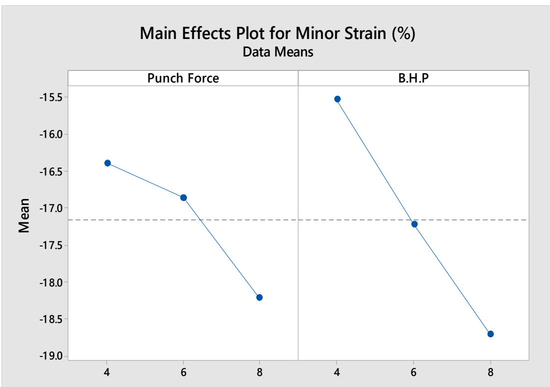

Figure 9: Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.673827	84.76%	83.49%	81.85%

In above ANOVA the P-value is less than 0.05, describes the input parameters are Good in Fit. Fig No 07

Lack of Fit" which is exactly opposite to Goodness of Fit, In case of "Minor Strain" the "Lack of Fit" obtained as 0.000 that indicate alternate hypothesis that means the model is not fit for Input Conditions. Hence there is need to work on input parameters for Minor Strain.

R-square represents the relationship between one or additional forecaster variables. In general, the value of R2 is higher, the goodness of fits is observed. Response parameter "Minor Strain" analyze the R2 as 84.76, defines a model is Fit. R-Square adjacent is important because it gives the increasing R2 value for any model when a novel term/factor is additional. For "Minor Strain" we obtained the value of R-Square (adjacent) is 83.49%.

R-Square predicted is mainly used in regression investigation to indicate how well the model predicts responses for new observations; whereas R-Square indicates how fine the model fits the data. The forecast R-Square in "Minor Strain" is observed as 81.85%.

The figure shows, Main effect of Punch Force and BHP on Minor Strain, describes the inclination of line. Inclination of input parameters levels defines the significant effect of Punch Force and BHP on "Minor Strain"

Factorial Regression: Thickness Reduction (%) versus Punch Force, B.H.P

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	3	61.966	20.6552	47.79	0.000
Linear	2	59.741	29.8707	69.11	0.000
Punch Force	1	44.806	44.8055	103.67	0.000
B.H.P	1	14.936	14.9359	34.56	0.000
2-Way Interactions	1	2.224	2.2242	5.15	0.033
Punch Force*B.H.P	1	2.224	2.2242	5.15	0.033
Error	23	9.941	0.4322		
Lack-of-Fit	5	8.087	1.6173	15.70	0.000
Pure Error	18	1.854	0.1030		
Total	26	71.906			

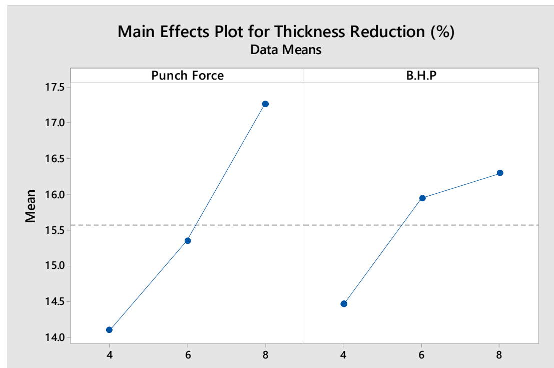

Figure 10: Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.657425	86.18%	84.37%	82.53%

.In above ANOVA the P-value is less than 0.05, Except Two Way interaction describes the input parameters are having good in Fit but need to work on interactions.

Lack of Fit" which is exactly opposite to Goodness of Fit, In case of "Thickness Reduction" the "Lack of Fit" obtained as 0.000 that indicate alternate hypothesis that means the model is not fit for Input Conditions. Hence there is need to work on input parameters for Thickness Reduction.

R-square represents the relationship between one or more predictor variables. In general, the value of R2 is higher, the goodness of fits is observed. Response parameter "Thickness Reduction" analyze the R2 as 86.18, defines a model is Fit.

R-Square adjacent is important because it gives the increasing R2 value for any model when a new term/factor is added. For "Thickness Reduction" we obtained the value of R-Square (adjacent) is 84.37%.

R-Square predicted is mainly used in regression analysis to indicate how well the model predicts responses for new observations, whereas R-Square indicates how well the model fits the data. The predicted R-Square in "Thickness Reduction" is observed as 82.53%.

The figure shows, Main effect of Punch Force and BHP on Thickness Reduction, describes the inclination of line. Inclination of input parameters levels defines the significant effect of Punch Force and BHP on "Thickness Reduction"

Factorial Regression: Ra (μm) versus Punch Force, B.H.P

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Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	2	0.262410	0.131205	84.00	0.000
Linear	2	0.262410	0.131205	84.00	0.000
Punch Force	1	0.228263	0.228263	146.13	0.000
B.H.P	1	0.034148	0.034148	21.86	0.000
Error	24	0.037489	0.001562		
Lack-of-Fit	6	0.005866	0.000978	0.56	0.759
Pure Error	18	0.031623	0.001757		
Total	26	0.299899			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.0395227	87.50%	86.46%	83.77%

In above ANOVA the P-value is less than 0.05, describes the input parameters are Good in Fit. Lack of Fit" which is exactly opposite to Goodness of Fit, In case of "Surface Roughness" the "Lack of Fit" obtained as 0.759, that indicate null hypothesis that means the model is fit.R-square represents the relationship between one or more predictor variables. In general, the value of R2 is higher, the goodness of fits is observed. Response parameter "Surface Roughness" analyze the R2 as 87.50, defines a model is Fit. R-Square adjacent is significant since it gives the increasing R2 value for any model when a new term/factor is added. For "Surface Roughness" we obtained the value of R-Square (adjacent) is 86.46%. R-Square predicted is mainly used in regression analysis to indicate how well the model predicts responses for new observations, whereas R-Square indicates how well the model fits the data. The predicted R-Square in "Surface Roughness" is observed as 83.77%. The figure shows, Main effect of Punch Force and BHP on Surface Roughness, describes the inclination of line. Inclination of input parameters levels defines the significant effect of Punch Force and BHP on "Surface Roughness".

4. CONCLUSION

The above investigation encompassed development of the a novel Fluid Assisted Blank (FAB) Holding system so as to enable analysis of the process parameters viz. Punch force and Blank holding force on out parameters namely Major strain, Minor strain, strain rate, thickness distribution. The experimental exploration and subsequent data acquisition has been carried by highly sophisticated and advanced photogrammetric technique; ARGUS. Statistical analysis of the gleaned data indicates that the proposed FAB system can be efficaciously used for generating wrinkle free sheet metal cups. Further the ANOVA results indicate that punch force is the most contributing factor for Major strain while the Minor strain ifs most significantly affected by blank holding force whereas the average surface roughness and thickness reduction are substantially affected by punch force.

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