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Evaluation of Deep Drawability Characteristics of Mild Steel and Brass

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ABSTRACT: Deep drawability is one of the forming characteristics of sheet metal. It is a function of sheet metal thickness and strain hardening exponent. So there is a need to study deep drawability in sheet metal forming processes. In cup drawing process the sheet is formed to cup shape. In this process the metal is stretched radially by tensile forces produced by punch, but it is compressed circumferentially as its diameter decreases. Deep drawability is a measure of the ability of sheet metal to be formed successfully into useful components without developing any failure. The common failures encountered during sheet metal forming are fracturing, wrinkling, shape distortion, loose metal. Deep drawability expressed through limiting drawing ratio, so deep drawability is the function of limiting drawing ratio of sheet metals. Limiting drawing ratio is used to measure the forming characteristics of sheet metals in sheet metal forming technology. The forming characteristics of sheet metals were deep drawability. Limiting drawing ratio is expressed as the ratio of maximum diameter of blank to diameter of punch. The maximum diameter shows that, in cup drawing operation of circular blank which gives the successful formation of cup. In this methodology, mild steel and brass material selected. Mild steel is a type of carbon steel with a low amount of carbon, it is actually also known as low carbon steel. It is one of the reasons why carbon steel (mild steel) is popular in many industries from the manufacture of household items to structural applications. Brass is an alloy of copper and zinc, in proportions which can be varied to achieve varying mechanical and electrical properties. Brass is stronger and harder than copper, but not as strong or hard as steel. It is easy to form into various shapes and good workability. The deep drawability of mild steel and brass are evaluated. The highest value deep drawability is to be obtained in brass material than mild steel. So brass is to better forming characteristics nature and workability in sheet metal forming.

KEY WORDS: Deep drawability, brass, mild steel, cup drawing, maximum diameter

I. INTRODUCTION

In cup drawing process, fracture of cup occurred in this process caused by too small die corner radius. The too small corner radius on the die can cause fracture of cup at die corner. The too small corner radius on the punch can cause fracture of cup at punch corner. And also fracture is the function of clearance. If the clearance is too small, the blank may simply be pierced or sheared by punch. In the drawing process compressive stresses are produced in the circumferential direction and radial stresses are in radial direction [1]. If these stresses reach critical level characteristics of the material thickness, it causes slight undulations known as buckles. Buckles may develop into more pronounced undulations (or) waves known as wrinkles. Formation of wrinkles in cup depends on blank holding pressure. The deep drawability of sheet metal depends on strain hardening coefficient (n value), strain rate sensitivity (m value), an isotropic factor (r value). Deep drawability of sheet metal can be evaluated using swift cup drawing test and other cup tests. This can be expressed as Limiting drawing ratio(LDR).The results of these deep drawability tests are used for grading, selecting and sorting of incoming sheet metals for manufacturing of various components[2-4].

The r-value is an isotropic factor is a measure of the ability of the material to resist thinning. An isotropic factor is divided into average normal an isotropy (rm) and planar anisotropy(r). The value of rm determines the average depth of deepest draw possible. The value of r determines the extent of earing. A combination of a high rm value and a low r-value provides optimal drawability [5-7]. At high n and m values lead to good deep drawability in stretching operations but have little effect on drawability. In drawing operation, metal in the flange must be drawn without causing fracture in the wall. In this case high n and m values strengthen the wall which is beneficial , but they also strengthen the flange

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and make it harder to draw in which is detrimental[8].The effect of temperature on deep drawability is when the temperature increases, n decreases, m increases, ductility and toughness increases and yield stress and Young's Modulus decreases. There is great interest in the cup drawing process because there is a continuous demand on the industry to produce light weight and high strength components [9-10]. For optimal formability in a wide range of applications, the work materials should be distribute strain uniformly, reach high strain without fracturing, with stand in plane compressive stresses without wrinkling, with stand in-plane shear stresses without fracturing, retain part shape upon removal from the die, retain a smooth surface and resist surface damage

II. EVALUATION OF DEEP DRAWABILITY

Evaluation of deep drawability characteristics of sheet metals carried through cup drawing test using Finite Element Simulation. In the cup drawing test, the materials tested are Mild steel MS (AISI 1006) and Cartridge brass. The finite element simulation cup drawing test set up is shown in Fig.2.1 for material MS (AISI 1006) and through the same setup is used for other material.

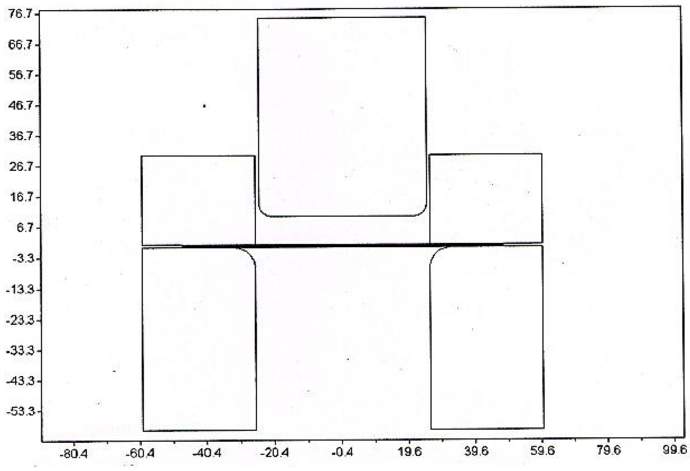

Fig.2.1 Cup Drawing of sheet metals.

Determination of limiting drawing ratio (LDR) from different diameters of blanks with constant thickness of sheet metals. This is used to measure of deep drawability. The deep drawability is expressed by Limiting Drawing ratio.

$$\text{Limiting Drawing ratio (LDR)} = D/d$$

Where D = Max. blank diameter of successful formation of cup or Critical diameter of the blank
d = Punch diameter

In cup drawing finite element simulation test the sheet metal blanks with different diameters and with constant thickness are performed as one by one drawn into the formation of the cup successfully or fracture at bottom of the cup by using flat bottom cylindrical punch. Under this test the blank which gives successful formation of cup just before fracture, is called largest blank. Corresponding to this blank diameter is called maximum diameter of blank or critical diameter of the blank (D). Above this critical diameter fracture is occurred in cup. Just below and at this diameter cup performs successfully. This diameter is used for determination of LDR.

III. RESULTS AND DISCUSSION

The observations and results are obtained from finite element simulation of cup drawing test for MS (AISI 1006) and Cartridge brass sheet metals at blank thickness 1.3mm, punch speed 12mm/sec, diameters of blanks for MS (AISI 1006) and cartridge brass is 75-95mm, diameter of punch d = 50 mm, blank holder force 800N and coefficient of friction is 0.06 are shown in Table.1

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Table.1.Results of Finite element simulation of cup drawing

Material	Maximum diameter or Critical diameter of blank (D) mm	LDR D/d	Deep drawability
MS(1006)	86	1.72	1.72
Cartridge brass	92	1.84	1.84

The time load characteristics of cup drawing of sheet metal as shown in Fig.3.1

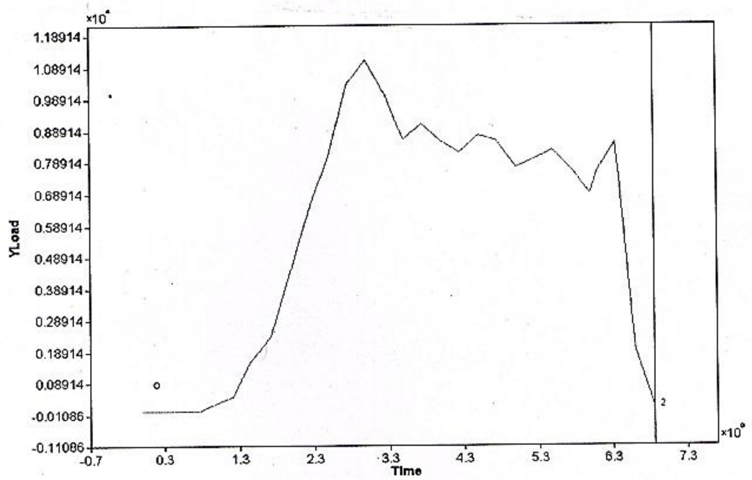

Fig.3.1 Time – Load characteristics of sheet metal.

In successful formation of cup, thickness of the wall, thickness of the bottom is decreasing with increasing with cup height. From load-time graph to obtain maximum load and time for formation of the cup .In the graph decremented steps obtained due to strain hardening experiment of the material. By Comparing of LDR of cartridge brass is greater than MS. Larger LDR is greater the ability of sheet metal to be drawn successfully without fracture

IV. CONCLUSION

The critical diameter of the blank is obtained from cup drawing test through finite element simulation. This diameter is used to determine limiting drawing ratio. So LDR is the deep drawability of this test. Deep drawability is a conceivable that given sheet metal could be formed successfully into particular component depending upon the process conditions and the tooling used. By comparison of deep drawability for these sheet metals, cartridge brass is having high value. So this sheet metal is having greater deep drawability characteristics. Deep drawability of sheet metals is used for grading, selecting and sorting of incoming sheet metal for manufacturing of various components in industries. It would allow better quantification of the formability of sheet metals, taking into account the synergistic interaction of sheet metal intrinsic properties and processing conditions during processing operations.

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