DETERMINATION OF FORMABILITY INDEX OF SHEET METALS

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ABSTRACT - Formability index is determined through erichsan cupping test. This is the one of the sheet metal forming test. In Erichsan cupping test, a single specimen with required dimension drawn into cup shaped until the fracture occurred at dome of cup by the force applied through continuous movement of hemispherical punch into specimen of sheet metal. The cup height at fracture and peak load is measured. These are used as a measure of the formability index. Cup height at fracture is measured in 'mm' as Erichsan number. Cup height at fracture is used as the measure of stretchability. The formability index can be expressed as erichsan number and peak load. In this test a spherical punch is used to evaluate the formability characteristics of sheet metals. In this test the formability characteristics of sheet metals such as alloys of aluminum, mild steel, titanium and also cartridge brass are studied through finite element analysis.

Key words: Formability index, stretching, peak load

1. INTRODUCTION

Research and development in sheet metal forming processes requires lengthy and expensive prototype testing and experimentation in arriving at a competitive product. The overall quality and performance of the object formed depends on the distribution of strains in the sheet material. Material properties, geometry parameters, machine parameters and process parameters affect the accurate response of the sheet material to mechanical forming of the component. The formability characteristics are can be evaluated through different formability tests. The tests are intrinsic tests and simulative tests. In the category of simulative tests such as bending tests, drawing tests, stretching tests and combined mode of tests. The formability characteristics of different sheet metals such as erichsan number and peak load can be studied from erichsan cupping tests. This test is under the category of stretching [1-3]. In this process the blank is generally pulled over the draw punch into the die; the blank holder prevents the wrinkling taking place in the flange. There is great interest in the process because there is a continuous demand on the industry to produce light weight and high strength components. Design in sheet metal forming, even after many years of practice, still remains more an art than science. This is due to the large number of parameters involved in stretching and their interdependence. These are material properties, machine parameters such as tool and die geometry, work piece geometry and working conditions. [4-6]. The effect of material properties on formability as the properties of sheet metals varies considerably, depending on the base metal (steel, aluminum, copper, and so on), alloying elements present , processing , heat treatment, gage, and level of cold work. Some processes can be successfully operated using work material that has a wide range of properties. In general, consistency in the forming properties of the work material is an important factor in producing a high output of dimensionally accurate parts.

For optimal formability in a wide range of applications, the work materials should: distribute strain uniformly, reach high strain with out fracturing, with stand in plane compressive stresses with out 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. Some production processes can be successfully operated only when the forming properties of the work material are with in a narrow range[7-10]. More frequently, the process can be adjusted to accommodate shifts in work material properties from one range to another, although some times at the cost of lower production and higher material waste. In selecting material for particular application, a compromise usually must be made between the functional properties required in the part and the forming properties of the available materials.

2. METHODOGY

In this paper the Finite element simulation of erichsan cupping test has been performed. The materials are tested in this test are aluminum alloy (Al 1100), mild steel (AISI1006), catridge brass and titanium alloy is 13V 11Cr 3Al,C. The FEA test set up and dimensions of tooling are shown in fig.1 for evaluation of formability index for material mild steel. Though same FEA setup used for other three materials.

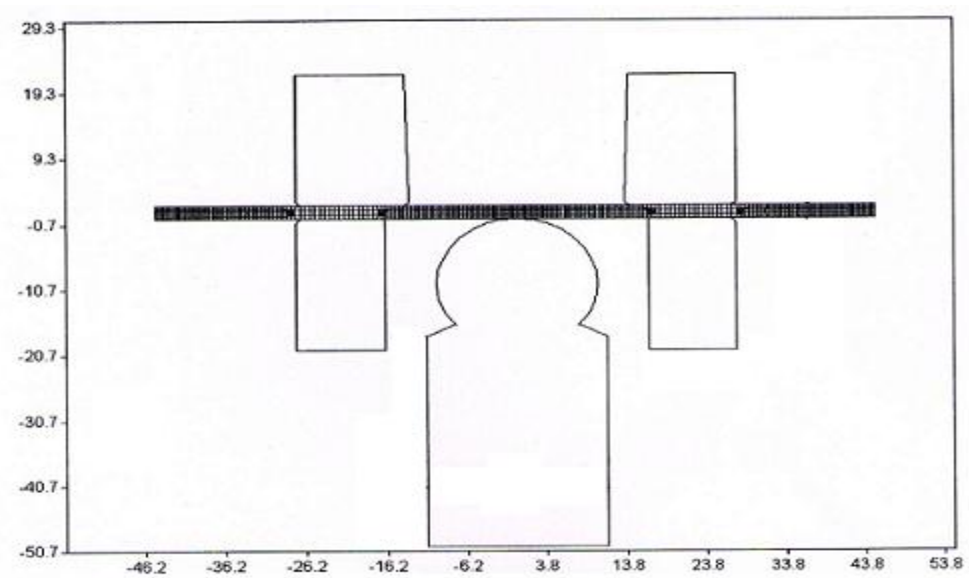

Fig.1. Erichsan cupping test setup for evaluating the formability index

In this test the blank with given diameter and thickness is clamped between die surface and blank holder (retaining ring) drawn into cup shaped until the fracture is occurred at dome of the cup by force applied and through continuous movement of hemispherical punch into blank material. From this test cup height at the fracture is measured and peak load is measured. So formability expressed as cup height at the fracture in mm and peak load. Cup height at the fracture in mm is measured as Erichsan number. Formability index is expressed as Erichsan number and peak load.

The results of simulation carried out using three materials at

Thickness of blank $t = 1.5$mm

Coefficient of friction $\mu = 0.1$

Punch speed u = 5mm/sec

Diameter of blank D = 95mm

Blank holding force F = 90kN

Hemispherical Punch diameter d = 20mm

The results are shown in table 1 and Fracture of material during the cup formation as shown in fig.2

Table.1.Results of test

Material	Cup height at the fracture (mm) [Erichsan number]	Peak load N	Formability Index Expressed	
			Erichsan number (mm)	Peak load N
Al 1100	17.68	6980	17.68	6980
MS[AISI 1006]	15.5	34968	15.5	34968
Catridge Brass	19.26	54352	19.26	54352
Titanium alloy 13V 11Cr 3Al,C	13.24	107126	13.24	107126

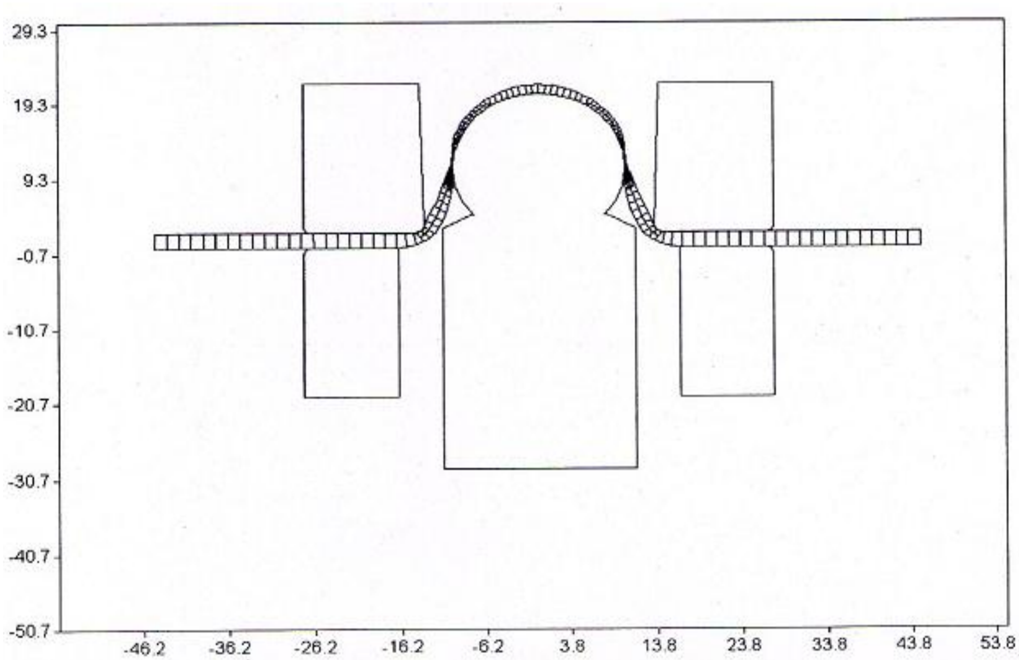

Fig.2 Fracture of material during the cup formation

3. RESULTS AND DISCUSSION

In this test formability index expressed erichsan number. The Erichsan number is expressed as height of cup at fracture is in mm.Height of cup at fracture is used to measure the stretch ability. Formability index for aluminum alloy is 17.68mm and 6980N, mild steel 15.5mm and 34968N, catridge brass is 19.26mm and 54352N and titanium alloy is 13.24mm and 107126N. The comparison formability index according to height is less for titanium alloy and high in catridge brass. According to peak load formability index low in aluminum alloy and high for titanium alloy. The maximum load during the test is obtained as less value of is in Aluminum alloy, high in titanium alloy. In this operation the thickness is decreased to up to fracture is obtained. The fracture is occurred at dome of cup. Because at that in the hemispherical punch continuously stretching of thickness reduced then fracture is occurred. Blank holder to prevent the certain extent of sheet blank. This test deforms the blank into the shape of hemispherical dome. Erichsan number is depends on thickness, as thickness is increased Erichsan number is increased.

4. CONCLUSION

The conclusions are drawn for formability index of sheet metals through erichsan test. It involves testing only single specimen such as sheet metal blank. In this test cup height at the fractures is measured and peak load is calculated. These are used as a measure of formability index. The formability index expressed in terms of erichsan number. The erichsan number is measured as cup height at fracture and peak load. Cup height at the fracture in mm is measured as erichsan number. Comparing the values of erichsan number of four materials, the erichsan number is high in catridge brass. So this material has better formability nature. The peak load higher for titanium alloy. The erichsan number depends on thickness of blanks. Erichsan test is used to measure the capability of sheet metal to be stretched before fracture. The erichsan number is increased with increasing the thickness of blank. Then based on the actual component geometry one can decide which formability index should be used as a criterion for selecting the sheet metal for that component. It is measure the capability of the sheet material to be stretched before fracture.

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