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Determination of Formability Index for Ninetydegrees Sheet Roll Direction Welded Joint

[1]K.C.Sabitha, [2] Dr.R.Uday Kumar

[1]*Assistant Professor, Dept.of Mechanical Engineering, Mahatma Gandhi Institute of Technology, Gandipet, Hyderabad-500075*

[2]*Associate Professor, Dept.of Mechanical Engineering, Mahatma Gandhi Institute of Technology, Gandipet, Hyderabad-500075*

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ABSTRACT

Sheet metal forming is the process of converting a flat sheet into a part of desired shape without fracture or excessive localized thinning. In the manufacture of most large stampings, a sheet metal blank is held on its edges by a blank-holder ring and is deformed by means of a punch and die. The moment of block into the die cavity is controlled by pressure between the upper and lower parts of the blank-holder ring.Material properties, geometry parameters, machine parameters and process parameters affect the accurate response of the sheet material to mechanical forming of the component.Erichsen number of metal sheet indicates the stretching ability.This paper presents experimental analysis of forming characteristicsof sheet metal welded blanks of two different materials such as Austenitic Stainless Steel 304 (ASS 304) and mild steel with same thickness are found out. The specimens of sheet metal welded blanks of mild Steel, austenitic stainless Steel 304 (ASS 304) with reference to 90°roll direction is prepared and welded using Tungsten Inert Gas welding.Formability Index is expressed through Erichsen Number. Formability Index is the measure of the capability of the sheet material to be stretched before fracture. To find out the Erichsen number the welded sheet metal blank with dimensions is clamped between die surface and blank holder (retaining ring) and then drawn to cup until the fracture is occurred at dome of cup by the application of force and through continuous movement of hemispherical punch into blank material. The hemispherical punch moves continuously into sheet metal welded blank until the fracture occurs at dome of cup, corresponding cup height at fracture is measured. The cup height at the fracture is taken as measure of formability index. Formability index is expressed as cup height at fracture. The cup height at fracture in millimeters is measured as Erichsen number.

Key words: Sheet metal welds, Erichsen number, Formability Index, Stretchability

I. INTRODUCTION

Two or more sheet metals which are welded together prior to forming are known as sheet metal welded blanks. The sheet metal welded blanks may be different in size, shape and even in thickness too. The blanks may be also differ in sense of coating and material grade. One continuous blank is formed by welding the different blanks .Sheet metal welded blanks reduce the manufacturing costs and weight and also improves the quality of the components. As the demand for different types of sheet metal welded blanks is increasing, the effects of difference in material properties, mechanical properties, forming characteristics, weld properties and its orientation on blank formability become important in various forming processes. 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. 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. [1-3].The formability characteristics of different sheet metals such as Formability Index and peak load can be studied from Erichsen cupping tests. This test is under the category of stretching operation [4-8]. In this process the blank

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is generally pulled over the draw punch into the die; the blank holder prevents to move 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. The effect of material properties on formability as the properties of sheet metals varies considerably, depending on the base metal (steel, aluminium, 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 without fracturing, withstand in plane compressive stresses without wrinkling 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 within a narrow range[9-12].The process can be adjusted to accommodate shifts in work material properties from one range to another, although. 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.

II. EXPERIMENT DETAILS

Formability Index is one of the forming characteristics of sheet metals under forming operation. The Erichsen cupping test is a ductility test which is employed to evaluate the ability of metallic sheets and strips to undergo plastic deformation in stretch forming.The test consists of forming an indentation by pressing a punch with a spherical end against a test piece clamped between a blank holder and a die, until a through crack appears on the test specimen.

Erichsen cupping test is used to evaluate the Formability Index. It consists of hemi spherical punch, blank holder, die with blank supporting plates. The diagram of Erichsen cupping test is shown in fig.1

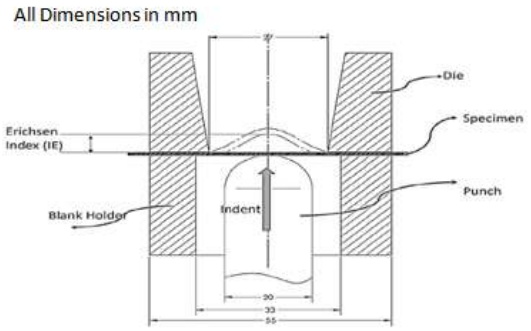

Fig.1 Erichsen Cupping Test

This test belongs to stretching operation. In this test the blank (specimen) with dimensions is clamped between die surface and blank holder and drawn to cup until fracture is generated or appears on the dome of the cup by the force applied through continuous penetration of hemispherical punch into the blank material.Formability Indexfor the sheet metal welded specimens of ASS 304 and Mild steel of dimensions90 mm x 90 mm and with 2 mm thickness of specimen is evaluated through the Erichsen cupping test machine.The preparation of specimen of sheet metal welds is carried out with TIG welded. The sheet metal welded blanks of Mild steel and ASS 304 of the following dimensions 90 mm x 45 mm, 90 mm x 45 mm are cut from the sheets with respect to 90^0roll direction and combined to form a sheet metal welded blank of 90 mm x 90 mm.Fig.2 represents sheet metal welds in different sheet roll direction.

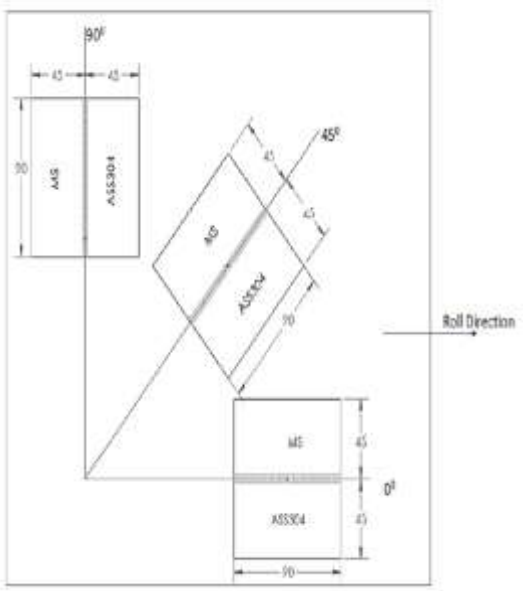

Fig.2 Sheet metal welds of Mild steel &ASS 304 in different sheet roll directions

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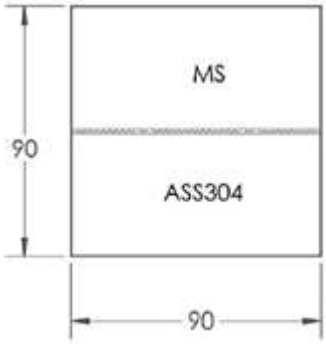

Fig.3 Specimen of 90° Sheet metal welded blanks for Erichsen Cup test

Fig.3 indicates the 90° sheet metal welded blanks used in Erichsen Cup test to determine Formability index.The final dimension of Sheet metal welded blanksmade of Mild steel and ASS304 is 90 mm x 90 mm with thickness of 2mm,which are TIG welded. The specimen of sheet metal welded joint of 90 x 90 mm is tested through Erichsen cupping test.In this process the hemispherical punch moves continuously onto the sheet metal welded blank and cup height is measured at point of fracture on the dome of the cup.The fracture occurred in deformed cup near and around weld region. The height of the cup at the fracture is taken as measure of formability.Formability index is indicated by the height of the cup at the fracture, measured in millimeters. Height of the cup at the fracture gives the formability index. The evaluated parameters are shown in Table 1

Table1 Evaluated parameters- Erichsen test

Sheet roll direction of sheet metal welds	Cup height at fracture during formation of cup (mm)	Formability Index
90^0	13.69	13.69

The deformed specimenof sheet metal welded jointsobtained from Erichsen test is shown in fig.4

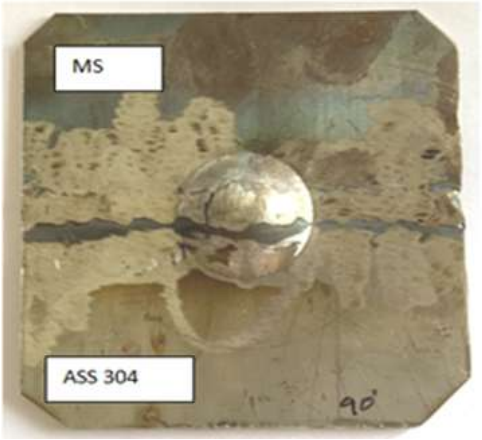

Fig.4 Deformed sheet metal welds specimens after Erichsen cupping test

III. RESULTS AND DISCUSSION

Formability Indexis determined for 90°sheet metal weld joints. Formability Indexis expressed by k.It is used for measuring the formability of sheet metal welded jointsand also its stretchability.Formability Index is the formation of cup height at the fracture during deformation. Formability Index for 90°sheet metal welds is obtained as 13.69 mm.Erichsen number for 90°sheet metal welded joint is shown in fig.5

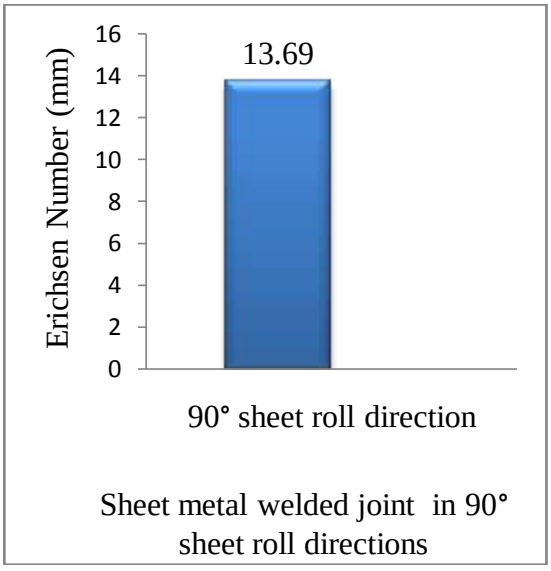

Fig.5. Erichsen Number for 90° Sheet metal welded joint

IV. CONCLUSIONS

- Formability Indexhas been determined for Sheet metal welded blanksof MS and ASS 304 with respect to roll directions 90°.

- Formability Indexobtained for 90 degree is 13.69mm.
- Formability Index is represented through Erichsen number.
- The higher value of Erichsen number of 13.69mm in the 90° sheet metal welded blanksshows greater formability.

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