INVESTIGATION ON THE DIFFERENT TYPES METHOD OF JOINING FOR AUTOMOTIVE PANEL

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ABSTRACT

In this paper, the objective is to study Quality comparison between different type methods of joining in tailor welded blank and Selection the type of welding process used to make a tailor blank. Tailor-welded blanks (TWBs) of the different material and with different thickness combinations were welded together to form a single part before the formability process . Thus, SPCC steel sheets of thickness of 0.7 and SPHC steel sheet of thickness 1.2 were studied and combined to form TWBs .Different types of welding such as ,shield metal arc welding(SMAW), metal inert gas welding(MIG), tungsten inert gas welding(TIG) and laser beam welding was used to weld the tailor-made blanks before the formability tests of the uniaxial tensile test. The experimental findings show those TWBs of different types of welding shows different strength and also different elongation and the effect to the parent material. The uniaxial tensile tests show that there are no significant differences between the tensile strengths of TWBs and their relative base metals.

ABSTRAK

Objektif dalam thesis ini adalah untuk mengkaji perbandingan kualiti diantara empat jenis kimpal yang berlainan mesin dan juga pemilihan mesin kimpal yang digunakan dalam process "adunan kepingan dikimpal".Proses adunan kepingan dikimpal yang mengunakan berlainan kepingan logam dan mempunyai kombinasi ketebalan yang berbeza dikimpal bersama untuk membentuk satu kepingan sebelum process pembentukan.Oleh itu kepingan logam SPCC yang berketebalan 0.7 mm dan kepingan logam SPHC yang berketebalan 1.2mm dikaji dan disambung bersama untuk membentuk proses yang dipanggil adunan kepingan kimpalan.Perbezaan diantara jenis mesin kimpal seperti shield "metal arc welding," "metal inert gas welding", "tungsten" "inert gas welding" dan "laser beam welding" digunakan untuk mengimpal kepingan logam tersebut sebelum melalui ujian kebolehtarikan. Penemuan ujikaji menunjukkan bahawa proses adunan kepingan kimpalan yang menggunakan berlainan proses kimpalan mempunyai kekuatan dan kebolehan pemanjangan yang berbeza kesan kepada specimen yang dikaji.Ujikaji juga menunjukkan bahawa tiada perbezaan yang ketara diantara kekuatan kimpalan dan bahan ijikaji itu sendiri.

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P	-	Pressure
F	-	Force
A	-	Area
E	-	Modulus of Elasticity
σ	-	Stress
e	-	Strain
ε	-	Strain
L	-	Length
L_i	-	Instantaneous length
L_o	-	Initial length
ΔL	-	Change in length

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CHAPTER 1

INTRODUCTION

1.1 Project background

Nowadays, the automotive industry is working toward reducing fuel consumption and weight reduction. In order to realize this effort, a significant portion is focused on reducing the overall vehicle weight. To overcome this problem, tailor welded blank of steel are in production use to improve automotive parts in terms of scrap, weight, cost, strength, stiffness, and quality.

A TWB is composed of more than two materials with similar or different strengths or thicknesses joined together to form a single part before the forming operation. This joining of various sheets into a single blank enables automobile designers to tailor the location in the blank where material properties are located leading to reduced weight, improved part stiffness, and lower manufacturing costs due to elimination of process dies and reduced scrap. The main advantage of using a TWB is that it gives thicker or stronger materials at critical parts of the sheet metal blank so as to increase the local stiffness. This can also reduce the weight of automotive panels. Weight savings can have a marked effect on a vehicle's efficiency, with research showing that a 1% reduction in vehicle weight can result in a 0.6–1% reduction in fuel consumption.

When introducing the technology of tailored welded blanks, it is important to select the materials, shape and thickness of the product correctly, but it is also important to select a proper welding process for joining tailored blanks. Welding is the one importance for successful introduction of the production of tailored blanks into the manufacture of final products (door inner).There are many types of welding processes are known today such as TIG welding ,MIG welding ,Shield metal ARC welding and laser beam welding. Welding is a materials joining process in which two or more parts are coalesced at their contacting surfaces by a suitable application of heat or pressure. Welding is most commonly associates with metal part and it also provides a permanent joint. Welding usually the most economical way to joint the component in terms of material usage and fabrications cost.

1.2 **Problem statement**

I. The increasing demand for improved fuel efficiency and weight reduction make theautomotive industry to seek methods to reduce the weight of existing vehicle structures.
II. Selection the type of welding process used to make a tailor welded blank can greatly affect cost, efficiency and performance

1.3 **Objective of the project**

I. Quality comparison between different type methods of joining in tailor weldedblank
II. Determine the strength of the joining process by using tensile test machine.

1.4 Project scope

This research is focus on method joining of automotive panels which is to investigate the best method of joining process for door inner car. This focus area is done based on the following aspect:

I. The material used in the project which is limited to normal draw steel and hardens steel, (cold roll steel sheet and hot roll steel sheet). This material were used to produce tailor welded blanks with different thickness

II. The equipment used in this project .There are several type of welding machine such as MIG welding machine, TIG welding machine, seam welding machine and ARCwelding machine.

III. The machine which is tensile test to make tensile test of the specimen.

CHAPTER 2

LITERITURE REVIEW

2.1 Definition of Tailor Welded Blank

Tailor welded blank, is multiple sheets of material are welded together prior to the forming process. The differences in the material within a TWB can be in the thickness, grade, or coating of the material for example galvanized versus none galvanized. When creating a tailor welded blank, designers are able to tailor, hence the name, the location in the blank where specific material properties are desired. Forming of tailor welded blank forming tailor welded blank is challenging due to a significant reduction of formability associated with this type of blank. First, material property changes in the heat-affected zone of the weld decrease the potential strain in the material prior to tearing failure. The thinner part of tailor welded blank maybe undergoes deformation than the thicker part which is stronger material in the forming area. (Kinsey, 2003)

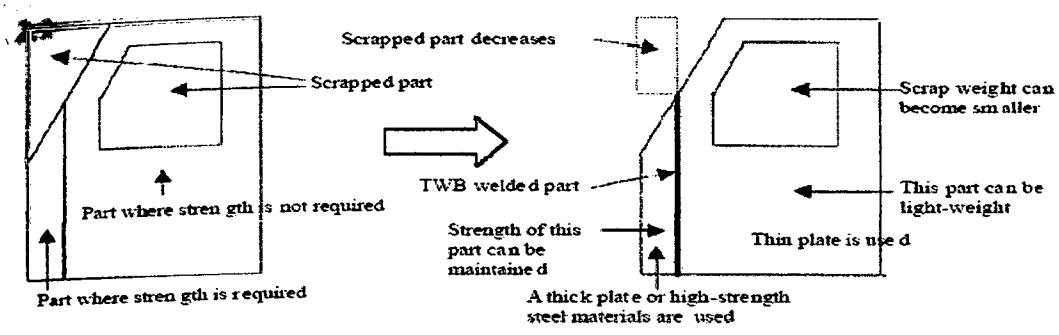

Figure2.1: Steel door with tailor welded blank (Toyo Kotetsu Co. Ltd)

Tailor welded blank is a new technology that allow the designer or engineer to create the something new in automotive technology in order to reduce component weight and the number of component in a structure without compromising the final strength, stiffness and durability of the component.

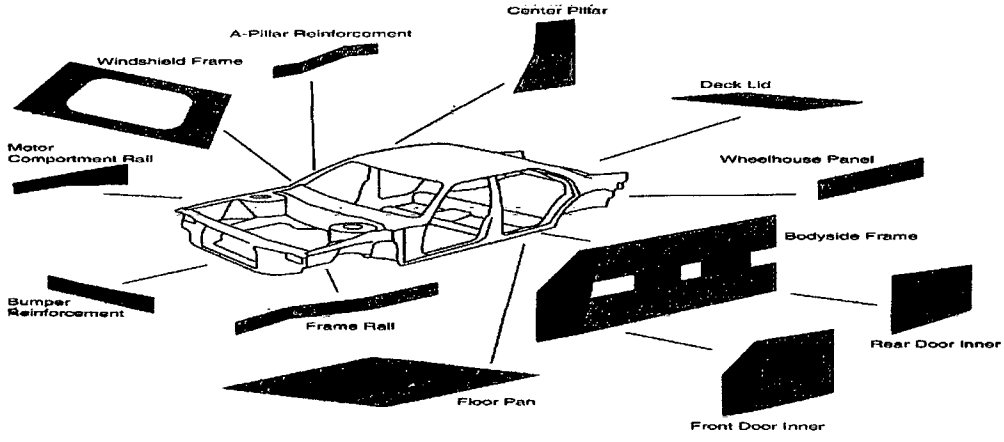

Figure 2.2: Exploded view of current and potential automotive tailor welded blank applications (Kinsey, 2003)

2.2 Benefit Of TWB

2.2.1 There are many benefits of tailor welded blank in automotive vehicles included:

I. Fewer parts
II. Fewer dies
III. Reduce design and development time
IV. Reduce material use
V. Weight reductions
VI. Improve dimensional accuracy

As for the material for automobile industry, this technology was one of the development trends for automobile industry because of its weight reduction, safety improvement and economical use of materials (Yan, Qi, 2005)

This joining of various sheets into a single blank enables automobile designers to tailor the location in the blank where material properties are located leading to reduced weight, improved part stiffness, and lower manufacturing costs due to elimination of process dies and reduced scrap.(Jian Cao 1999).

2.3 Welding Process

Joining of two dissimilar materials has been given more attention in recent years because of their superior capabilities. The example of the combination two dissimilar materials is the combination between aluminum and steel due to their potential in automotive applications. Suitable welding process and the welding technique is a significant consideration in tailor welded blank process. For example joining of aluminums and steel should be made through some advance welding technique and welding process due to the melting temperature between these two materials are quite different. The choice of the welding technique depends on the

production of a sound, heterogeneous, mixture of aluminum and steel at the interface. (Padmanabhan, 2006)

Welding is the permanent joining of two materials usually metal through localizes, resulting from a suitable combination of temperature, pressure and metallurgical conditions. The various welding process differ considerably in terms of temperature and pressure are combined and achieved. They also vary as to the attention that must be given to the cleanliness of the metal surfaces prior to welding and to possible oxidation or contamination of the metal during welding. If high temperature is used, most metal are affected more adversely by surrounding environment. (De Garmo ,1974)

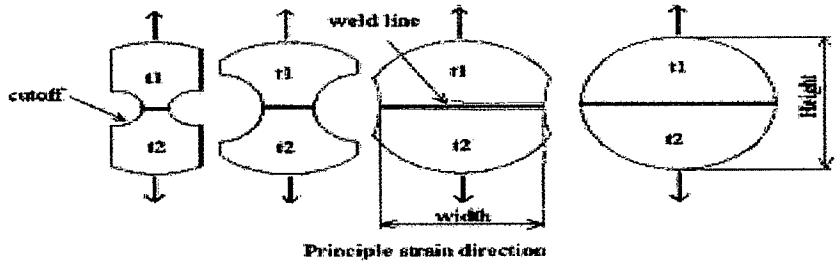

Figure 2.3: Weld line orientation of the tailor welded blank (S. M. Chan, 2003)

2.3.1 TIG Welding

Gas tungsten arc welding or also called TIG welding is a process that uses a no consumable tungsten electrode and an inert gas for art shielding. Filler metal is added to the weld pool from a separate rod or wire. The filler metal will be melt by the heat of the arc. Because of the tungsten has high melting point, (3410^0c) is a good electrode material. Gas tungsten arc welding applicable to all metal in a wide range stock of thickness and also can be use for joining various combinations of dissimilar material. The most common application for these applications is stainless steel and aluminum. TIG welding is generally slower and more cost than consumable electrode in steel welding application except when thin section are involved and high quality weld required. The advantages of TIG in the applications , it is suit include

high quality welds and also no weld spatter because no filler metal is transferred across the arc and no post welding cleaning because no flux is use.(Groover, 2004)

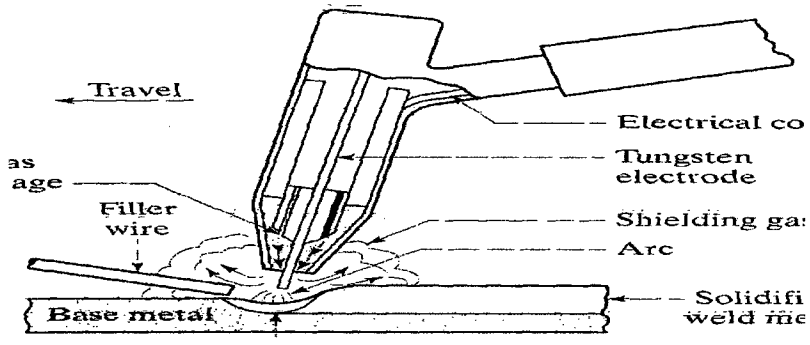

Figure 2.4: The gas tungsten –arc welding process (Serope Kalpakjian 2001)

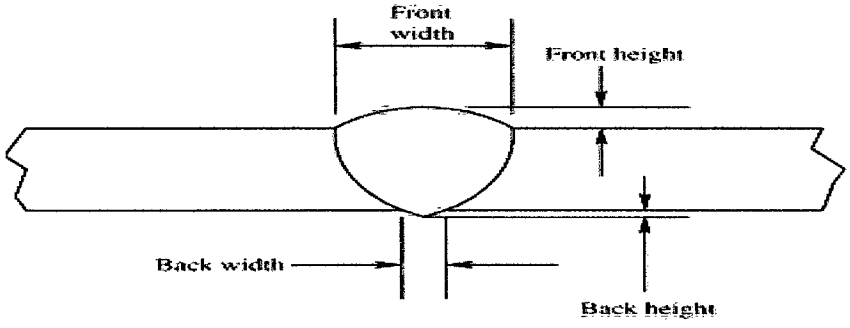

Figure 2.5: A schematic diagram showing the weld bead geometric parameters

The power supply that is used either DC at 200 A or AC at 500 A and its depending on the metals to be welded. AC current is preferred for aluminum and magnesium because cleaning action of AC removes oxides and removes weld quality. Thorium and zirconium maybe use in tungsten electrodes to improve the electrode emission characteristics. The power requirement range from 8 kw to 20 kw. (Kalpakjian 2001)

2.3.1.1 Advantages And Major Uses

I It will make high quality welds in almost all metals and alloys.

ii The arc and weld pool are clearly visible to the welder

iii No filler metal is carried across the arc there is no little and spatter

iv Welding can be perform in all positions

v There is no slug produced that might be trapped in the weld.

Gas tungsten arc welding used in many manufacturing operation primarily on thinner material. This process was originally developed for the hard to weld metal. It can be used to weld more different kinds of metals than any other arc welding process. This process can be weld thin metals normally by the automatic method and without the addition of filler metal. A joint preparation usually required. However this depends on the base metal type and welding position.(B Cary2005)

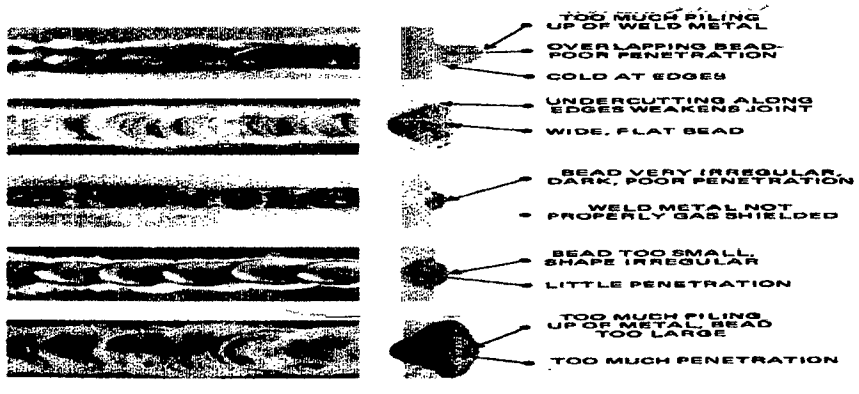

Figure 2.6: Quality factor for gas tungsten arc welding (B Cary2005)

2.3.1.2 Quality Of Weld

The quality of gas tungsten arc weld ranks higher than the quality of any of the arc welding process High level of quality is obtain when all necessary precaution

are taken. The filers' metal should be clean, the gas must be welding grade and the apparatus must be in excellent condition. When the heat input is too low, which can occur from too low welding current or too fast welding speed, the high small bead is evidence and the penetration is minor. When the welding current is too low, the bead is too high; there is poor penetration and the possibility of overlapping at the edge increases. When the welding speed is too fast, the bead is too small and penetration is minimal. When the heat input is too great, this can occur from too high a welding current and or too low a welding speed .The bead become extremely large usually wide and flat. There is too much penetration and spatter may occur. (B Cary, 2005)

2.3.2 MIG Welding

MIG (Metal Inert Gas) welding, also called GMAW(gas metal arc welding), is a welding process that was developed back in the 1940's for welding aluminum and other non-ferrous metals. MIG welding is an automatic or semi automatic process in which a wire connected to a source of direct current acts as an electrode joins two pieces of metal, as it is continuously passed through a welding gun. A flow of an inert gas is also passed through the welding gun at the same time as the wire electrode. This inert gas acts as a shield, keeping air borne contaminants away from the weld zone.

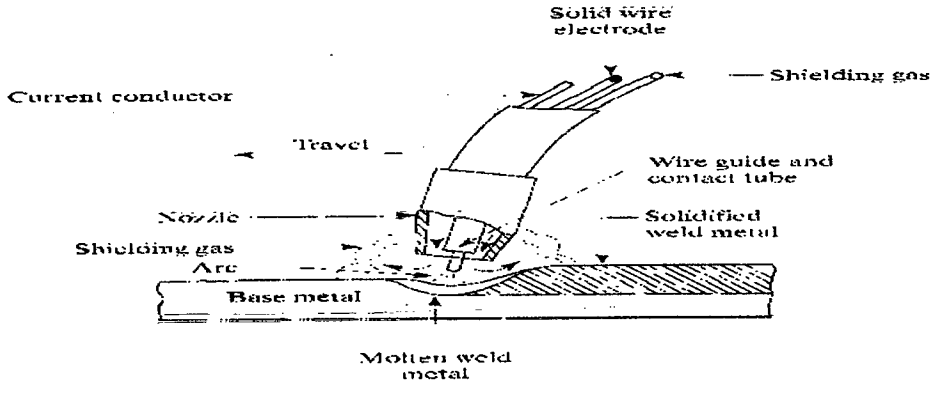

Figure 2.7: Schematic illustration of the gas metal arc welding process (Kalpakjian 2001)

2.3.2.1 Metal Transfer Characteristic

Three methods metal can be transferred in MIG welding .It is divided to the spray, the globular and the short circuiting.

2.3.2.1.1 Spray Transfer

In spray transfer small droplet of molten metal are transferred to the weld area from the electrode at a rate of several hundred droplets per second. Large diameter electrode, high DC current and voltage are used, with argon or an argon rich gas mixture use as shielding gas.

2.3.2.1.2 Globular Transfer

Carbon dioxides rich gases are utilized in globular transferred and globules propel by the force of electric arc transferred the metal with considerable spatter. The globular transfer used the high current and make possible weld penetration and welding speed than are achieved in spray transfer. This method is commonly joined for heavier section.

2.3.2.1.3 Short circuiting Transfer.

In short circuiting the metal is transferred in individual droplets more than 50 per second. Low current and voltage are utilized with carbon dioxides rich gases and with electrode made of small diameter wire. The power required is about 2 kw. This process is easy to use and popular for welding ferrous metal in thin section. (Kalpakjian 2001)

2.3.2.2 Advantages of Gas Metal Arc Welding

i) Lower welding cost on metal more than 6mm thick
ii) Low distortion-distortion using GMAW is generally low due to the high welding speed which result in rapid chilling of the weld area
iii) Good weld quality-By using the GMAW spray transfer, the quality of weld produces is very high.
iv) High deposition rate-With the large diameter of filler wire (up to 5.5mm D) when they are used with high welding current high rate of metal deposition are easy to obtain.
v) Readily adapted to the machine welding-GMAW can be readily adapted to automatic welding for metal from 0.75mm thick to the thickest commercially available because of its semiautomatic nature.(N R Mandal 2002)

2.3.2.3 Position Capabilities

The gas metal arc welding process is use in all position process. Depending on electrode size and metal transfer, each of the variation has its own position capabilities. Normally, the spray arc position use in flat and horizontal position. If smaller electrode are employed, it can used in vertical and overhead position. The short circuiting and pulsed position can be used in all position.

2.3.2.4 Weldable Metals and Thickness Range

This welding process can be use to weld most metals. This process can also be use for surfacing and for build up using special metal for bearing surface and corrosion resistance surface. The thickness metals can be weld is 0.13 mm upward.

2.3.2.5 Joint Design

The diameters of the electrode employed by gas metal arc welding are smaller than those employed by shield metal arc welding. Because it can reduces the groove angles. Reducing groove angle, will still allow the electrode to be directed to the root of the weld joint so that complete penetration will occur.(B Cary, 2005)

2.3.3 Shield Metal Arc Welding

Shield metal arc welding is the simplest, versatile joining and one of the oldest joining processes. The electric arc is produced by touching the tip of coated electrode against the work piece and withdraws it quickly to a distance sufficient to maintain the arc. The electrodes are in the shape of thin long stick this is because these processes also known as stick welding. The heat generated melts portion of the tip of the electrode, of its coating, and of the base metal in the immediate are of the arc. A weld form after the molten metal, a mixture of the base metal, and substance of the coating on the electrode, solidified in the weld area. The electrode coating deoxidizes the weld area and provides a shielding gas to protect it from oxygen in the environment. (Kalpakjian, 2001)

These coating may accommodate all or the number of the following requirements.

I) To provided a protective atmosphere
ii) To stabilize the arc
iii) Act as a flux to removes impurities from the molten metal
iv) To add alloying elements
v) To affect arc penetration (De garmo 1974)