Design And Analysis of Joining Process

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ABSTRACT

The increased application of lightweight materials, such as aluminium has initiated many investigations into new joining techniques for aluminium alloys. The Resistance Spot Welding (RSW) concept for aluminium has always attracted many researchers from different organizations. Self- piercing riveting (SPR) is the major production process used to join aluminium sheet body structures for the automotive industry. Self-piercing riveting (SPR) is a cold mechanical joining process used to join two or more sheets of materials by driving a rivet piercing through the top sheet or the top and middle sheets and subsequently lock into the bottom sheet under the guidance of a suitable die. Here gives an in depth comparison of the mechanical behavior for each joint type under different loading conditions. It covers symmetrical and asymmetrical assembly from thin gauge of 1.0mm to thick gauge of 3.0mm., and the performance of SPR joints improves as the thickness increases. Developing reliable simulation methods for SPR process and joint performance to reduce the need of physical testing has been identified as one of the main challenges.

Keyword :*Welding, Aluminium sheets, Structure joining ,Mechanical strength, Light weighting , Mechanical joining*

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1. INTRODUCTION

Today's automotive industry is a challenging business. It is required not only to respond to environmental concerns such as greenhouse gases and fuel economy, but also to meet customer expectations. Therefore, a need for weight reduction has emerged and this in turn has led to the increased application of lightweight materials, such as aluminium and polymer composites. The use of aluminium alloys offers an opportunity for vehicle weight reduction, which can lead to a reduction of fuel consumption and emissions without compromising performance, comfort and safety. Aluminium alloys can offer high corrosion resistance, good formability and good crashworthiness. In addition, the recyclability of aluminium alloys is also a considerable attraction to manufacturers. However, the use of aluminium requires not only a different approach in car design but also a different approach to manufacturing technology and in particular joining methods. As a result many investigations into advanced joining techniques for aluminium structures have been instigated.

Resistance Spot Welding (RSW) of steel is the most popular conventional joining technique for body structures, but the technology requires adoption of significant process changes in order for it to be suitable for resistance spot welding of aluminium. It is generally recognised that the short life of the welding electrodes and the associated reduction in weld quality as the electrodes degrade

Self-piercing riveting (SPR) is a key production process used to join aluminium sheet body structures in the automotive industry. The technology has many advantages, such as no pre-drilled hole requirement, capability to join a wide range of similar or dissimilar materials and combinations of materials, no fume emissions etc. However, the process is limited by the inability to change process parameters such as rivet size or die configuration "on the fly" between successive joint positions on a vehicle structure. This leads to potential increasing costs and limits the application of the technology. In addition, the use of steel rivets not only adds weight and cost to Body in White (BIW) assembly, but also raises concerns of recyclability and corrosion

1.1 PROJECT DEFINATION

Application selected for Selection and optimize the process parameters of joining process for ducts at elbow joints.

1.2 OBJECTIVE

As a key objective of this research is to provide engineering solutions, the materials, stacks and process parameters have been chosen to represent production applications

2. METHADOLOGY

The method adopted for the design of flywheel for punching machine is Analytical method. Now let us determine the various parameters in regard with flywheel design.

Mean speed of flywheel N= 9 Number of strokes/min

=9×30

=270rpm

Maximum shear stress required to punch a hole =Shear strength ×resisting area

=fs× π dt

=240× π×25×18 1000

=339.3kN

Energy required to punch one hole =average force × distance travelled by punch

=0.5×339.3× 18

=3053.7N

Since mechanical efficiency is less than 100%, assuming as 85% ,therefore Total energy required, E=3053.7/0.85

=3592.6N-m

Actual punching operation lasts for the 1/10th of the cycle period. Therefore, during remaining period 9/10th of the cycle period, the energy is stored by the flywheel. Thus fluctuation of energy =9/10× E

= 3233.3Nm

Maximum space available is 100mm,therefore considering as D=800mm to carry out design

Rim Velocity= π× 0.8×270 60 =11.3m/s…which is less than the maximum permissible velocity for grey cast iron

Mass of flywheel, m=fluctuation of energy

V2 × Cs

= 3233.3

= 253.3 Kg

Assuming mass of rim as 90%of total mass, rim =0.9×253.2

=227.88Kg

mrim= πDhp ….used to determine dimensions of rim

Where,

p=7100kg/m3for C.I.

Therefore, h=90mm, b=150mm

Outer diameter of flywheel=Do=D+h=0.89m, which is less than the maximum space of 1m, hence the design dimensions are within limit.

To determine Shaft diameter

Bending moment M =weight of flywheel× overhang

=253.2×9.81× 0.2

=496.78N-m

Average torque =Energy required/min 2πN

= 107778

2π×270

=63.53N-m

Assuming suddenly applied load condition with shock and fatigue factor of 1.5 and 2 Equivalent torque =((Cm×M)2 +(Ct× T)2)1/2

=755.92N-m

Shaft is made of medium carbon steel, with shear strength 360N-mm2, Factor of safety is 4,therefore shaft diameter can be determined by using torsion equation

Shaft diameter,ds =34.96 say=40mm

Hub diameter, dh= 2ds=80mm

Length of hub, lh = 2.5 ds=100mm

To determine the Stresses in the rim of flywheel

Stresses in unstrained rim = pv2

= 7100×11.32

=0.9066MN/m2

Stresses in restrained rim = pv2(2πR2/ i2h)

=4.97 MN/m2

Total Stress in the rim = 0.75 Stresses in unstrained rim+0.25 Stresses restrained rim

=1.922 MN/m2….which is less than the allowable strength of C.I, hence design of rim is safe

To determine stress in arm of flywheel Considering arm type flywheel of four arms Bending stress in the arm =10N/mm2

=T(D-dh) iDz

Where,

Z=modulus of elasticity=1429.4mm3

i=numbers of arms=4

Direct stress due to centrifugal force =pv2=0.9066N/mm2

Total stress = Bending stress+ Direct stress

=10+0.9066=10.9066N/mm2

Total stress is less than the allowable strength 20N/mm2, hence the design of the arms are safe.

3 PROCESS PARAMETER SELECTION

As various rivet and die combinations can be used to produce an SPR joint for a given stack-up, different combinations including one set that was considered to be an optimum selection were chosen. Similar to SPR joints, the nugget size of a RSW joint can range from an industry standard minimum criteria of 4√t where t is the thinnest sheet thickness in the joint stack, to an optimum nugget diameter depending on process parameters. In order to make a fair comparison RSW joints with different nugget diameters were also produced, with one selected to be near to optimum nugget diameter for the stack being tested. For RSW, nugget diameter was used to indicate different process selections; while for SPR, a Set Number was used to represent different rivet and die combinations for each stack.

4. EXPERIMENTAL PROCEDURE

4.1 MATERIALS

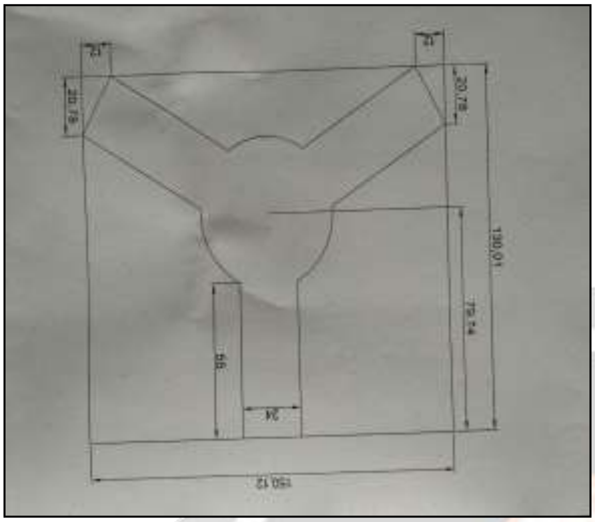
Commercial aluminium alloy with various thicknesses was used to form different joint stacks. The automotive grade material was supplied and was joined in the as-received pre-treated and lubricated condition. The material properties of the AA5754 aluminium are listed in Table 1

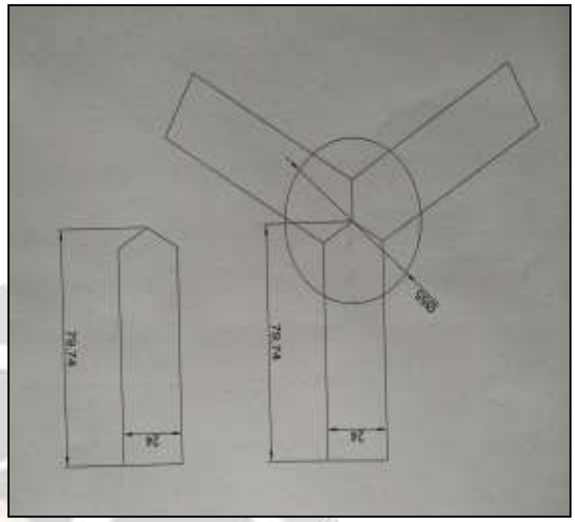
MECHANICAL PROPERTIES				
Young's Modulus (GPa)	Tensile strength (MPa)	Elongation	Hardness (HV)	
70	240	22%	63.5	
NOMINAL COMPOSITION(BALANCE Al) wt%				
Si	Fe	Cu	Mn	Mg
0-0.40	0-0.40	0-0.10	0-0.50	2.60-3.60

Table 1: Compositions and mechanical properties of AA5754 alloy

4.2SPECIEMEN AND TEST CONDITIONS

Industry standard samples were made using the two joining processes. To allow for the shunting effect in the resistance spot welding process, lap shear and T-peel samples were produced in large coupons using special fixtures. The final test pieces, with dimensions were cut from these large coupons. X-tension samples, were produced using a purpose designed lattice fixture to compensate for shunting. For self-piercing riveting, all test pieces were made individually to the same dimensions. At least 5 samples for each process and condition were tested, using a standard tensile test machine with a 30kN load capacity. All tests were carried out using a cross head speed of 10mm/min.





5. RESULT AND DISCUSSION

In comparing SPR and RSW processes it is clear that direct ‘back to back’ analysis is complicated. The nature of the two technologies, one mechanical, the other fusion, means the interaction between their various attributes with the loading geometries tested are important. In addition, the ranking of results can be significantly altered depending on the degree of optimisation of parameters for each process. A number of fundamental conclusions can be drawn from the results reported here.

- The selection of process parameters for both RSW and SPR joints affect their strength, energy absorption and failure mode.
- A general observation is that SPR samples tend to exhibit less scatter than the RSW joints, and the performance of SPR joints improves as the thickness increases.
- SPR joints generally achieved similar or higher peel strengths than the RSW samples. For SPR joints the cross tension test purely tests the interlock of the joints, whilst for RSW samples the periphery of the nugget is tested.
- Stack orientation has no obvious effect on joint strength and energy absorption for RSW samples, but a significant effect for SPR joints.

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