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EXPERIMENTAL ANALYSIS OF A WELDED COMPONENT MADE WITH COPPER ALLOY ELECTRODE CAP TIP IN RESISTANCE SPOT WELDING

A.G.Venkatesh[1], V. Venugopal Reddy [2] and V. Madhusudhan Reddy[3]

PG Student, Mechanical Engineering Department, J.N.T.U.A. College of Engineering, Pulivendula, India[1]
Professor, Mechanical Engineering Department, J.N.T.U.A. College of Engineering, Pulivendula, India[2]
Assistant Professor, Mechanical Engineering Department, J.N.T.U.A. College of Engineering, Pulivendula, India[3]

Abstract— *Resistance spot welding is essential in automobile industry to perform resistance welding, including nut and bolt, spot and stud welding. Thousands of spot weld supports the quality and reliability of an automobiles body structure. It's normally used in the automobile industry because of its advantage of high speed, high production assembly lines that is suitable for automation. In resistance welding, the existing obara electrode cap tip cost is found to be high. In order to reduce the cost the current project is carried out. The experimental studies were done on the different aspects of the electrode cap tip such as the alloy composition, No. of spots welded, weld nugget diameter. The outcome of this project is to find out critical nugget diameter and No. of spots welded and compare the results with the existing one and choose the best electrode cap tip for implementation in the production unit which results in the great strength withstand ability and also cost reduction.*

Key words: *Resistance Spot Welding, Chisel Test, Critical Nugget Diameter, Peel off Test.*

I.INTRODUCTION

Resistance Spot welding is one of the ancient welding processes. It is a type of resistance welding, in which two or more metal sheets combine together without use of any filler material by applying pressure and heat to the area to be welded. Resistance spot welding is a broadly used for joining of fabricating sheet metal assemblies such as automobiles, truck cabins, rail vehicles and house hold applications due to the advantages in welding efficiency and suitability for automation. It is an cost-effective and major method for joining metals because of its speed, accuracy, efficiency and resulting cost reductions afforded by automated resistance spot welding are well documented and accepted in automotive industry.

Resistance spot welding (RSW) is a process in which metal sheets are joined in one or more spots by resistance to the flow of electric current through work pieces that are held together under force of electrodes. The weld is made by a combination of heat, pressure, and time. This method is used for joining sheet metals and uses shaped copper alloy electrodes to apply pressure and convey the electrical current through the work piece. Heat is developed mainly at the interface between two sheets, ultimately causing the material being welded to melt, forming a molten pool, the weld nugget. The molten pool is enclosed by the pressure applied by the electrode tip and the surrounding solid metal. The "nugget" of molten metal solidifies forming the joint. In the Figure.1 the illustration of resistance spot weld nugget formation is shown below.

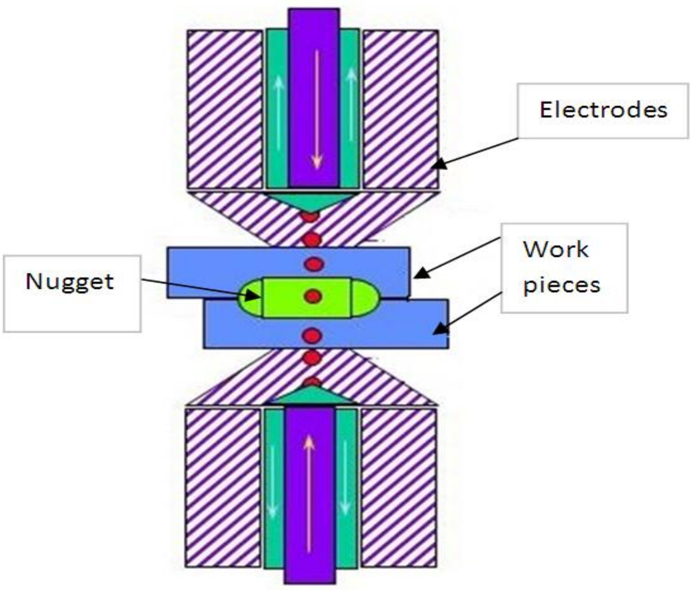

Figure.1: Formation of Weld Nugget

Spot welding operates on the four factors listed below:

1. Amount of current that passes through the work piece.
2. Pressure applied on the work piece by the electrodes.
3. The current flow time through the work piece.
4. The contact surface area of the electrode tip with the work piece.

The cycle of the spots welded are shown in the below Figure.2.

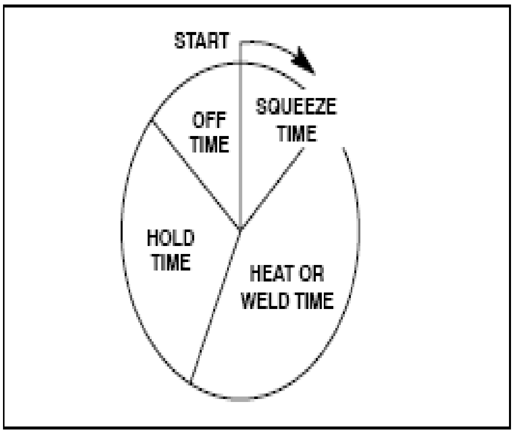

Figure.2: Spot Welding Time Cycle

The heat that is generated in this welding mainly depends on the electric current and the time being used on the electrical resistance of material between electrodes. According to the Joule's law the amount of heat generated is given by the equation

$$H = I^2Rt$$

Where

H = Heat generated (Joule)	I = Current (Ampere)
R = Electrical Resistance (ohm)	t =Time (seconds)

II. Experimental Method

The dimensions of both the Obara and Seam electrode cap tips are measured and the critical nugget diameter is found out.

A. Electrode Cap Tip:

The basic electrode cap tip is usually selected to improve the electrical-thermal-mechanical performance of an electrode. This is generally a geometry in which the cross-sectional area increases rapidly with distance from the work piece, thereby providing a good heat sink. The basic cap tip is shown in Figure.3.

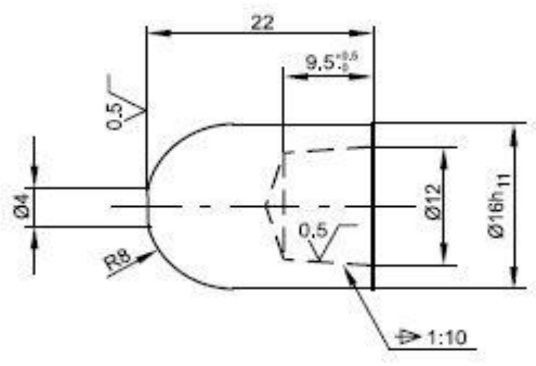

Figure.3: Line Diagram of an Electrode Cap Tip

The contact surface of the electrode diameter is taken in to consideration: too small area will form undersized welds with inadequate strength; too large area will lead to unstable and inconsistent weld growth characteristics.

The dimensions of both the company cap tips are measured and are tabulated as shown below in Table 1.

TABLE 1: Cap Tip Dimensions

Supplier	**Obara**		**Seam**	
Tip no	1	2	1	2
Length	23.15	23.16	22.96	22.95
Outer dia	16.02	16.01	15.95	15.96
Inner dia top	12.13	12.14	12.02	12.04
Inner dia bottom	11.78	11.78	11.41	11.41
Wall thickness	2.04	2.05	2.04	2.05
Depth	9.44	9.44	8.96	8.96

The tools that are used to measure the dimensions of cap tip are mentioned below in Table.2

Table 2: Measuring Tools

Tool	**Company**	**Product code**
Depth gauge	ANYI	BQC/15/010
Vernier calipers	MITUTOYO	BQC/15/009

B. Testing:

The spot weld quality can be determined by destructive and non-destructive testing methods.

*1) **Chisel Test:***

The chisel test is the method of applying the chisel by means mechanical force by a hammer as shown in the below Figure 4.

Figure.4: Drive Check

*2) **Peel off Test:***

In this method the pneumatic weld nugget removers is placed in between the sheets and apply the pneumatic force to unbutton the sheets as shown in the Figure5.

The critical nugget diameter can be found out by measuring the dia of the nugget that is formed on the sheet metal and comparing it with the theoretical value obtained.

Figure.5: Destructive Peel off Test

The chemical composition of the electrode cap tip has been collected from their respective suppliers as shown below in Table 3.

Table 3: Chemical Composition

Supplier	Obara	Seam
Alloy composition	Cucr	Cucr
Hardness HRB	70-75B	70-80B
Electrical conductivity	75<	80-85
Tensile strength N/mm^2	46	45-55
Elongation %	15<	10-15

III. Results and Discussion

A. Obara Tip Calculations:

a) No. of spots welded = No. of bodies × No. of spots welded per body.

For LH (no. of spots welded/body is 92):

No. of spots welded =No. of bodies × No .of spots welded per body
= 115 × 92= 10580 spots

For RH (no. of spot welded/body is 89):

No. of spots welded = No. of bodies × No. of spots welded per body
= 115 × 89= 10235 spots

b) Dressing frequency = No of bodies / 5(fixed number for dressing)
= 115/ 5 = 23

The duration of the cap tip is found by the number of bodies welded. The each body is welded by their specific gun at their specific location. The spots welded can be found by the product of the number of bodies produced and the spots produced on each body. The calculated data is tabulated in Table.4.

Table 4: Duration of OBARA Cap Tips

Gun no	T-07 C3746 (LH-92)			T-08 C3746 (RH-89)		
Duration of tip	13/10 - 24/10	7/12 - 21/12	21/12 - 13/1	13/10- 24/10	7/12 - 21/12	21/12- 13/1
No. of Bodies	115	113	109	115	113	109
No. of Spots welded	10580	10396	10028	10235	10057	9701
Dressing Frequency	23	22	22	23	22	22

B. Seam Tip Calculations

a) No. of spots welded = No. of bodies × No. of spots welded per body.

For LH (no. of spots welded/body is 92):

No. of spots welded = No. of bodies × No .of spots welded per body.
= 95 × 92 = 8740 spots

For RH (No. of spot welded/body is 89):

No. of spots welded = No. of bodies × No. of spots welded per body
= 95 × 89= 8188 spots

b) *Dressing frequency* = No of bodies / 5(fixed number for dressing)
= 95/ 5

= 19

The duration of the cap tip is found by the number of bodies welded. The each body is welded by their specific gun at their specific location. The spots welded can be found by the product of the number of bodies produced and the spots produced on each body. The calculated data is tabulated in Table.5.

Table 5: Duration of Seam Cap Tips

Gun No	**T-07 C3746 (LH-92)**			**T-08 C3746 (RH-89)**		
Duration of tip	23/1-14/2	14/2 -9/3	9/3 - 30/3	23/1-14/2	14/2 -9/3	9/3 - 30/3
No. of Bodies	95	87	76	95	87	76
No .of Spots welded	8740	8004	6992	8188	7743	6764
Dressing Frequency	19	17	15	19	17	15

C. Finding out the Critical Nugget Diameter

The critical nugget diameter can be found by initially measuring the diameter of the unbuttoned area of the peel off sheet. The measured values are tabulated below in Table.6. The critical nugget diameter can be found out by measuring the dia of the nugget that is formed on the sheet metal and comparing it with the theoretical value obtained.

Table 6: Measured Diameter of Cap Tips

Company	**Diameter d1**	**Diameter d2**	**Average (d1+d2)/2**
Obara	5.51	5.43	(5.51+5.43)/2 **5.47**
Seam	5.62	5.52	(5.62+5.52)/2 **5.57**

Note: All the dimensions are in mm.

By using the Vernier calipers the thickness of the various sheets are measured and are tabulated as shown in the Table7.

Table 7: Thickness of Measured Sheets

Part no	**No. of sheets**	**Thickness**
1	1	0.78
2	2	**1.91**
3	3	3.80

Note: All the dimensions are in mm.

From the above table considering the next middle value of the sheet thickness we can calculate the nugget dia by using the formula shown below.

Nugget dia $= 4\sqrt{t}$

$=4\times\sqrt{1.91} = 5.5281\text{mm}$

Therefore nugget dia is 5.5281mm.

Comparing it from the Table 6.measured dia we can say that the calculated value is in the permissible limits.

D. Calculation of Average No. of Spots Welded

Average no. of spots welded for

a) Obara electrode cap tip

Average No. of bodies= No. of bodies welded/ 3

$= (115+113+109)/3$

$= 112.33$

No. of spots welded by the gun = (no. of bodies welded× no. of spots welded by the gun)

$= (112.33\times 92)$

= 10334.6
≈ 10335 spots

b) Seam electrode cap tip

Average no. of bodies=No. of bodies welded/ 3
= (95+87+76)/3
= 85.33

No. of spots welded by the gun = (no. of bodies welded× no. of spots welded by the gun)
= (85.33×92)
= 7850.667 ≈ 7851 spots

E. Consumption Rate of Cap Tip

For producing 500 vehicles we have 500×92=48000spots

1) ***Obara electrode cap tip consumes***

I.e. (Total no. of spots to be welded)/ (average life of each pair of tips)
=48000/10335
=4.45≈5 pair of tips

Considering Obara cap tip we have to make 48000 spots by using 5 pairs of cap tips

2) ***Seam electrode cap tip consumes***

I.e. (Total no. of spots to be welded)/ (average life of each pair of tips)
= 48000/7851
=6.11≈6 pair of tips

So from the above calculations we can say that if the Obara cap tip can complete the 500 vehicles in 5 pairs of cap tips then the seam tip takes 6pairs to complete the same no. of vehicles. So from the above statement we can correlate the no of tips consumable for welding spots as shown below in Table.8.

Table 8: Consumption Rate of Tips

S.No	Obara	Seam
1	10	12
2	100	120
3	200	240
4	300	360
5	400	480
6	500	600

Each Obara electrode cap tip cost =48 rupees
Obara consumes 5pairs (10) cap tips to complete 500 vehicles= 48*10 = 480rupees
Each seam electrode cap tip cost =20 rupees.
Seam consumes 6pairs (12) cap tips to complete 500 vehicles = 20*12= 240 rupees.
Cost savings= $\frac{240}{480}$=50%
So from the data we can correlate the price and consumption as shown in the Table.9

Table 9: Consumption &Cost Data of Tips

Supplier	Obara	Nash
Consumption/month	500	600
Cost/tip	48rs	20rs
Cost /month	24000rs	12000rs
Consumption /year	6000	7200
Cost /year	288000rs	144000rs

IV. CONCLUSION

The critical nugget diameter and no. of spots welded is determined and by comparing the results, the seam electrode cap tip supplier has the equivalent properties of the existing Obara cap tip.
So from the consumption and cost data it is clear that the seam electrode cap tip can be replaced by the existing Obara cap tip which results in the savings of 50% amount that was spent on the Obara cap tips.

REFERENCES

1. ISUZU Motor India Private Limited, Sricity, Chittoor, Andhra Pradesh.
2. CMW, Resistance Welding Industries {@ONLINE}, 2012
3. K. Lindgren, "Tactical replacement of old materials by new: Applications in automotive product development," *Materials & Design*, vol. 25, no. 6, pp. 529- 533, 2004.
4. M. Thomson and L. Han, "Development of aluminum by NDT in resistance spot welding using ultrasonic C-scan," *NDT & E International,* vol. 48, pp. 30-38, 2012.
5. L. Edwards, Computational welding mechanics: thermal and micro structural simulations, Wood head, 2007.
6. M. Galler and W. Ernst, "The influence of electrode wear on current density IIW SC 27 09," IIW, 2009.

