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Design and Development of Automated Welding Fixture for Semicircular Weld

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***Abstract*: Now-a-days, automation is gaining so much importance in all aspects of industry such as production, manufacturing and what not. It reduces the cycle time and operator labor while increasing functionality. Welding the various parts in manufacturing is very common and popular form of permanent metal joining process. Welding is very delicate joining process which requires very high skill for fine work. In industry there are many size and shape parts that has to be weld. Semi-circular weld is one of them. When it comes to manually welding in semicircular shape, there are so many limitations such as less accuracy, work fatigue, etc.**

***Keywords*: automated welding fixture, semicircular weld**

1. Introduction

When we approached the industry, we identified the problems faced by the industry regarding semi- circular weld of bracket shackle. It was found that the job was difficult to weld as well as it was time consuming. Hence, we decided to design fixture for easy mounting and use of automation. By doing this we can achieve improved weld quality and decrease the time required for it. For having easy mounting, we designed a suitable fixture having mounting plate and pin locators for appropriate positioning of job and by using motors we can rotate our workpiece according to the requirement and a similar motor can be used for torch to reduce complexity and easy welding operation. For automation, microcontroller is used which is interfaced with the motor to give precise motion. Limit switches are used to limit the motion of motor to semicircular region. The automated welding fixture can used for jobs having different shape for any external circular weld by just changing the support plate.

2. Design calculations

1) Baseplate
Material:40C8
σ_{ut} =600MPa
FOS=2
d=200mm (due to size of bracket shackle)

Calculation:
σ_{all} =F/A
300= $(5\times 9.81) \div (\pi \times 200 \times t)$
t= 1.26mm
t_{actual} = 5mm

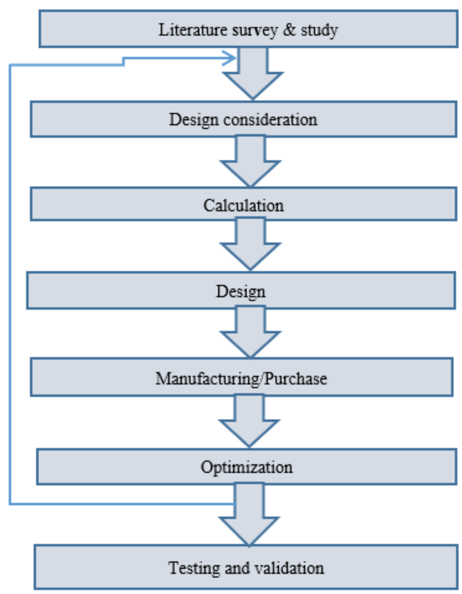

Fig. 1. Methodology

2) Thrust bearing selection
Load = 5× 9.81 + (Weight of plate)
= $5\times9.81 + (\pi d^2 t)\times7700\times9.81$
=60.91N
total axial load = 61N
∴ Selected bearing= 51102 series (Thrust ball bearing) [10]
C_0 =Static load capacity = 16800N
C =Dynamic load capacity = 10500N
$C = W \times (L_{10}/10^6)^{1/3}$
= 117.8N
∴ Selected bearing is safe
Dimension of bearing
d = 15mm
D = 28mm
H = 9mm

3) Shaft for gun holder
Material: 40C8
σ_{ut} =600Mpa
FOS =3
Gun mass = 2kg
Weight of gun =19.62N ≈ $20N$

L =160mm

Calculations:

$\sigma_{all} = \sigma_{ut}/FOS$

$=600/3=200MPa$

$\tau_{per} = 0.18\times 0.75 \times \sigma_{all}$

$=27MPa$

T =40kgcm =3.92 Nmm

$M = 10 \times 80 = 800$ Nmm

According to ASME

$\pi/16\ d^2 \times \tau_{per} = \sqrt{(K_b M^2+K_t T^2)}$

$d = 2.3 \approx 3mm$

$d_{act} = 10 > d_{all}$

Design is safe

4) Motor selection

Load on plate= 61N

C.G. of job lies at < 51.2 mm from Centre.

Torque = 5.12 * 6.22 = 31.84kgcm

Therefore, Selected DC motor is of rated torque 40kgcm

Calculations:

$\sigma_{all} = \sigma_{ut}/FOS$

$=600/3=200MPa$

$\tau_{per} = 0.18\times 0.75 \times \sigma_{all}$

$=27MPa$

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$d = 2.3 \approx 3mm$

$d_{act} = 10 > d_{all}$

Design is safe

5) Radial bearing for shaft

Radial load = 10N

Selected bearing series 6002 (Single row deep groove) [10]

$C_0 = 5600N$

C = 2850N

$L_{10h} = 12000$ Hrs.

$L_{10} = 50 * 12000 * 60$

= 36 million rev.

$C_0 = W (L_{10}/10^6)^3$

$C_0 = 60$ N

Therefore, Selected Bearing is safe.

Dimensions of bearing:

d = 15mm

D = 32mm

H = 9mm

3. Automation

1) Motor driver

Common DC gear head motors need current above 250mA. There are many integrated circuits like ATmega16 Microcontroller, 555 timer IC. But, IC 74 series cannot supply this amount of current. When the motor is directly connected to the o/p of the above ICs then, they might damage. To overcome this problem, a motor control circuit is required, which can act as a bridge between the above motors and ICs (integrated circuits).

- Motor Driver used: SmartElex 15D Dual channel DC motor Driver
- Specifications:

1. Supply Voltage: 6.8 – 30 VDC
2. Continuous current: 13 Amp
3. Current limiting at 30 Amp

2) Micro controller

- A microcontroller is made up of inbuilt with the processor, memory, timer, counter etc. all those peripherals. MCU is the brain of the embedded systems that can control the action of each device or different devices. They are small low power computers. This device allows us to choose our own input and output.
- Microcontroller used: Arduino ATmega 328p

Table 1
Specifications

Microcontroller	ATmega328P – 8-bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Boot loader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	Hz

3) Feedback system

Infrared Sensor

- Rotation of the workpiece can be controlled by colour marking on base plate.
- Also, by shine of the workpiece rotation can be controlled

Specifications:

- Input Power: 3.3V or 5VDC.
- 3 pin interface which are OUT, GND and VCC:
- OUT is digital output pin from sensor module, please connect to any digital input on your microcontroller. Will output logic LOW when object is detection.

4. Working

- When the workpiece is placed on baseplate it is sensed by IR sensor 1.
- Welding torch will rotate downward for welding until it is sensed by IR sensor 4.
- After torch is ready to weld the baseplate will start rotating with the help of motor and IR sensor 2.
- When the welding is completed its position is sensed by the IR sensor 3 and baseplate stops rotating.
- Again, torch will move to its initial position.
- After the welding is completed workpiece can be replaced manually for next cycle.

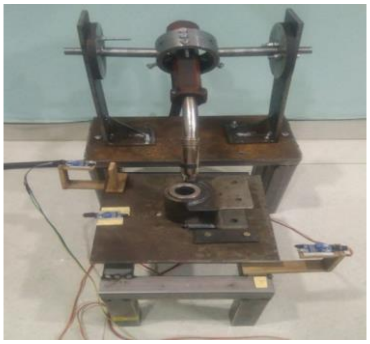

Fig. 23. Automatic welding Fixture

5. Results

Table 1
Results

S. no.		Before Automation	After Automation
1.	Cycle time (Sec)	39	33
2.	Quality of weld:		
	a. Start and end position of weld	Inaccurate	Accurate
	b. Welding defects like Excessive penetration and underfill, overlap (Frequency of occurrence)	Moderate	Low
	c. Uniformity of weld thickness	Less	High
3.	Continuous process: Number of workpieces welded in 4 Hrs.(9AM-1PM)	291	350
4.	Need of skilled worker	Yes	No

6. Conclusion

This paper presented design and development of automated welding fixture for semicircular weld.

References

[1] Roxanne Raye, "Economic Analysis and justification for automated welding systems" 2015.
[2] N. B. Totala, Sarang Bhutada, "Design Manufacturing and testing of circular welding positioner," IJERD, vol. 10, issue 2, 2015.
[3] S. N. Shinde, Siddharth Kshirsagar, "Design of welding fixtures and positioners," IJSER, vol.2, issue 5, 2014.
[4] M. Vural, "The effect of welding fixtures on welding distortions," 2013.
[5] Nilesh Chanevar, "A review on design and development of jig and fixture for circular welding," IJSER, vol 8, Issue 3, March 17.
[6] J. C. Trappey, "Issues of automatic fixture design in computer integrated manufacturing systems," International association of science and technology for development, pp. 149-154, 2015.
[7] U. C. Tapici, "Fixture design for robotic welding applications and analysis of welding distortions," IST, 2016.
[8] Randy Stevens, "Automatic welding operations" Manufacturing Engineering, pp. 87-94, 2015.
[9] Jeffrey J. Madden, "Welding fixture with active position adopting functions," 2014.
[10] V. B. Bhandari, "Machine design data book," India: McGraw Hill, 2014.