International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Design and analysis of fixture for easy lug plate fit up at bend portion of first pass and second pass gang bend water wall panels phase I

Kali Prasad Patnaik [1,*] and M Sudhahar [2]

[1] *Tubular Production Department, Bharat Heavy Electricals Limited, Tiruchirappalli-620014, Tamilnadu, India.*
[2] *Mechanical Department, Prist Deemed to be University, Tanjavore-613403, Tamilnadu, India.*

International Journal of Science and Research Archive, 2023, 08(01), 525–531

Publication history: Received on 07 December 2022; revised on 25 January 2023; accepted on 27 January 2023

Article DOI: https://doi.org/10.30574/ijsra.2023.8.1.0079

Abstract

With the technological evolution of "high-pressure steam generators" from sub-critical to the super-critical stage, the "Water-wall Panels" is transformed from "straight panels" to "terminal bend panels" and "gang bend panels". The lug plates are fitted at the bend portion of the terminal and gang bend panels as per the design. The traditional method of lug plate fit up has an awkward impact on the working method, productivity, quality, and re-work. This paper aims to discuss the design and analysis of the fixture to avoid the manual lug plate fit up. With the proposed design of the fixture, the lug plate fit up can be done easily at the bend portion of tubes of gang bend and terminal bend "Water-wall Panels". Proposed design not only solves the problems being faced while giving the easy fit up but also brings in marked improvements in workplace-safety, productivity, working environment coupled with a considerable reduction in manpower and operational risks.

Keywords: Lug plate; Terminal Bend and gang bend Water Wall Panel; Fixture; Workplace Safety

1. Introduction

A boiler comprises "Water-wall Panels" which plays a major in carrying the steam and water. These are the membrane-walls that are made off with a set of tubes welded together with or without a metal strip in between the tubes.

The "Water-wall Panels" are of two types, viz., "first pass terminal bend panels" and "second pass gang bend panels".

These water wall panels comprise both "straight tubes" & "terminal bend end tubes" and the same will be assembled with the "furnace upper front outlet header" at the site. The lug plate is fitted at the bend portion of the terminal and gang bend panels. The collector plate is fitted at the lug plate. The purpose of the lug and collector plate is to give support to the panels at site in hanging position. In the super-critical boilers, "Water-wall Panels" are important parts for steam generation.

Lug plate and collector plate fit up is a critical step before welding. Precise lug fit up in straight position is essential to avoid wastage of material. Utmost care is needed while fabricating "Water-wall Panels", as these panels are always kept under a pressure-state.

1.1. Process

Full assembly of a Boiler (Steam Generator) constitutes the following major components:

- Boiler drum

* Corresponding author: Kali Prasad Patnaik; Email: kaliprasad@yahoo.com

- Headers
- Straight Water-wall panels
- First pass terminal water wall panels
- Second pass Gang bend water wall panels
- Economizer coils
- Super heater coils
- Re-heater coils
- Various types of valves

In the heavy engineering industry, the above components are fabricated. The heavy engineering industry is one of the most dangerous work environments worldwide because of the products which are manufactured like high-pressure vessels, valves, water-wall panels, and super heater coils for thermal power plant boilers.

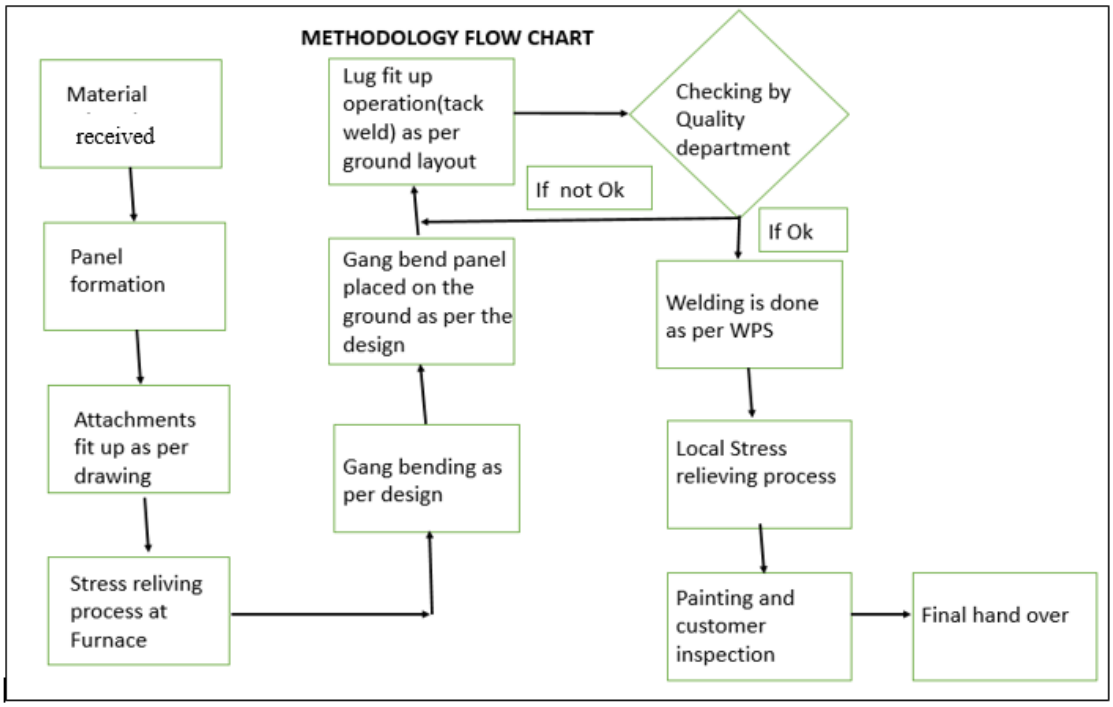

Figure 1 Flow Chart for the products

The Figure 1 shows the main processes for panel fabrication, besides the above there are also some other processes as follows:

- Rework welding
- Bow correction
- Dimension marking
- Attachment fit-up
- TIG welding
- Pug cutting
- Gang bending
- Lug fit up
- End cutting
- Edge preparation by chamfering
- Final Inspection
- Shipping

Lug fit up process is a very critical operation in bend panel fabrication.

1.2. Problem identification

1.2.1. Existing procedures of lug plate fit up at the bend portion of the first pass and second pass water wall panels

In the existing method, the panel is loaded on the ground layout drawn as per the design. The lug plate is given fit up at the bottom tube. For giving the lug fit up,2 man powers are required to hold the lug plate parallel to ground against the gravity. The weight of the lug plate is approximately 8 kg. If the man powers observe that the lug plate is in straight position, then the lug is tack welded with the tube. In the same process all the lug plates are given fit up as per the design. After lug fit up, inspection is carried out to check the straight ness of the lug plates with respect to ground by spirit level by the quality control department. If any deviations are found, all the lug plates are removed and the tack welded portion is grinded. After that the above operation is repeated for lug fit up.

Figure 2 Conventional lug plate fit up method

Figure 2 shows the conventional method of lug plate fit up process in which 2 employees are holding the lug plate and the welder is doing tack welding. This is very difficult to guess the straightness of the lug with respect to other lugs.

1.3. Problems experienced in the conventional Lug fit up method

- It is an unsafe condition as holding the lug plate in hand. Proper body posture has to be maintained while lifting, pushing, and pulling to avoid illness/injury due to Muscular-Skeletal Disorders (MSDs).
- The lug plates should be parallel to ground and straight line as per the design which is judged only through visually in conventional method. Most of the cases, after lug fit up when the lug fit up is checked by the quality control department the lug plates are found not in straight line. So, once more the lug plates are removed, grinding is done for the tack welded areas and the lug fit up is started from the starting which is time consuming. Also more reworks are occurred.
- More cycle time.in conventional method. For giving lug plate fit up it is required minimum 3 shifts for first pass and second pass gang bend panels.
- Cost to organization is more due to more grinding wheels and electrodes are consumed for lug plate fit up.
- Quality of lug fit up also not satisfactory as the operation is done only though guessing. This process leads to the requirement of more manpower and wastage of materials.
- For doing the lug fit up operation, more man powers required to hold the lug plates in straight portion. After quality inspection, if reworks occur, then for doing rework extra manpower and materials are required.

Due to the above problems, there is a need to simplify the method of lug fit up.

2. Material and methods

Due to the above problems that occur in the conventional method, it is planned:

- To avoid using hands to hold the lug plates while giving lug plate fit up.
- To develop an ultimate method of holding the lug plates while lug plate fit up operation.

In this development, our ultimate aim is to ensure the safety of the workers while operating the machine, completely avoiding the rework and to increase productivity.

Objectives sought to be achieved

- To design and fabricate a new fixture for lug plate fit up.
- To standardize the method of fit up of lug plates.
- To simply the lug fit up process by keeping the fixture simply on the correspondent ground or lug plate.

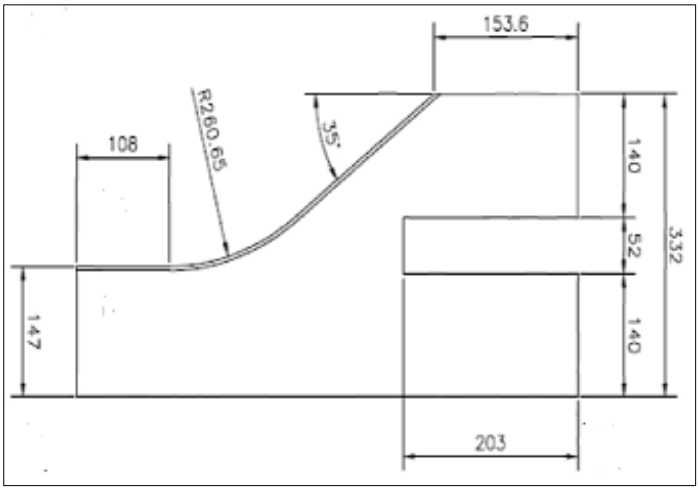

Figure 3 Schematic diagram of lug plate (Dim. are in mm)

The figure 3 shows the diagram of the lug plate which is fixed at the bend portion of the panel and the materials used for lug plates are SA 213 T12 or SA 213 T12.

2.1. Methodology

A fixture is planned to design after a detailed study of the lug plate dimensions.

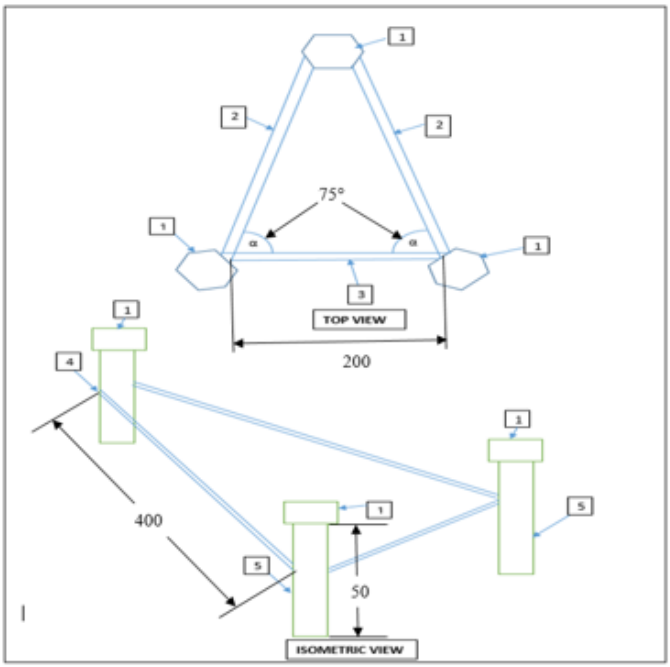

Figure 4 Dimensions of fixture for lug plate fit up (Dim. are in mm)

For designing the Fixture, the following calculations has been taken:

- The weight of the fixture should be such that the fixture can withstand the weight of the lug plate (8 kg. s) as

lug plate is placed on the fixture.

- The weight of the fixture should not damage the lug plate as the fixture is placed on the lug plate.
- For pitch adjustment, nut arrangement is planned.

The developed fixture as shown in figure-5 is planned to use for lug fit up. The figure-4 shows the fixture comprises of 3 small tubes (4,5) the tube are of 50 mm length and outer diameter of 18 mm and inner diameter of 12 mm at the top end. The tubes (4,5) are having internal threads in the top for 20 mm. The top of the tubes are screwed with m-12 bolt (1) with 20 mm length. The purpose of the bolt is to do height adjustment. The two tubes (5) are welded by manual arc welding method with third tube (4) by 6 mm thickness fin plate (2), 10mm width and 400 mm length.

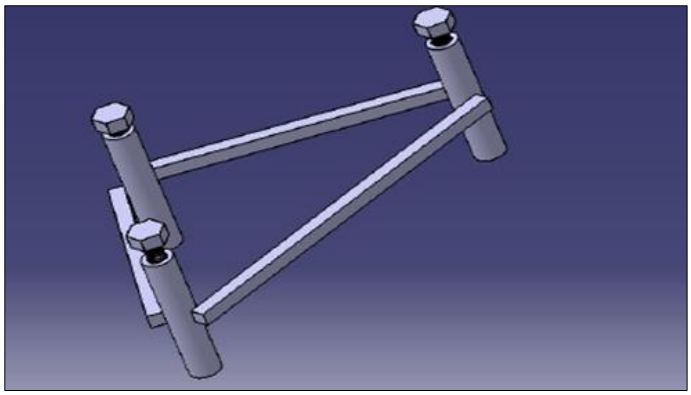

Figure 5 Model diagram of fixture for fit up of lug plates

Table 1 Part Description with material details

Part No.	Part Description	Material
1	3 M-12 bolts with 12 mm length	Grade-8 Carbon Alloy steel tensile strength: 150,000 psi
2	2 No.s fin flat of 6 mm thickness,10 mm width,400 mm length	SA213T12 Tensile Strength: ksi: 60 MPa: 415 Yield: ksi: 32 MPa: 220 Brinell: 163 HBW Max Rockwell B: 85 HRB Max
3	1 No fin flat of 6 mm thickness,10 mm width,200 mm length	SA213T12 Tensile Strength: ksi: 60 MPa: 415 Yield: ksi: 32 MPa: 220 Brinell: 163 HBW Max Rockwell B: 85 HRB Max
4,5	3 tubes of 50 mm length, outer diameter of 18 mm and inner diameter of 12 mm with internal tread up to 20 mm from top	SA213T12 Tensile Strength: ksi: 60 MPa: 415 Yield: ksi: 32 MPa: 220 Brinell: 163 HBW Max Rockwell B: 85 HRB Max

The two tubes (5) are welded each other with fin flat (3) of thickness 6 mm, 10 mm width and 200 mm length. The fins are welded at the tubes 25 mm from bottom (exactly at centre of the tubes). The fins are at angle of $\alpha=75°$ an $\beta=30°$.

The distance between the two tubes (3) are maintained 200 mm and the width of the lug plate is 332 mm as per the design.

The total distance from each side of the lug plate

= 332 mm-200 mm=132 mm.

To keep the fixture at the centre of the lug plate the distance should be maintained equally distributed from each side.

The distance from each side of the lug plate should be

=132 mm/2=66 mm.

The distance between the two tubes (2) are maintained 400mm and the length of the lug plate is 608mm as per the design.

The total distance from each side of the lug plate

=608 mm-400 mm=208 mm.

To keep the fixture at the centre of the lug plate, the distance from each side of the lug plate should be

=208 mm/2=104 mm.

The fixture can be placed easily on the ground floor easily as the bottom legs are flat. While giving lug fit up the fixture can be placed and height adjustment can be done through the bolts. The lug can be placed on the top of the bolt.

3. Results and discussion

The fixture is fabricated by utilizing the waste materials from the scrap yard. Accordingly, the prepared fixture is to reduce the human efforts and mistakes due to visual inspection.

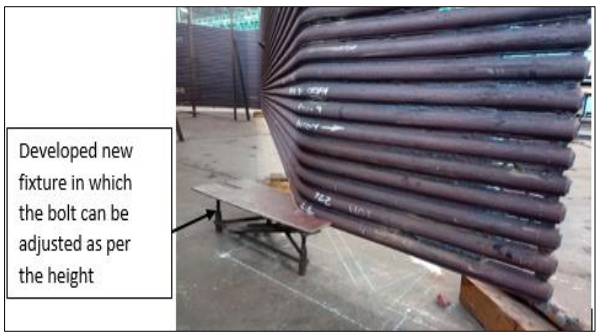

Figure 6 Newly developed lug plate fit up method

Figure 6 shows fit up of first lug plate by keeping the developed fixture on the ground. While giving lug fit up, the first lug is to be placed from bottom as per the ground layout. So the fixture is placed on the ground floor. The height of the lug from ground floor is adjusted by the nut provided on the top of the fixture. After adjusting the height, the lug is placed on the fixture in alignment with the bend portion on the panel & tack welded.

Due to the method, there is no need to hold the lug manually, instead it can be simply placed on the fixture and tack weld can be done with the panel. After first lug plate placed on the fixture and tack welded, the fixture is removed and placed on the first lug plate. Second lug is placed on the fixture as shown in the figure 7 and tack welded at the centre of the bend tube. The same process is continued to fix all the lug plates as per the design. A trail operation had been performed for lug plate fit up of 34 tubes. The lug plate fit up operation is found to be very less time consuming.

The positioning of the lug plates is very easy without any constraints. Holding of lug plates is now avoided as the lug plates can be placed on the fixture and height only can be adjusted through the nut provided on the fixture. To identify

the advantages after the project implementation, all relevant data is collected to calculate the time-slots involved in Lug fit up at the bend portion of the water wall panel, using the newly developed fixture.

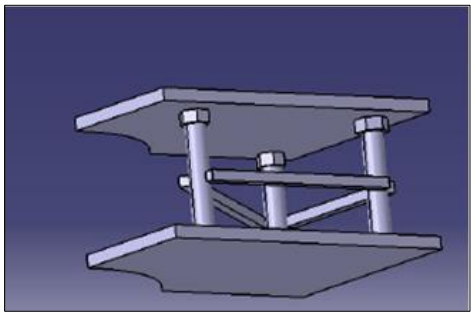

Figure 7 Placing of lug plates with respect to the first lug plate

4. Conclusion

From the above experiment it is found that the time consumed for lug plate fit up operation is very less, fatigue for the employees involved in the operation is less, productivity increased and cost to organization is also reduced. We can conclude that the developed fixture can be used for lug fit up of all types of gang bend and terminal water wall panels in less time and increase in safety.

Compliance with ethical standards

Acknowledgments

The authors are grateful to the management of Bharat Heavy Electricals Limited, Tiruchirappalli, India, and PRIST Deemed to be University, Tanjavore for their support and consent to carry out this study.

Disclosure of conflict of interest

The authors certify that they have No Conflict of Interest in the subject matter or materials discussed in this manuscript.

References

[1] Liu, Huiying, Yuexin Lu, Guorui Wu, and Shiqi Zhang. "Wheel cap section chamfering device." U.S. Patent Application 15/802,896, filed January 24, 2019.

[2] Takahashi, Hikaru. "Chamfer machining method." U.S. Patent 9,956,624, issued May 1, 2018.

[3] Glaser, Rami. "Self-adjusting chamfering tool." U.S. Patent 9,808,866, issued November 7, 2017.

[4] Rieth, Stephan. "Device for holding a milling and/or grinding machine." U.S. Patent 9,802,285, issued October 31, 2017.

[5] Uenishi, Daisuke. "Milling/cutting tool and processing apparatus." U.S. Patent Application 15/923,409, filed October 11, 2018.

[6] Choi, Insung. "Chamfering machine for providing optimal operation condition during operation of cutting surface of circular material and surface cutting method." U.S. Patent 9,669,475, issued June 6, 2017.

[7] Lee, Jong Il. "Portable pipe outer diameter-chamfering apparatus with improved weld ability." U.S. Patent 9,630,252, issued April 25, 2017.

[8] Dinagaran D, Balasubramanian K. R., Sivapirakasam S. P., and Gopanna, K, (2019) 'Discomfort and Postural Analysis of Flux Cored Arc Welding Machine Operators', Journal of Ergonomics Studies and Research, Vol. 1, No. 1, p.103.

[9] Dinagaran D, Balasubramanian K. R., Sivapirakasam S. P., and Gopanna, K, (2019) 'Behavior-based safety approach to improving workplace safety in heavy equipment manufacturing industry' Journal of Human Factors and Ergonomics, Vol. 6, No. 3, pp.255-264