

Pre-Weld Strength Improvement in Fillet Weld

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Abstract— Welding is an efficient method for joining of metals. Welding has made significant impact on large number of industries due to its flexibility, low fabrication cost and high rate of production. And also out of available different types of welding Arc welding is widely used because of its high reliability, deep penetration, smooth finish and high productivity [1]. Welding is a method in which coalescence of metals is achieved by fusion in which there is extremely high localised temperature which products distortion and high level of residual stress. This tends to reduce the strength of structure which becomes more vulnerable to fracture and fatigue failure during operation [2]. Fatigue life analysis of various mechanical components is influenced by various factors but it becomes more complicated in case of welded structures because of additional variables such as residual stresses, distortion and various weld defects. Fatigue analysis of weld is done with the help of various international standards such as IIW, Eurocode, etc. According to IIW and other standards fatigue of weld can be commonly assessed by three ways. These are Nominal stress, the Structural Hot Spot and the Effective Notch stress approach. And also their applicability varies with different applications.

Key words: Welding, Fillet Weld, Butt Joint

I. INTRODUCTION

Welding is a fabrication process used to join materials, usually metals or thermoplastics, together. During welding, the pieces to be joined (the work pieces) are melted at the joining interface and usually a filler material is added to form a pool of molten material (the weld pool) that solidifies to become a strong joint. In Arc welding, a welding power supply is used to create and maintain an electric arc between an electrode and the base material to melt metals at the welding point. In such welding processes the power supply could be AC or DC, the electrode could be consumable or non-consumable and a filler material may or may not be added.

In welding there are basically five types of joint are welded.

A. Butt Joint

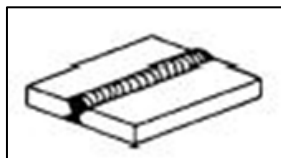


Fig. 1: Butt Joint

B. Corner and Tee Joints

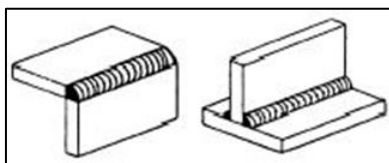


Fig. 2: Corner and Tee Joints

C. Lap Joint

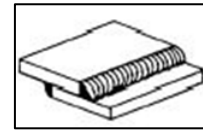


Fig. 3: Lap Joint

D. Edge Joint

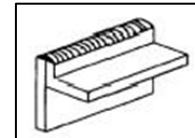


Fig. 4: Edge Joint

In arc welding processes since there is rapid heating and cooling of workpiece it results in uneven expansion and contrast in all the direction. This results in distortion in different direction of workpiece and also formation of residual stress. Residual stress has a strong influence on weld deformation, fatigue strength, fractures toughness and buckling strength.

II. THE TEST SPECIMEN

The main structure of Fly-Ash brick machine is fabricated by using 25mm M.S. plates. An arc welding is used and there is a fillet weld having 7mm leg length. Hence for experimentation 25mm square bar is used in which there is a arc welded fillet joint of 7mm leg length so that it can resembles with the main structure of fly ash brick machine. The CAD model of specimen is shown below.

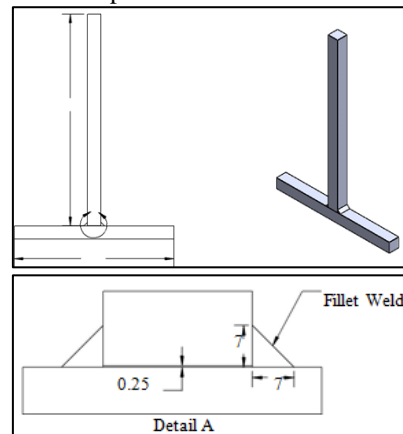


Fig. 5: CAD model of specimen

A. Photograph of Fabricated Specimen



Fig. 6: Photograph of Specimen



Fig. 7(a): Enlarged view of Specimen (b): Specimen SMAW2525 in the UTM before testing.

B. Specimen after Testing

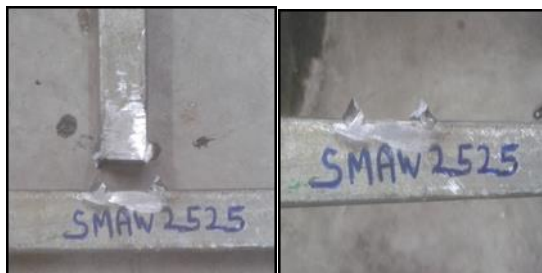


Fig. 8: Specimen SMAW2525 after testing in UTM. For the above specimen, the breaking load is found to be 53.4KN.

III. PRE WELD STRENGTH IMPROVEMENT

Since this project is related with accessing and improving the fatigue life of fillet weld of main structure of fly-ash brick machine, there is a constraint that the design of main structure cannot be changed in order to improve the fatigue life. Hence improvement has to done on same design only. Therefore the option is to do post weld improvement. Post weld improvement techniques are standard techniques given in IIW. In present study an alternative to post weld improvement technique is given i.e. pre weld strength improvement.

In this study a champher and different types of grooves with high tension bolted connection of 8mm diameter is created on the base metal along with a fillet weld of leg length of 7mm. Total four specimens are manufactured by 25mm square bar and its breaking load is determined in the UTM.

A. Preparation of Specimen



Fig. 9(a): Manufacturing of specimen (b) enlarged view of vertical bar showing tapped hole of 8mm dia.

1) Champher

A champher of 3.5mm is created on the vertical bar as shown in figure and a fillet weld of leg length 7mm is done on it as shown in figure. In this specimen there is no bolted connection as shown in figure.

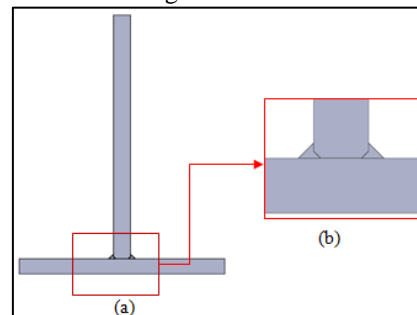


Fig. 10: Chamfer of 3.5mm Photograph of Fabricated Specimen

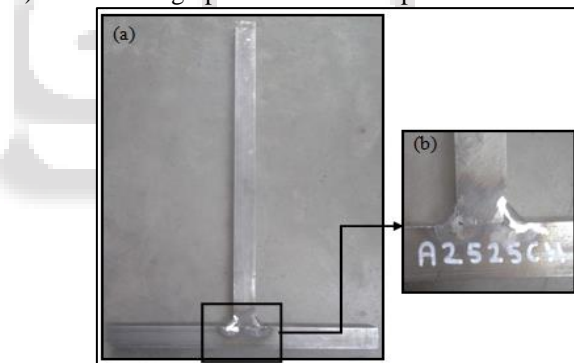


Fig. 11: (a) Photograph of Specimen A2525CH before test (b) enlarged view

b) Specimen after Testing

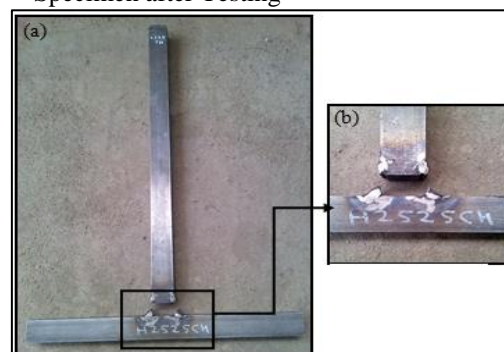


Fig. 12: (a) Photograph of Specimen A2525CH after test (b) enlarged view

The breaking load is found to be 133.38 KN.

2) Semi Circular Groove

Two semi-circular groove of radius 1mm is created and a fillet weld of leg length 7mm is done on it as shown in figure.

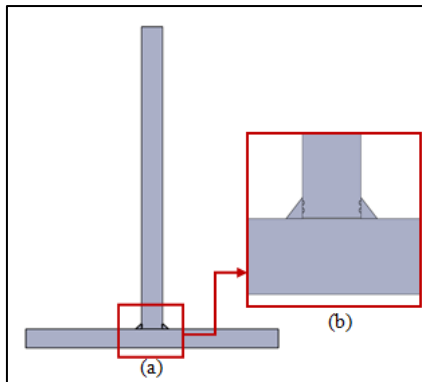


Fig. 13: (a) CAD model of specimen (b) enlarged view showing semi-circular groove

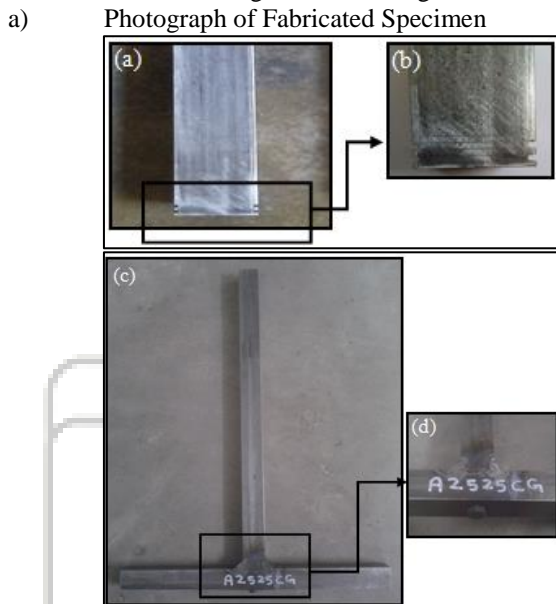


Fig. 14: Photograph of Specimen A2525CG before test (a) semi-circular groove (b) enlarged view showing circular groove (c) photograph of specimen with fillet weld (d) enlarged view showing weld and bolt



Fig. 15: (a) Photograph of Specimen A2525CG after test (b) enlarged view showing hole and bolt broken at head
The breaking load is found to be 159.12 KN.

3) Triangular Groove

Two triangular groove of height 2mm is created on the vertical bar and a fillet weld of leg length 7mm is done on it as shown in figure.

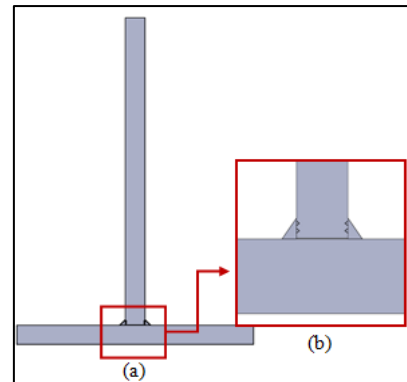


Fig. 16: (a) CAD model of specimen (b) enlarged view showing triangular groove

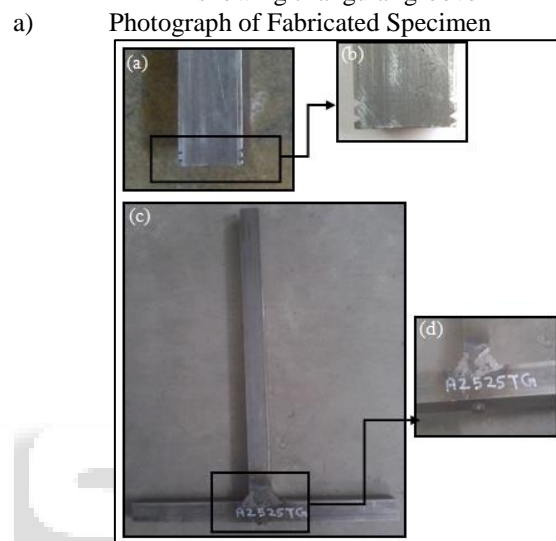


Fig. 17: Photograph of Specimen A2525TG before test (a) triangular groove (b) enlarged view showing triangular groove (c) photograph of specimen with fillet weld (d) enlarged view showing weld and bolt.

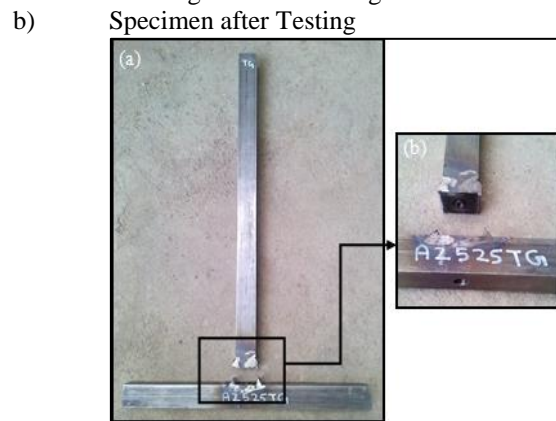


Fig. 18: (a) Photograph of Specimen A2525TG after test (b) enlarged view (c) enlarged view showing hole and bolt broken at head

The breaking load is found to be 173.82 KN.

4) Square Groove

Two square groove of 2mm is created on the vertical bar and a fillet weld of leg length 7mm is done on it as shown in figure.

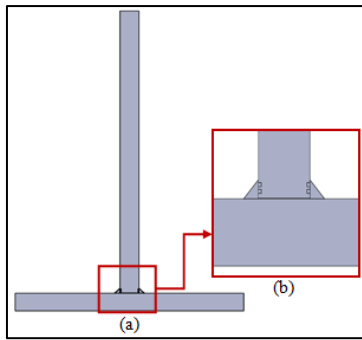


Fig. 19: (a) CAD model of specimen (b) enlarged view showing square groove.

a) Photograph of Fabricated Specimen

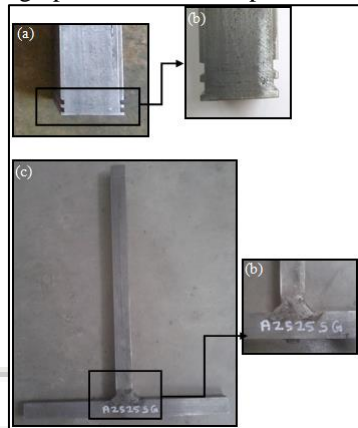


Fig. 20: Photograph of Specimen A2525SG before test (a) square groove (b) enlarged view showing square groove (c) photograph of specimen with fillet weld (d) enlarged view showing weld and bolt

b) Specimen after Testing



Fig. 21: (a) Photograph of Specimen A2525SG after test (b) enlarged view (c) enlarged view showing hole and bolt broken at head.

The breaking load is found to be 173.82 KN

IV. CONCLUSION

The method used for the test is: IS 1608:2008. All the specimen is manufactured from 25 square bar and electrode E 6013 is used for welding and there is a fillet weld of leg length of 7mm. Electrode E 6013 and a fillet weld of leg length 7mm is used because the same type of welding is done for fabrication of main structure of fly-ash brick machine. It is seen that welding cracks are initiated from the critical areas and from the open portions of welded structure. Therefore it is suggested that chamfer and grooves should be provided only in that place so that

initiation of weld cracks will stop and naturally it fatigue life will increase. The detail test report is mentioned in the table below.

Sr. No.	Specimen ID	Breaking load KN	Broken At
1	SMAW2525	53.4	Weld Metal
2	A2525CH	133.38	Weld Metal
3	A2525CG	159.12	Weld Metal
4	A2525TG	173.82	Weld Metal
5	A2525SG	173.82	Weld Metal

Table 1: Detail Test Report

The above test report is mentioned in the form of bar chart shown in figure.

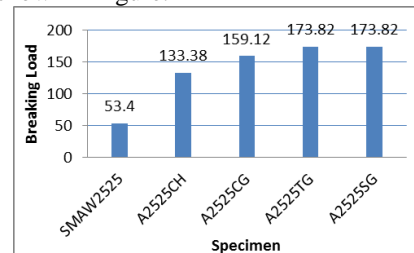


Fig. 22: Bar chart showing increase in strength of weld by chamfer and different grooves

According to the above results it can be seen that there is a significant increase in the weld strength. The specimen SMAW2525 represents the actual weld condition in the main structure of fly-ash brick machine in which there is a simple arc weld of leg length 7mm and its breaking load found in UTM is 53.4 KN.

The breaking load of specimen A2525CH in which there is a chamfer of 3.5 mm and same fillet weld of leg length of 7mm is found to be 133.38 KN. Thus the increase in strength of specimen A2525CH is 2.49 times the strength of SMAW2525.

The breaking load of specimen A2525CG in which there is a semi-circular groove of radius 1 mm and same fillet weld of leg length of 7mm is found to be 159.12 KN. Thus the increase in strength of specimen A2525CG is 2.98 times the strength of SMAW2525.

The breaking load of specimen A2525TG in which there is a triangular groove of height 2 mm and same fillet weld of leg length of 7mm is found to be 173.82 KN. Thus the increase in strength of specimen A2525TG is 3.26 times the strength of SMAW2525.

The breaking load of specimen A2525SG in which there is a triangular groove of height 2 mm and same fillet weld of leg length of 7mm is found to be 173.82 KN. Thus the increase in strength of specimen A2525SG is 3.26 times the strength of SMAW2525.

Since there is significant improve in the strength of the weld therefore it can be say that there can also be significant increase in the fatigue life of the weld.

REFERENCES

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