Volume 4, Issue 3, pp. 32-34, 2020.

International Journal of Scientific Engineering and Science
ISSN (Online): 2456-7361

Effect of the Rolling Direction to the Ultimate Tensile Strength of Butt Welds for ASTM A36 Steel

Hung Ho-Sy, Long Nguyen-Nhut-Phi*, Hao Nguyen-Van, Viet Nguyen-Quoc
Faculty of Mechanical Engineering, HCMC University of Technology and Education (HCMUTE), Thu Duc-71307, Ho Chi Minh City, Viet Nam
Email address: hunghs @ hcmute.edu.vn, longnnp @ hcmute.edu.vn*, 15104016 @ student.hcmute.edu.vn, 15104066 @ student.hcmute.edu.vn

Abstract— *The objective of the paper is to give different results on the ultimate tensile strength (UTS) of the weld with samples cut from three different positions on the ASTM A36 steel plate. Specifically, every two samples are cut respectively in the rolling direction (RD), perpendicular to the RD, and 45 degrees to the RD. Three butt welds are made using the flux-cored arc welding (FCAW) technology. The results show that the UTS of R1-R2 weld is higher than C1-C2 and T1-T2 welds.*

Keywords— *ASTM A36 steel; butt weld; flux-cored arc welding (FCAW); rolling direction (RD); ultimate tensile strength (UTS).*

I. INTRODUCTION

ASTM A36 steel is one of the types of carbon structural steel with many applications: frames, fixtures, machinery parts, base plates, bearing plates, tanks, and options of fabrication: bending, punching, forming, machining, welding.

After the rolling process, the steel sheets have a non-homogeneous distribution structure, creating a mechanical anisotropy of the material. Several studies have mentioned the effect of rolling direction on the mechanical properties of the material:

The evaluation of the influence of RD (0, 30, 60, and 90 degrees) and the reduction of plate thickness by cold working to the microstructure, hardness, and durability of DIN CK 45 steel is mentioned in [1].

The research [2] has presented the influence of RD and sample width on the elastic modulus (E) and yield strength (YS) of C17200 alloy: the YS achieved maximum when pulling in the RD and the E is reduced by 4% when the width of the sample decreases from 12.5 mm to 2.5 mm.

The paper [3] presented the effects of RD on elastic modulus (E), ultimate tensile strength (UTS) of AA5083 alloys with angles of 0, 45, and 90 degrees. The results show that when the orientation angle increases: the UTS increases, E decreases, and the largest strain with an angle of 45 degrees.

In the study [4], the influence of RD on Linear-Elastic Plane-Strain Fracture Toughness (K_{IC}) of 7075-T651 aluminum alloy was highlighted. The author used ASTM E399 to test the K_{IC} specimens for three directions and six orientations (L-T, T-L, T S, S-T, L-S, S-L). The results clearly show the influence of K_{IC} on the RD, and the highest value of this parameter is achieved in the T-S and L-T cases.

The article [5] investigated the microstructure and compared the mechanical properties of two welded joints for DP1000 steel by the gas metal arc welding (GMAW) technology: the weld the same direction with the RD (RD weld) and the weld perpendicular with the RD (TD weld). The results showed that, although the degree of softening of the heat-affected zone of the TD weld was higher, it did not affect UTS, the hardness and elongation doubled compared to RD weld.

II. EXPERIMENTAL

A. Base Metal

The chemical compositions and ultimate tensile strength (UTS) of ASTM A36 steel are shown in Table I.

TABLE I. Specification of ASTM A36 steel

Chemical compositions (%)						UTS
C	**Mn**	**Si**	**S**	**P**	**Cu**	**(MPa)**
0.25-0.29	1.03	0.28	0.05	0.04	0.2	400-550

B. Sample

Six samples with dimensions of 400×200×14 mm were cut, as shown in Fig. 1

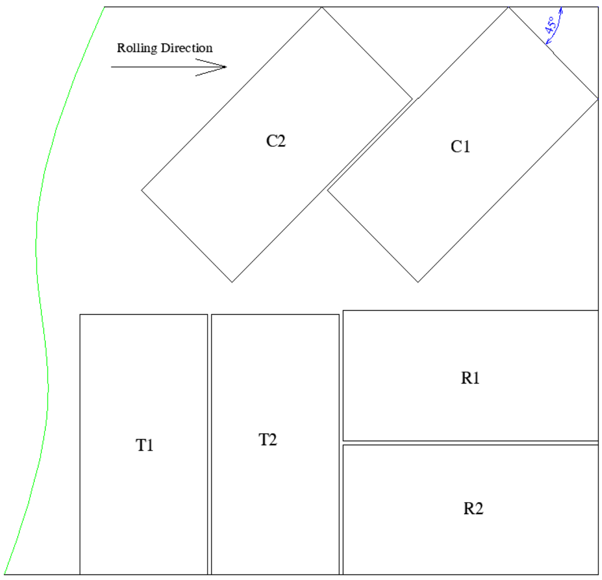

Fig. 1. Arranging cutting samples on a steel plate (R: Rolling direction, T: Traverse direction, and C: 45° above the rolling direction)

C. Prepare Weld Joint

The welds are prepared as shown in Fig. 2

International Journal of Scientific Engineering and Science
Volume 4, Issue 3, pp. 32-34, 2020. ISSN (Online): 2456-7361

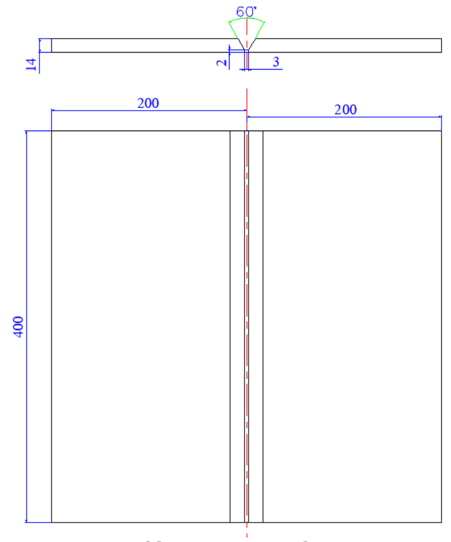

Fig. 2. Welding preparation drawing

D. Welding Procedure

Three welds of R1-R2, T1-T2, and C1-C2 samples (parameters present in Table II, and joint details as shown Fig. 4) are made at the Suoi Tien CO., LTD by the DM-350 CO_2/MAG Inverter welding machine

Fig. 3. The DM-350 CO2/MAG Inverter welding machine

TABLE II. Welding parameters

Layers	Process	Filler metal		Current		Volts. (V)	Travel speed (cm/min)	Heat input (kJ/mm)
		Class	Dia. (mm)	Type & Polarity	Amps. (A)			
Root/ Fill	FCAW	E71T-1C	1.2	DCEP	130-160	20-24	15-19	0.82-1.54
Cap 1	FCAW	E71T-1C	1.2	DCEP	140-170	22-26	14-18	1.03-1.89
Cap 2	FCAW	E71T-1C	1.2	DCEP	140-170	22-26	16-20	0.92-1.66

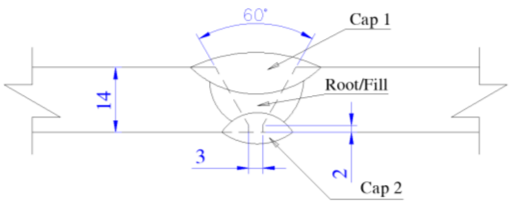

Fig. 4. Joint details

After welding, two tensile specimens are cut from each weld with dimensions shown as Fig. 5

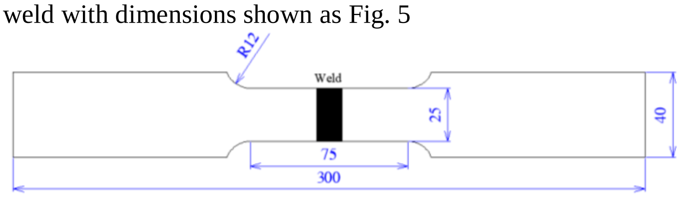

Fig. 5. Tensile samples drawing with weld

Next, the six tensile specimens were tested on the WA-1000B-LUDA Universal Testing Machine at the Dong Nai Department of Science and Technology.

Fig. 6. The WA-1000B-LUDA Universal Testing Machine

III. Results and Discussion

Figure 7 shows six specimens after tensile testing

(a) R1-R2 specimens

(b) C1-C2 specimens

(c) T1-T2 specimens

Fig. 7. The samples were fractured

Table III presents the results of the tensile test.

TABLE III. The results of the ultimate tensile test (UTS)

Weld	UTS (MPa)		
	Sample 1	**Sample 2**	**Average**
R1-R2	479.82	489.13	*484.475*
C1-C2	471.01	481.82	*476.415*
T1-T2	462.98	461.54	*462.260*

The comparison results are shown in Fig. 8

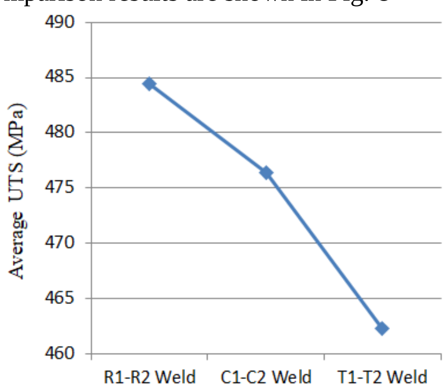

Fig. 8. Chart of the average ultimate tensile strength of three welds

The results show that the ultimate tensile strength of R1-R2 weld with the cut sample in the rolling direction is higher than others.

IV. CONCLUSION

In this article, the authors gave the value of tensile strength of butt welds for ASTM A36 steel using FCAW technology depending on the rolling direction (RD). The three sample positions to be cut on a steel plate are proposed to be 0, 45, and 90 degrees, respectively. The results show that selecting a suitable sample cutting position makes a welded structure that satisfies better working conditions.

ACKNOWLEDGMENT

The authors sincerely thank the HCMC University of Technology and Education for grants through the HCMUTE T2019-12TĐ research project, the support of the Mechanical & Industrial Construction JSC, the Suoi Tien CO., LTD, and the Dong Nai Department of Science and Technology.

REFERENCES

[1] Younis Fakher Aoda, Dr. Lattif Shekher Jabur, "Effect of the Rolling Direction and Draft on Some of the Mechanical Properties for the Medium Carbon Steel," *International Journal of Science and Research* (IJSR), Volume 3, Issue 12, 2014 (DOI: 10.1016/j.cscm.2017.01.006)

[2] Lee, W. C., & Liu, Z. R., "Effects of specimen width and rolling direction on the mechanical properties of beryllium copper alloy C17200", in *IOP Conference Series: Materials Science and Engineering*, 103, 012051, 2015 (DOI:10.1088/1757-899x/103/1/012051)

[3] Najib, L. M., Alisibramulisi, A., Amin, N. M., Bakar, I. A. A., & Hasim, S., "The Effect of Rolling Direction to the Tensile Properties of AA5083 Specimen", in *InCIEC 2014*, 779–787, 2015 (DOI:10.1007/978-981-287-290-6_67)

[4] İriç, S. & Ayhan, A.O., "Dependence of Fracture Toughness on Rolling Direction in Aluminium 7075 Alloys", *Acta Physica Polonica A*, 132, 892-895, 2017 (DOI:10.12693/APhysPolA.132.892)

[5] Khraisat, W., Abu Jadayil, W., Al-Zain, Y., & Musmar, S., "The effect of rolling direction on the weld structure and mechanical properties of DP 1000 steel", *Cogent Engineering*, 5(1), 1–11, 2018 (DOI:10.1080/23311916.2018.1491019)