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IMPACT OF ELECTRIC-ARC WELDING ON THE MECHANICAL PROPERTIES OF AISI 1055 MEDIUM CARBON STEEL WITH VARIED GAUGE DIAMETERS

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ABSTRACT

Purpose: This paper investigated through experimentation, the impact of electric-arc welding processes on the mechanical properties of AISI 1055 steel medium carbon steel material with varied gauge diameters.

Design/Methodology/Approach: The study used experimental and analytical methods to investigate the impact of electric arc welding on the mechanical properties of AISI 1055 Medium Carbon Steel. The test samples were prepared based on the standards of the American Iron and Steel Institute (AISI), with varied gauge diameters. Standard tensile tests were performed on the samples before welding and after welding, using a computer-interfaced Universal Tensile Testing Machine. Data obtained from the study was analyzed using graphs, tables and charts. Finally, the sets of results for both welded and unwelded specimens were compared to determine the impact that welding has on welded medium carbon steel components and structures.

Findings: The data recorded by the computer-interfaced tensile test machine was used to plot and display, the stress-stain graphs for the various sets of samples. The results showed that the welding processes adversely affected the Ultimate Tensile Strength (UTS), Yield Strength, Elastic Modulus and Impact Strength of the samples studied; since all the samples studied had their initial values dropped after undergoing welding and testing. However, the strain of the samples increased after welding.

Research Limitation/Implication: Although there are other methods and techniques of welding metals, this study adopted electric arc welding to weld the samples used for the study due to resource constraints.

Practical Implication: The findings of this study also bring to the fore, the need for industry regulators to promulgate standards to regulate the welding of medium carbon steel and by extension, other industrial materials to preserve the natural properties of the materials.

Originality/Value: This study introduced an important perspective to the testing of engineering materials by varying the gauge diameters (a key determinant of the dimensional specifications of the specimen), to obtain a comprehensive insight into the impact of electric-arc welding on the mechanical properties of the material.

Keywords**:** *Carbon steel. electric-arc. gauge-diameter. mechanical. welding.*

INTRODUCTION

Medium Carbon Steel is one of the most important engineering materials due to its vast areas of applications. It has similar properties as low-carbon steel except that it contains Carbon content of 0.30 % - 0.60% and Manganese between 0.60% and 1.65% (Ramesh Singh, 2020). Medium Carbon steel boasts a fine combination of high strength, ductility, weldability, good resistance to wear and excellent thermal and electrical conductivity.

Due to its excellent mechanical properties, medium carbon steel is used for making machine components such as shafts, axles, forgings, and structural works, among others. The carbon content gives this type of steel hardness and high strength in addition to being relatively inexpensive as compared to other industrial metals. Being strong, Medium Carbon Steel can withstand large impact loads and shocks, whereas low or mild steel could fail. The properties of Medium Carbon Steel allow electric current to travel through the metal without distorting the elemental makeup of the material. Just like low-carbon and mild steels, Medium Carbon Steel is weldable (Singh, 2012).

Welding is the process of uniting two pieces of similar metals or metal alloys by fusion. Intense heat is applied close to the parts to be welded, keeping the two pieces of metal together to form a molten puddle and thereby uniting the metals together after cooling. Engineers and metal artisans apply various methods and techniques of welding processes to join Medium Carbon Steel mechanical components and parts. During the welding process, the strength and the mechanical properties of the parent metals may be affected as a result of the intensity of the heat applied and the residual thermal stresses that may be induced (Kredegh et al., 2016).

Welding may also exert a significant influence on the toughness of welded Medium Carbon Steel components, particularly in cases where the parent metals are not completely heat-treated after being welded. Preheating reduces significantly, the possibility of thermal gradients or stresses developing in the weld and slows down the rate of cooling of the weld deposit. Increasing the preheating temperature of Medium Carbon Steel has a beneficial effect on the toughness of the material (Jeffus, 2011).

This study sought to experimentally investigate the extent to which the strength and the mechanical properties of Medium Carbon Steel components are affected after being welded. The study was conducted by analyzing the strength and mechanical properties of Medium Carbon Steel before welding and after welding.

LITERATURE REVIEW:

The American Iron and Steel Institute (AISI) defines carbon steel as follows: Steel is considered to be Carbon Steel when no minimum content is specified or required for Chromium, Cobalt, Molybdenum, Nickel, Titanium, Tungsten, Zirconium, or any other element to be added to obtain a desired alloying effect; when the specified minimum for Copper does not exceed 0.40 per cent; or when the maximum content specified for any of the following elements does not exceed the percentages noted: Manganese 1.65, Silicon 0.60, Copper 0.60. Carbon Steel can be classified, according to various deoxidation practices; as rimmed, capped, semi-killed, or killed steel. Deoxidation practices and the steelmaking process will affect the properties of the steel. However, variations in carbon have the greatest effect on mechanical properties, with increasing Carbon content leading to increased hardness and strength. As such, Carbon Steels are generally categorized according to their Carbon content. Generally speaking, carbon steels contain up to 2% total alloying elements and can be subdivided into low-carbon Steels, medium-carbon Steels, high-carbon Steels, and ultrahigh-carbon Steels; each of these designations is discussed below.

As a group, Carbon steel is by far the most frequently used steel. More than 85% of the steel produced and shipped in the United States is Carbon Steel.

Low-carbon steels contain up to 0.30% C. The largest category of this class of steel is flat-rolled products (sheet or strip), usually in cold-rolled and annealed conditions. The Carbon content for these high-formability steels is very low, less than 0.10% C, with up to 0.4% Mn. Typical uses are in automobile body panels, tin plates, and wire products.
For rolled steel structural plates and sections, the Carbon content may be increased to approximately 0.30%, with higher Manganese content up to 1.5%. These materials may be used for stampings, forgings, seamless tubes, and boilerplates.

Medium-carbon steels are similar to low-carbon steels except that the Carbon ranges from 0.30 to 0.60% and the Manganese from 0.60 to 1.65%. Increasing the Carbon content to approximately 0.5% with an accompanying increase in Manganese allows medium Carbon steel to be used in the quenched and tempered condition. The uses of medium Carbon-Manganese steels include shafts, axles, gears, crankshafts, couplings and forgings. Steels in the 0.40 to 0.60 % C range are also used for rails, railway wheels and rail axles.

High-Carbon steels contain from 0.60 to 1.00% C with Manganese contents ranging from 0.30 to 0.90%. High-carbon steels are used for spring materials and high-strength wires.

Ultrahigh-Carbon steels are experimental alloys containing 1.25 to 2.0% C. These steels are thermo-mechanically processed to produce microstructures that consist of ultrafine, equiaxed grains of spherical, discontinuous proeutectoid carbide particles.

Electric Arc Welding Processes

An electric arc welding system is composed of a power source, an electrode and a workpiece. The lack of protection from the air can cause a continuous deterioration of the hot electrode and harmful effects upon the highly reactive molten weld metal, due to Oxygen, Hydrogen and Nitrogen present in the atmosphere. Hence, a shielding system is used for protecting the weld pool and electrode from the environment and, also, helps to stabilize the arc. Direct Current (DC) power sources can be designed to keep a convenient relationship between voltage and current, both before and after the establishment of the arc Ghosh, (2015). Singh (2020) classifies them as drooping, constant and rising arc voltage machines (DAV, CAV and RAV, respectively).

However, updated literature by the American Society for Metals simply distinguishes between constant-current and constant-voltage sources. For the sake of completeness, it is only pointed out that the former is commonly used in SMAW and GTAW, whereas constant-voltage sources are used in GMAW, FACW & SAW. The power source operates generally in the range of 10-2000 A and at 10-50 V and is responsible for setting the electric arc in the gap between the electrode and the workpiece when the breakdown voltage of the gas is exceeded. This is highly desirable since the extremely high temperature of the arc permits it to supply a large amount of energy to a small area.

Ndaliman, (2006) assessed the mechanical properties of medium carbon steel under different quenching media. The mechanical properties of medium carbon steel (0.36 C) were investigated under two different quenching media (water and palm oil). The properties were; the strengths, impact strength and hardness of the material. The investigations centred on non-heat-treated, normalized; water and palm oil quenched, and tempered conditions. The tempering temperature was 200 °C. An AISI steel of grade C1035 was used for comparison of the properties. The results showed that water-quenched steel produced its best properties in strength and hardness, while palm oil-quenched steel has its best properties in impact strength.

Talabi et al., (2014) evaluated the effect of welding variables on the mechanical properties of welded 10 mm thick low carbon steel plate, using the Shielded Metal Arc Welding (SMAW) method. The welding parameters evaluated were; welding current, arc voltage, welding speed and electrode diameter. The welded samples were cut and machined to standard configurations for tensile, impact toughness, and hardness tests. The test results showed that the selected welding parameters had significant effects on the mechanical properties of the welded samples.

In his work titled "*Design of Welded Steel Structures: Principles and Practice*", Ghosh (2015) provided a solid foundation of theoretical and practical knowledge necessary for the design of welded steel structures. The work began by explaining the basics of arc welding, describing the salient features of modern arc welding processes as well as the types and characteristics of welded joints, their common defects, and recommended remedial measures. The work then addressed the analysis and design of welded structures, explored the design of joints concerning common welded steel structures: and identified the cost factors involved in welded steelwork".

Sumardiyanto and Susiowati (2019) studied the mechanical properties of welding variables on API 5L low-carbon steel through SMAW welding. "The welding variable used consists of various types of welding electrodes and variations in the amount of current. The types of welding electrodes are E6010, E7016 and E7018 and the welding current given is 90 A and 100 A. Welding samples were cut and machined to standard configurations for tensile strength, impact, and hardness tests and SEM for microstructure tests. The results showed that there are significant effects of welding variables (type of electrodes and current given) on the tensile strength, impact and hardness of the welding metal. The result shows that for all types of electrodes when the amount of current given increases then the mechanical properties such as tensile strength, impact and hardness decrease. The optimum tensile strength for welding metal was produced by the welding electrode E7016 at 90 A with 617.155 MPa while the lowest value is 505.215 MPa for E6013 at 100 A. The optimum of hardness is produced by E7018 at a welding current of 90A with 194.40 VH while the lowest is 170.60 VH for E6013 at 100 A and impact 1.915 J/mm^2 by E 7018 at 90 A while the lowest is 0.728 J/mm^2 for E6013 at 100 A. Observation of the microstructure by SEM showed several phases namely Acicula Ferrite (AF), Grain Boundary Ferrite (GBF) and Bainite".

Miles (2016) stated that the weldability of steel is influenced mainly by the Carbon content. Carbon equivalents of 0.35 or less are safe to weld without any pre-weld or post-weld heat treatments required. At higher Carbon levels, steels may require either pre- or post-weld heat treatment to prevent stress buildup and weld cracking. The weldability is negatively influenced by free-machining additives such as Sulfur. Weldability can also be influenced by grain size. The thickness of the welded section is also a factor in determining the need for pre-and post-weld thermal treatment.

Morisada et al. (2020) demonstrated the "weldability of medium Carbon and High Carbon Steels using friction welding at high temperatures. Medium and high carbon steel rods were welded by friction welding at a high friction pressure and low rotation rate to decrease the peak temperature during the welding. The peak temperatures at both joint surfaces were confirmed to be below the transformation temperature, thus martensitic transformation was prohibited at the dominant part of the joints. These joints had both superior tensile strength and larger elongation than those formed by conventional methods. These results revealed that friction welding below the temperature can improve the mechanical properties of similar joints of medium and Carbon steel.

Peasura (2017) studied the effects of submerged arc welding (SAW) process parameters on the mechanical properties of pressure vessel ASTM A283 steel. The weld samples were obtained from an ASTM A283 grade sheet of 6.00 mm thickness. The welding sample was treated using SAW with the variation of three process factors. For the first factor, welding currents of 260 A, 270 A, and 280 A were investigated. The second factor assessed was the travel speed, which was tested at both 10 and 11 mm/s. The third factor examined the voltage parameter, which was varied between 28 V and 33 V. Each welding condition was conducted randomly, and each condition was tested a total of three times, using a full factorial design. The resulting materials were examined using tensile strength and hardness tests and were observed with optical microscopy (OM). The tensile strength and hardness obtained for the weld samples were found to correspond to the formation of pearlite density and fine pearlite in the weld metal and heat-affected zone".

Tian et al., (2017) used two low-carbon micro-alloyed steels, named steel A and steel B, and fabricated by ultra-fast cooling (UFC) to analyze the microstructure and mechanical properties of low-carbon micro-alloyed steels. "In both steels, the microstructures containing quasi polygonal ferrite (QF), acicular ferrite (AF) and granular bainite (GB) were obtained by UFC process. The amount of AF in steel B is more than that in steel A. The size and distribution of precipitates (Nb/Ti carbonitrides) in steel B are finer and more dispersed than those of steel A due to the relatively low finish cooling temperature. The mechanical properties of both steels were effectively enhanced by the UFC process. UFC process produced low-temperature transformation microstructures containing a significant amount of AF. The mechanical properties of steel B were more satisfactory than those of steel A due to the finer average grain size, the greater amount of volume fractions and the smaller size of secondary phases.

MATERIALS AND METHODS

The study used experimental and analytical methods to investigate the impact of arc welding on the strength and mechanical properties of medium carbon steel. The specimen used for the study is AISI 1055 Medium Carbon Steel material. The study used varied gauge diameters of 12 mm, 14 mm, 16 mm, 18 mm and 20 mm Both welded and unwelded samples were prepared from the AISI 1055 steel material with a carbon content of 0.5500%. Other major elements present in this steel material are; Manganese (0.7500%), Sulphur (0.0500%) Phosphorus (0.0400%). Standard mechanical tests were done using both welded and unwelded Medium Carbon Steel. Accordingly, the following machines and equipment were used for the study; Standard Universal Tensile Test Machine (for tensile test analyses) and impact test machine (for impact test analyses). The mechanical properties analyzed are; Ultimate Tensile Strength (UTS), Yield Strength, Tensile Strength, Elastic Modulus, and Strain.

Both samples (welded and unwelded), were prepared to the required specifications using a centre lathe. Also, the surfaces of all the samples were machined (smoothened) to reduce their surface roughness. All the tensile test samples were machined into a "dog bone" shape of standard dimensions, using the American Iron and Steel Institute (AISI) standard relation for dimensioning the tensile test specimen. The samples were heat-treated and quenched in 'still air' to ensure uniformity.

The relation is stated as follows;
$d \geq 10$ mm – 20 mm (gauge diameter). Per the AISI standard, the gauge diameter (d) can vary from 10 mm to 20 mm.
$L_O = 5d$ (gauge length)
$L_C = L_O + (\frac{d}{2})$ (reduced section length)
$R \geq 1.5d$ (fillet radius)

D (grip section diameter); it has no specified value. However, the grip section diameter (D) should be significantly bigger than the gauge diameter (d) to ensure a firm grip of the specimen in the tensile test machine.

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The gauge diameter (d) was varied with values of d = 12 mm, 14 mm, 16 mm, 18 mm and 20 mm.

Dimensions of first tensile test sample specimen (Specimen A)

d = 12 mm

L_0 = 5(12) = **60 mm**

L_c = 60 + ($\frac{12}{2}$) = **66 mm**

R = 1.5(12) = **18 mm**

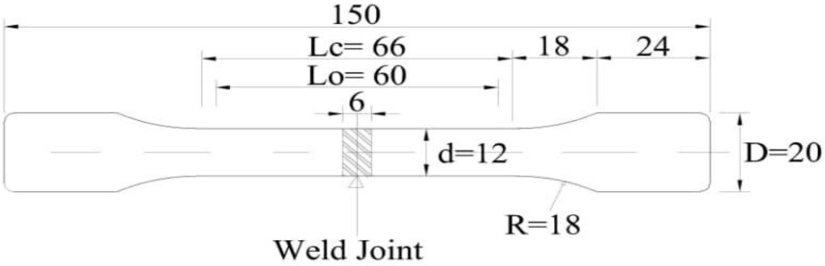

Figure 1 Geometric Shape of Specimen 'A'

Dimensions of the second tensile test sample (Specimen B)

d = 14 mm

L_0 = 5(14) = **70 mm**

L_c = 70 + ($\frac{14}{2}$) = **77 mm**

R = 1.5(14) = **21 mm**

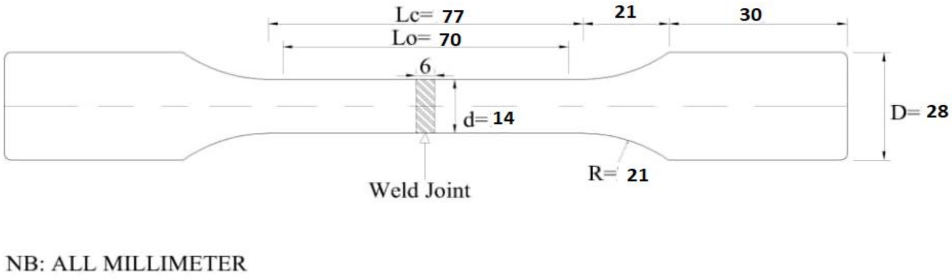

Figure 2 Geometric Shape of Specimen 'B'

Dimensions of third tensile test sample specimen (Specimen C)

d = 16 mm

L_0 = 5(16) = **80 mm**

L_c = 80 + ($\frac{16}{2}$) = **88 mm**

R = 1.5(16) = **24 mm**

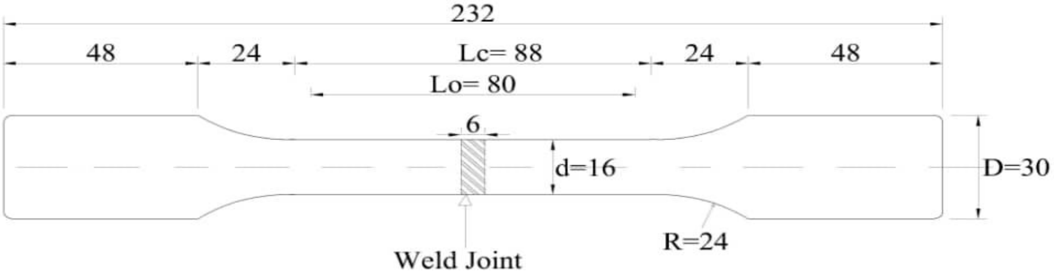

Figure 3 Geometric Shape of Specimen 'C'

Dimensions of the fourth tensile test sample specimen (Specimen D)
d = 18 mm

L_o = 5(18) = **90 mm**

L_c = 90 + $(\frac{18}{2})$ = **99 mm**

R = 1.5(18) = **27 mm**

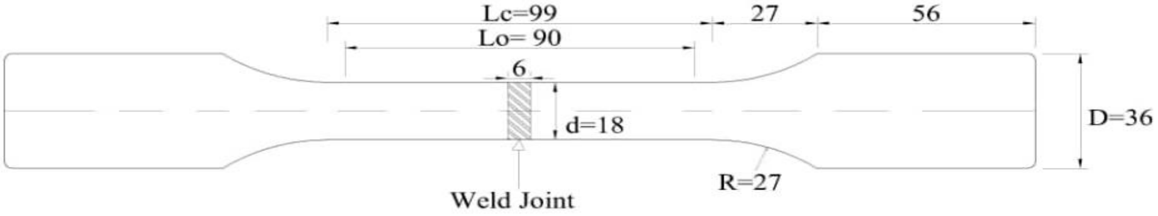

Figure 4 Geometric Shape of Specimen 'D'

Dimensions of the fifth tensile test sample (Specimen E)
d = 20 mm

L_o = 5(20) = **100 mm**

L_c = 100 + $(\frac{20}{2})$ = **110 mm**

R = 1.5(20) = **30 mm**

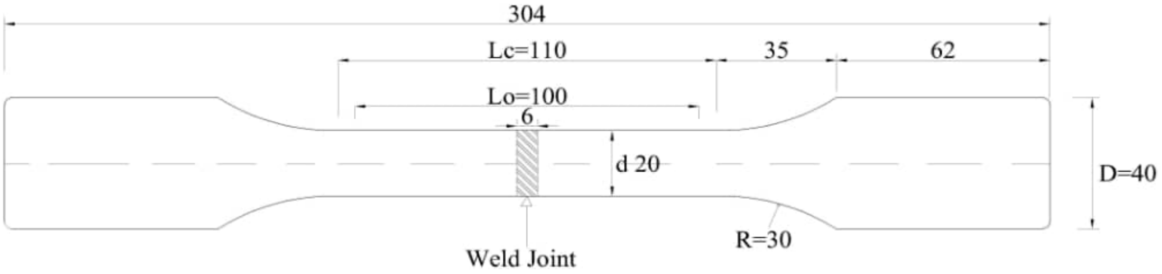

Figure 5 Geometric Shape of Specimen 'D'

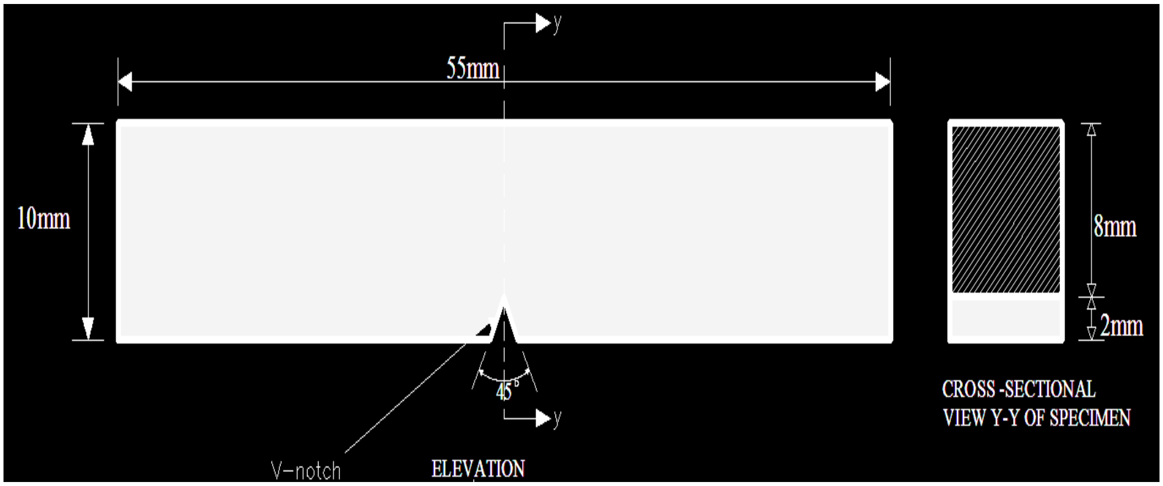

Figure 6 Geometric Outline of Charpy Impact (V-Notch) Test Specimen

Figure 7 Welded Tensile Test Sample

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Figure 8 Unwelded Tensile Test Sample

RESULTS AND DISCUSSION

The results are presented in order of the procedure adopted for the study; tensile test results and impact strength results. The tensile test results were obtained from the combined stress-strain graphs.

Tensile Test Results.

Table 1 Tensile Test Results for Specimen 'A'

	UTS (MPa)	Yield Strength (MPa)	Elastic Modulus (GPa)	Strain (%)
US	698	481	203	10.34
WS	621	442	201	12.47

KEY: US – Unwelded Sample: WS – Welded Sample

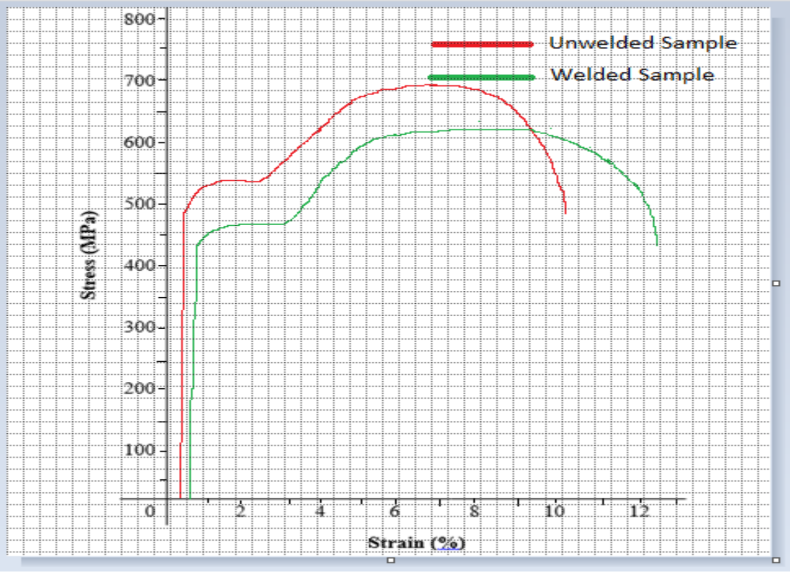

Figure 9 Stress-Strain Graph for Specimen 'A'

Table 1 and Figure 9, the Ultimate Tensile Strength (UTS) of Specimen 'A' before welding was 698 MPa. The UTS of the sample specimen after welding and tensile testing, dropped to 621 MPa; representing a drop of 11.03%. The yield strength of specimen 'A' before welding is 481 MPa. The Yield Strength dropped to 442 MPa after welding. This represents a percentage drop of 8.11%. The elastic Moduli of specimen 'A' before welding and after welding are 203 GPa and 201 GPa respectively. This indicates a marginal reduction of 5 GPa and a percentage drop of 0.99%. the percentage strain of specimen 'A' before welding was 10.34%. After welding, the strain increased to 12.47%; implying an increase of 2.13%. These are in agreement with the findings of Roodgari, Jamaati, and Aval, (2021) which were much higher than the initial samples and other fabricated dual-phase steels. They concluded that the excellent strength-ductility balance was achieved compared with the conventional trend in steels, which was mainly due to the formation of a proper laminated structure.

Table 2 Tensile Test Results for Specimen 'B'

	UTS (MPa)	Yield Strength (MPa)	Elastic Modulus (GPa)	Strain (%)
US	697	478	207	8.93
WS	623	429	203	10.89

KEY: US – Unwelded Sample WS – Welded Sample

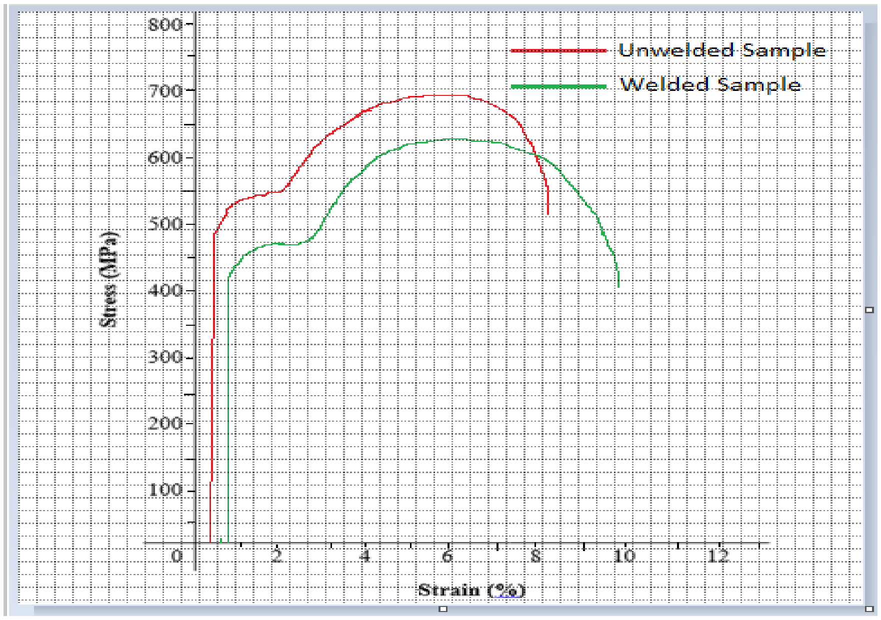

Figure 10 Stress-Strain Graph for Specimen 'B'

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Table 2 and Figure 10, the Ultimate Tensile Strength (UTS) of Specimen 'B' before welding was 697 MPa. The UTS of the sample specimen after welding and tensile testing, dropped to 623 MPa; indicating a reduction of 10.62%. The Yield strength of specimen 'B' before welding and after welding is 478 MPa and 429 MPa respectively. This indicates a percentage drop of 10.25%. While the Elastic modulus of specimen 'B' before welding is 207 GPa. After welding, the Elastic modulus increased to 203 GPa. This implies that the elastic modulus of the specimen decreased by 4 GPa, indicating a percentage reduction of 1.93%. The percentage strain of specimen 'B' before and after welding is 8.93% and 10.89%. This represents an increase of 1.96%. Wu et al., (2023) agree with the findings. They claimed that the decrease was due to the improvement of corrosion products and the weakening of the acidification process. Specifically, the corrosion products became compact and electrochemically stable.

Table 3 Tensile Test Results for Specimen 'C'

	UTS (MPa)	Yield Strength (MPa)	Elastic Modulus (GPa)	Strain (%)
US	700	531	211	7.13
WS	625	475	207	9.11

KEY: US –Unwelded Sample WS – Welded Sample

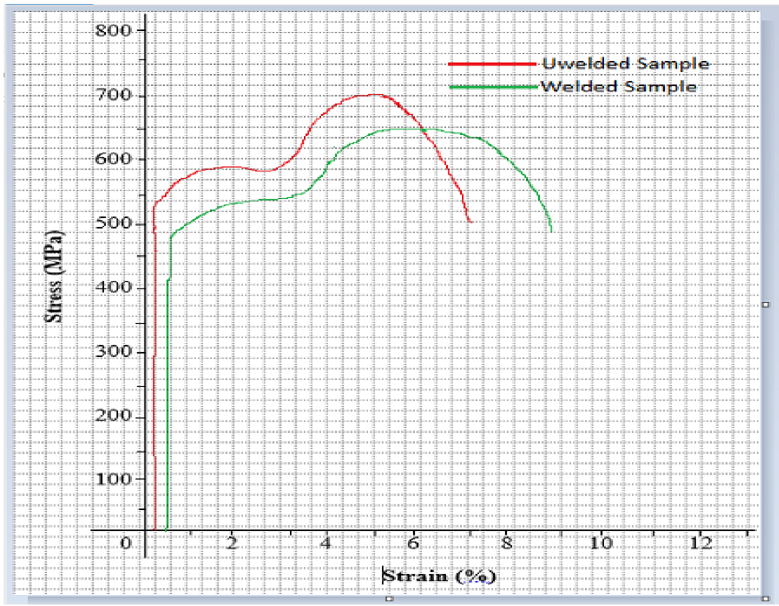

Figure 11 Stress-Strain Graph for Specimen 'C'

In Table 3 and Figure 11, the Ultimate Tensile Strength (UTS) of Specimen ‘C’ before welding was 700 MPa. After welding and tensile testing, the UTS of the specimen dropped to 625 MPa; representing a drop of 10.71%. The Yield Strength of Specimen ‘C’ before welding is 531 MPa while after welding, it is reduced to 475 MPa. This translates into a percentage drop of 10.55%. The Elastic Modulus of specimen ‘C’ before welding was 211 GPa. After welding, the Elastic Modulus increased to 207 GPa, implying a nominal reduction of 4 GPa. This translates into a percentage drop of 1.90%. The strain of the specimen ‘C’ before welding was 7.13%. The strain increased to 9.11%; representing an increase of 1.98% after welding. Chen et al., (2019) corroborate the findings and conclude that it has excellent weldability, especially in the sense of reduced preheating requirements and reduced.

Table 4 Mechanical Properties for Specimen ‘D’

	UTS (MPa)	Yield Strength (MPa)	Elastic Modulus (GPa)	Strain (%)
US	702	549	215	5.49
WS	628	481	209	7.41

KEY: US –Unwelded Sample WS – Welded Sample

Figure 12 Stress-Strain Graph for Specimen ‘D’

From Table 4 and Figure 12, the Ultimate Tensile Strength (UTS) of Specimen 'D' before welding was 702 MPa. After welding and tensile testing, the UTS of the specimen dropped to 628 MPa; representing a drop of 10.54%. The Yield strength of specimen 'D' before and after welding are 549 MPa and 481 MPa respectively. This means that the Yield strength of the sample was reduced by 12.39% after welding and tensile testing. Table 4, the Elastic Moduli of specimen 'D' before and after the welding process are 215 GPa and 209 GPa respectively. This means that the Elastic modulus of the specimen was reduced by 6 GPa after undergoing welding, marking a marginal reduction of 2.79%. Table 4, the percentage strain specimen 'D' was 5.49% before welding. The percentage strain increased to 7.41% after welding. This shows an increase in strain of 1.92%. The findings agree with the study of Wei et al., (2020), who noted that the ultimate strength increased with increasing corner radius

Table 5 Mechanical Properties for Specimen 'E'

	UTS (MPa)	Yield Strength (MPa)	Elastic Modulus (GPa)	Strain (%)
US	704	541	218	3.38
WS	630	461	213	6.10

KEY: US –Unwelded Sample WS – Welded Sample

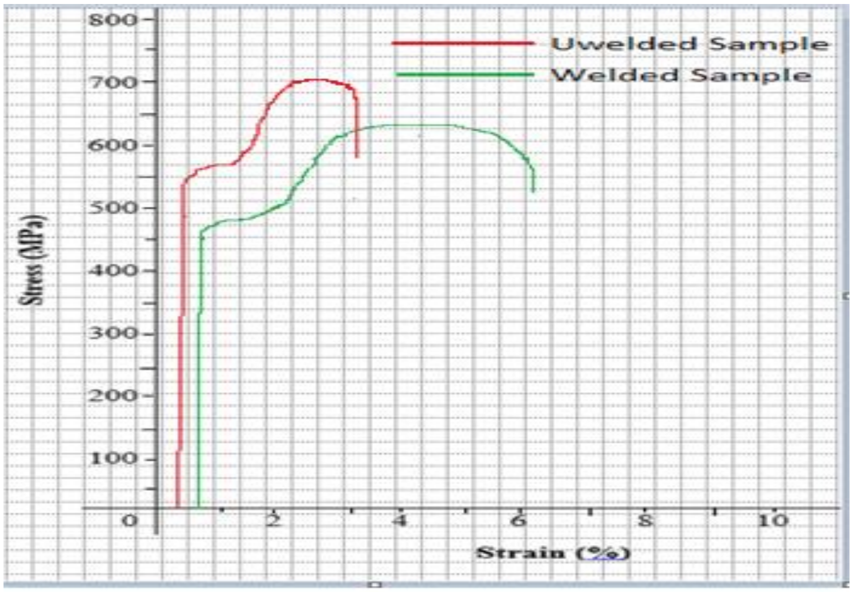

Figure 13 Stress-Strain graph for Specimen 'E'

From Table 5 and Figure 13, the Ultimate Tensile Strength (UTS) of Specimen 'E' before welding was 704 MPa. The UTS of the sample specimen after welding and tensile testing, dropped to 630 MPa; representing a drop of 10.51%. The Yield strength of specimen 'E' before welding was 541 MPa. After welding, the yield strength reduced to 461 MPa, indicating a percentage reduction of 14.79%. The Elastic Modulus of specimen 'E' before welding was 218 GPa. After welding the specimen, its Elastic Modulus was reduced to 213 GPa. This represents a marginal drop of 2 GPa and implies a 2.29% decrease in the Elastic Modulus of the specimen after welding. The findings are consistent with Rezaeian et al., (2020) who also revealed that After welding, the welded specimens gradually cooled down to ambient temperature. Also, the percentage strain of specimen 'E' before welding and after welding is 3.38% and 6.10% respectively. This implies that the strain of the welded sample increased by 2.72% after the welding process.

Impact Strength

The impact energy of the impact test specimen was reduced from 228 MJ to 194 MJ after undergoing welding and testing. This represents a percentage drop of 14.91%. This means that the impact strength of the sample specimen was reduced significantly after welding the test samples.

CONCLUSION

This study introduced an important perspective to the testing of engineering materials by varying the gauge diameters (a key determinant of the dimensional specifications of the specimen), to obtain a comprehensive insight into the impact of electric-arc welding on the mechanical properties of the material. This is a departure from previous studies which used single gauge diameter. From the results, it can be stated that the welding processes adversely affected the Ultimate Tensile Strength (UTS), Yield Strength, Elastic Modulus and Impact Strength of the samples studied; since all the samples studied had their Ultimate Tensile Strength, Yield Strength, Elastic Moduli and Impact reduced after undergoing welding. These findings are generally consistent with existing literature in the study area, specifically in the studies of Talabi et al., (2014), Sumardiyanto & Susiowati (2019), Morisada et al., (2020), Singh, (2012) and Manik et al., (2013), who found that the welding has significant adverse effects on the mechanical (i.e. tensile and impact) properties of engineering materials, as the values of these properties decreased after welding.

However, the strain of the samples increased after subjecting the samples to welding and testing. The increase in the strain of the welded samples is attributable to the heat treatment (annealing and normalizing) and heat induced during the electric arc welding processes.

The study however, established a negative (inverse) relationship between the gauge diameters and the Strain; the strain of both the welded and unwelded samples reduced consistently as the gauge diameters varied upwards from 12 mm to 20 mm. This is a departure from the findings of previous related studies which used single gauge diameter.

Practical Implications

The findings of this study will go a long way to help metal fabrication professionals, artisans and regulators to better appreciate the impact of electric arc welding on the mechanical properties of medium carbon steel components and structures. The findings also bring to the fore, the need for industry regulators to promulgate standards to regulate the welding of medium carbon steel and possibly other industrial materials to preserve the natural properties of the materials.

Social Implications

Poorly welded machines or structural components could have dire safety consequences. This study highlighted the need to properly weld medium carbon steel components and structures to avoid or minimize catastrophic fractures which could lead to serious injuries, death and loss of productivity.

Recommendation

It is recommended that future studies on the mechanical strength of engineering materials (especially metals) should include a variation of the gauge diameter to obtain a comprehensive understanding of the mechanical properties of the material. Also, other methods of welding should be applied to weld medium carbon, since the study used only electric arc welding to weld the test specimen.

Furthermore, welding of medium carbon steel components and for that matter, any other metal components should be standardized and regulated as this study has established that some important mechanical properties of the samples studied, were negatively affected by the process of welding. The process of regulation and standardization of the welding profession could be achieved through the training and certification of welding professionals and metal artisans.

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