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EFFECT OF ORIENTATION OF ARC WELDING ON ITS TENSILE STRENGTH – AN EXPERIMENTAL STUDY

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ABSTRACT :

The purpose of testing specimens with and without Arc welding is to evaluate and compare the mechanical properties, performance, and behavior in both scenarios. This testing serves several purposes. In the present work destructive tests such as the Tensile test have been performed for Mild Steel (MS) with and without Arc welding. For that six samples have been prepared for each test and results have been evaluated for all scenarios.

Keywords: Welding Influence on Mechanical Properties, Comparative Mild Steel (MS) Testing, Tensile Test on MS, Variations in Mechanical Behavior due to Welding.

INTRODUCTION :

Overview

An essential component of engineering and material science is evaluating the strength of materials. Understanding and assessing the strength attributes of a material is essential for ensuring safety, dependability, and optimal performance when constructing structures, producing components, or inventing novel materials. The term "material strength" describes a material's capacity to bear external forces without deforming, failing, or suffering long-term harm. It covers several characteristics, including tensile strength, compressive strength, shear strength, and fatigue strength, among others. It takes a methodical methodology thatincludes both theoretical study and experimental testing to evaluate these strength properties.

Determining material strength is crucial for assessing the load-bearing capacity of various components and structures in the field of structural engineering. To ensure that materials can survive the anticipated loads and environmental conditions throughout the planned lifespan, engineers must thoroughly examine the stress and strain distribution inside the materials. Additionally, the evaluation of material strength is crucial in the industrial industries. Understanding the strength of materials aids in choosing the proper materials and production procedures for a variety of products, from consumer goods to automotive to aerospace. It helpsto improve efficiency, minimize the possibility of product failures, and optimize design decisions.

In the past, determining a material's strength was largely based on empirical testing, which involved applying controlled loads to physical specimens and observing how they responded. Nevertheless, developments in computer modelling and simulation methods have increased ourcapacity to anticipate material strength with a higher level of efficiency and accuracy. Computational fluid dynamics (CFD) and finite element analysis (FEA) have developed into important techniques for modelling and studying the behaviour of materials under various loading circumstances.

OBJECTIVE

Problem Formulation

The common applications of are Oil & petroleum refining equipment, Aerospace structures, Stainless steel base, Food processing equipment, Pulp and paper processing equipment, Soap and photographic handling equipment, Textile industry equipment, Architectural, Pharmaceutical processing equipment etc.

The big problem is that after the failure of the machine component like shaft, there is a lot of problem in getting the same product like that; either it may take more time to call that item, during this time the production will suffer. To overcome this problem if we repairer that shaftby welding and put it in the machine. If so, will it behave like the original component or not?

Testing SS316L with both welding and non-welding components is necessary to evaluate weldquality, validate design assumptions, understand material behaviour, optimize performance, and ensure compliance with industry standards. It provides essential data and insights for engineers, designers, and manufacturers, enabling them to make informed decisions and produce reliableand durable welded structures.

Objective

The primary objective of this work to evaluate weld quality, validate design assumptions, understand material behaviour, optimize performance, and ensure compliance with industry standards. There are following objective of this work.

- To perform the tensile test on MS with Arc welding at different orientation (0^o, 15^o, 30^o, 45^o and 60^o with the horizontal).
- To develop correlation for tensile strength in terms of strain and orientation.

METHODOLOGY AND EXPERIMENTAL SETUP

The purpose of testing specimens with and without Arc welding is to evaluate and compare themechanical properties, performance, and behaviour in both scenarios. This testing serves several purposes. In the present work different destructive test such as Tensile Test have been performed for MS with and without Arc welding. For that three-three samples have been prepared for each test and results have been evaluated for both scenarios.

Experimental Set-up and Procedure

Tensile Test

Tensile testing is a type of mechanical testing that measures the behavior of a material when subjected to a stretching force. Tensile test has been performed on MS in order to observethe yield stress, Ultimate stress, Nominal braking stress, percentage elongation in length for welded and There are following steps have been followed to conduct the tensile test on the MS.

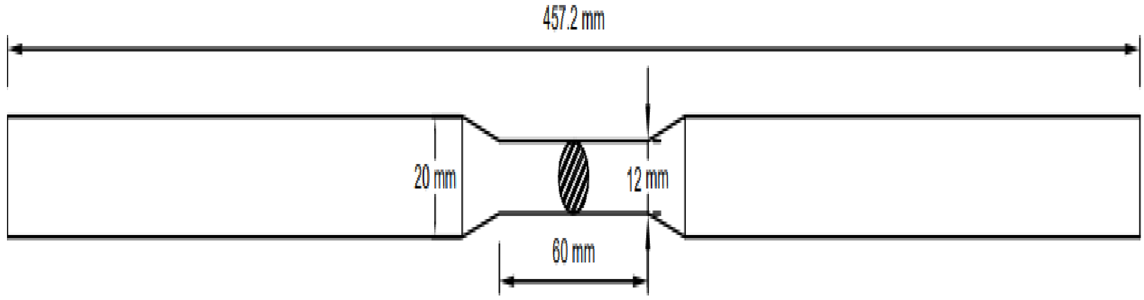

Fig.-Dimensional Description of Specimen

Components of Universal Testing Machine

A universal testing machine consists of two main parts:

- Loading Unit
- Control Unit

The loading unit controls the placement of the test specimen and the load's exertion. The controlunit provides information on changes in how the load is applied and the corresponding test outcomes.
The loading unit of a UTM consists of the following components:

- Load Frame
- Upper crosshead and Lower crosshead
- Elongation Scale

Load Frame

One support or two supports may be used to construct the load frame of a universal testing device. The specimen is put on the table for the compression test, and the load Frame is madeup of an upper crosshead and a lower crosshead.

Upper Crosshead and Lower Crosshead

The test specimen's one end is clamped using the upper crosshead. The moveable crosshead in the load frame is the lower crosshead, which may be raised or lowered by loosening and tightening its screws. The centre of each crosshead is a tapered slot. The tensile test specimen will be held in place by a pair of racking jaws located in this slot.

Elongation Scale

The relative movement of the lower and upper table is measured by an elongation scale whichis provided along with the loading unit.

Control Unit

The main components of the control unit in a universal testing machine are:

- Hydraulic Power Unit
- Load Measuring Unit
- Control Devices

Hydraulic Power Unit

This component comprises of an oil pump that supplies steady oil flow into the load unit's maincylinder. This flow aids in the gentle application of load to the specimen. An electric motor and sump operate the oil pump inside a hydraulic power unit.

Load Measuring Unit

A small cylinder with a piston that moves in synchrony with the non-pulsating oil flow makes up the pendulum dynamometer unit of this device. By means of a pivot lever, the pendulum isattached to the piston. The load placed on the specimen determines how much the pivot lever will flex. The load pointer on the dial is generated from this deflection and shows the load.

Control Devices

Electric or hydraulic control devices are both acceptable. Switches are used by electric control devices to turn the unit on and off and move the crossheads. Right Control Valve and Left Control Valve or Release Valve are the two valves that make up a hydraulic control mechanism.For the purpose of loading the specimen, a right control valve is utilized.

The main functions of UTM are to test the mechanical properties of materials. The standard tests performed by UTM are: Tensile Test, Compression Test, Adhesion Tests, Pull-Out Tests,Bending Test, Hysteresis Test.

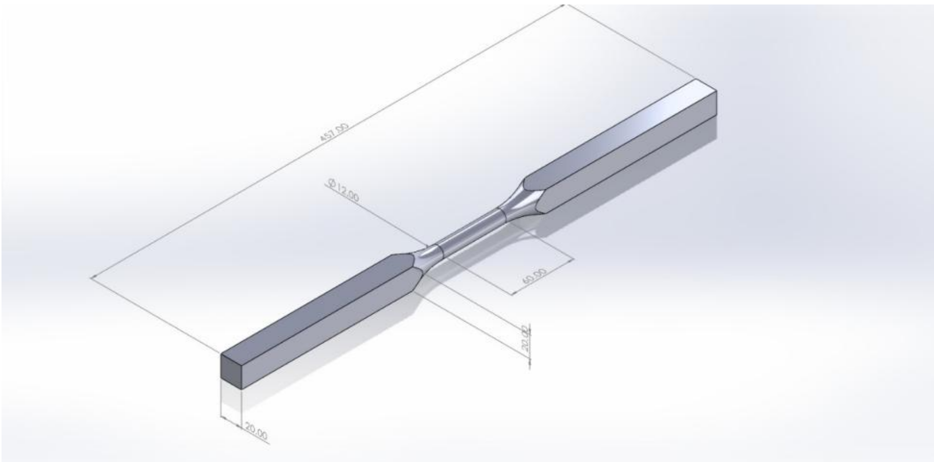

Fig. Test Specimen

RESULT AND CONCLUSION

Mathematical Calculation for the Tensile Test

$$Yield\ Stress = \frac{Yield\ Point}{Initial\ Area}$$

$$Ultimate\ Stress = \frac{Ultimate\ Load}{Initial\ Area}$$

$$Breaking\ Stress = \frac{Breaking\ Load}{Initial\ Area}$$

$$Elongation\ in\ Length = \frac{Final\ Length - Initial\ Length}{Initial\ Length} \times 100$$

$$Reduction\ in\ Area = \frac{Initial\ Area - Neck\ Area}{Initial\ Area} \times 100$$

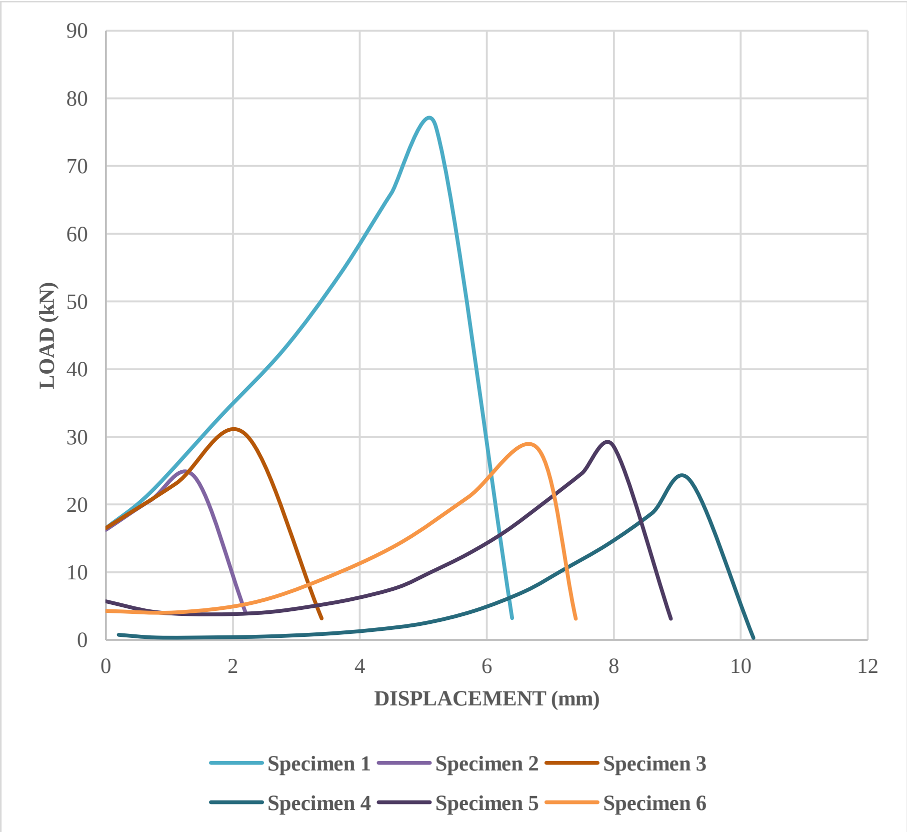

Fig. Comparative Results of Stress -Strain Diagram During Tensile Test of all Specimen

Summary

For the load vs deformation behavior and peak load values for the tensile tests on MS specimens indicate a higher load-bearing capacity for the specimens without Arc welding compared to the specimens with Arc welding.

In the case of the non-welded specimen, Specimen 1 fractured at a load of 7.8kN. The peak loads occurred at 5.2mm deformation and was 75.780kN.

In the case of the welded specimens, Specimen 2 fractured at a load of 4.09kN, Specimen 3 fractured at a load of 4.75kN, Specimen 4 fractured at a load of 4.22kN, Specimen 5 fractured at a load of 5.3kN & Specimen 6 fractured at a load of 5.51kN. The peak loads occurred at 1.3mm for Specimen 2, 2.4mm for Specimen 3, 9.6mm for Specimen 4, 8.2mm for Specimen 5 & 6.7mm for Specimen 6 deformation and were 24.17kN, 31.41kN, 25.36kN, 29.28kN & 28.28kN for the respective samples.

Comparing the results between all the cases, it can be observed that the specimen without Arc welding demonstrated higher peak loads and fracture loads compared to the specimens with Arc welding.