Studies on Tensile Strength And Fractography of CMT Welded ASTM A588 Corten Steel Sheet

Mr. Sreejith.S. Nair[1], Khiruthik M U[2], Ganesh Prabhu K R[3], Jeevanantham R[4]
[1, 2, 3, 4] Dept of Mechanical Engineering
[1, 2, 3, 4] Dr. Mahalingam College of Engineering and Technology,Pollachi.

Abstract- *The main objective of any manufacturing process is to produce better quality product at low cost and increase productivity. The objective of this project work is to study about the tensile strength and fractography of ASTM A588 Corten Steel Plates.The tensile test reveal that the CMT welded joints are having high tensile strength when compared to base metal. The SEM analysis of fractured tensile tested specimens discloses the presence of voids and dimples resulting the transaction of ductile to brittle behaviour has happened in the weldments due to the microstructural features of weld metal.*

I. INTRODUCTION

Welding is a manufacturing process that joins materials, usually metals or thermoplastics, using high heat to fuse the parts together and allowing them to cool, resulting in a joint weld. Cold metal transfer welding is a modified MIG welding process based on the short-circuit transfer process. This process differs from the MIG/MAG welding process only in the mechanical drop cutting method, which has not been encountered before. During welding, the temperature fluctuations of welds and base metals significantly affect the properties of the material, the residual stresses and the accuracy of the dimensions and shape of the welded products. Cold Metal Transfer offers a controlled material application method and low heat output by integrating an innovative wire feed system with high-speed digital control.

II. MATERIAL

The ASTM A588 standard (also called ASME SA588) specifies the grades of high-strength, low-alloy ASTM A588 weathering steel for structural purposes, it includes 4 grades: A588 Grade A, A588 Grade B, A588 Grade C, A588 Grade K. It also has high tensile strength against corrosion and excellent protection against corrosion pitting and pitting.

Its excellent corrosion resistance and ability to resist oxidation, toxic gases, reducing and reactive chemicals are some of its many corrosion-related advantages. In addition, it can withstand very hot conditions and extreme temperatures. This material is excellent in terms of weldability and machinability. The material is ideal for joining and bending. Very stiff and hard, they can be smoothly bent and joined. The mechanical and physical properties of ASTM A588 steel is displayed in the Table-1

III. METHODOLOGY

3.1. SPECIMEN PREPARATION AND TENSILE TESTING

Dog bone shape tensile test specimens are primarily used in tensile tests. The sample has a shoulder at each end and a gauge section in between. The shoulders are wider than the gauge section which causes a stress concentration to occur in the middle when the sample is loaded with a tensile force.

3.2 METALLOGRAPHY

Metallographic analysis was performed by cutting the sample perpendicular to the weld. A metallographic examination is performed to assess the macrostructure of the fusion zone and to check weld defects such as impenetrability and porosity. Samples were prepared for optical microscopy using multi-step grinding, diamond polishing and etching in 10 mL of 40% HF, 30 mL of 65% HNO3 and 20 mL of glycerin.

IV. RESULTS AND DISCUSSION

CMT-welded corten steel plates and corten steel base metal plates were investigated to understand the effect of welding parameters on weld geometry, mechanical properties, microstructure and fracture surface morphology. Initially, a visual inspection was performed to ensure that the joints were welded to full penetration depth and free of defects such as porosity and cracks.

4.1. TENSILE TESTING PROCESS

A tensile test was performed from the welded joint according to the standard ASTM E8/E8M-16a. The mechanical behavior was investigated by tensile tests

performed at room temperature with a loading rate of 1 mm/min.The tensile strength value of CMT welded specimen is found to be 530.303 N/mm^2.The Tensile plots of Tensile Stress vs. Tensile strain of Weld metal is indicted in the Figure1.The tensile strength of the base metal is 509.685 N/mm2 which can be identified from Figure 2.

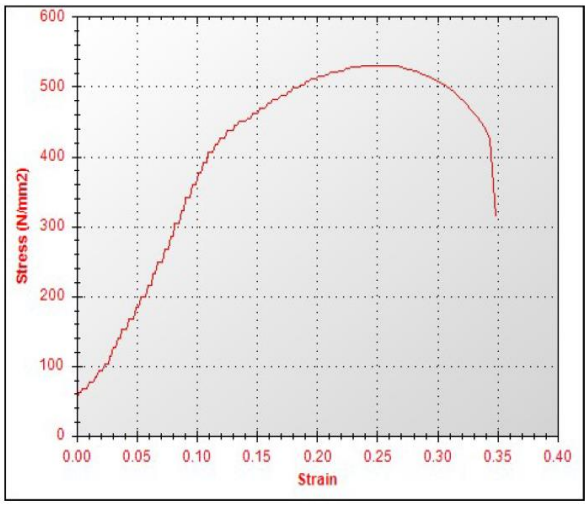

Figure 1 Tensile plots of Tensile Stress vs. Tensile strain of Weld metal

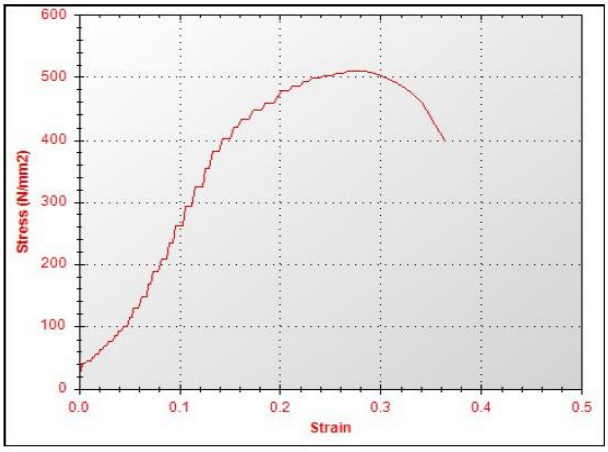

Figure 2 Tensile plots of Tensile Stress vs. Tensile strain of Base metal

From the Figure 1 and Figure 2, it is clear that the weld metal is relatively stronger and the joint properties are governed by the chemical composition and microstructure of the weld metal and this ensures better tensile strength in the welds.

4.2 FRACTOGRAPHY ANALYSIS

Figure 3 shows the fracture morphology of Corten steel under fractured tensile tested specimen conditions. Figure 3 clearly illustrates that many dimples are viewed and it increases the tensile strength of the Corten steel. The SEM analysis of fractured tensile tested specimens discloses the presence of voids and dimples resulting the transaction of ductile to brittle behavior have happened in the weld ments due to the microstructural feature so weld metal.

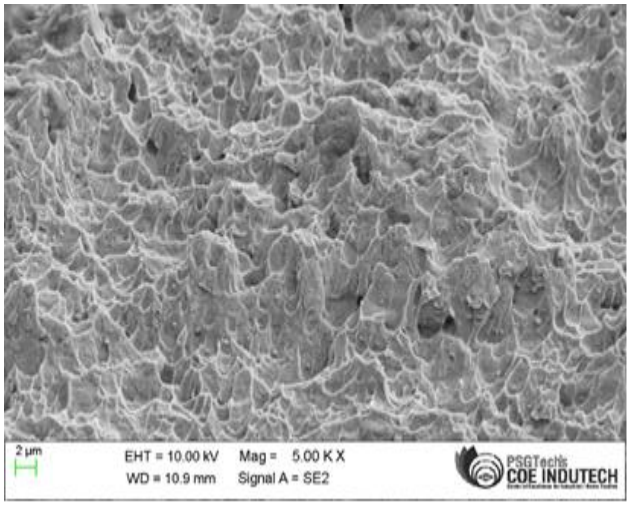

Figure 3. Scanning Electron Microscope image of fractured tensile tested specimen

V. CONCLUSION

This study addresses the successful joining of ASTM A588 Weld joints using Cold metal transfer welding process. The following are the outcomes drawn from the present study.

- All the tensile tested weld joints were failed in the base metal region of the weld joint.
- The tensile strength of CMT welded ASTM A588 Corten steel sheets of 3 mm thickness obtained are 530.303 N/mm^2 .
- The SEM analysis of fractured tensile tested specimens discloses the presence of voids and dimples resulting the transaction of ductile to brittle behavior has happened in the weld ments due to the microstructural feature so weld metal.

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