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IDENTIFICATION AND ANALYSIS OF WELDING DEFECTS OF SUBMERGED ARC WELDING TO ENHANCE THE QUALITY OF WELDS

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Abstract

Submerged arc welding is a common joining process used extensively in automobile industries, aircraft machine frames structural work ship building and various other fields. The physical properties of these welds are influenced by several factors. In order to produce satisfactory weldments which fulfill the requirement of quality the integrity of quality control is important. To understand the various defects, their causes and remedies can help to ensure higher quality and longer lasting welds. This report contains essential information of surface irregularities and weld discontinuities. Surface irregularities include uneven weld ripples, excessive reinforcement, concave or convex fillet welds, uneven-leg fillet welds, etc. Weld discontinuities is an interruption of the typical structure of a material, such as a lack of homogeneity in the mechanical, metallurgical or physical characteristics of the material or weldments. Weld discontinuities include porosity, slag inclusions, incomplete fusion, incomplete joint penetration, excessive melt-through, cold cracks, and hot cracks. However, a surface irregularity or weld discontinuity is not a rejectable defect when it is within the permissible range of extent according to the relevant specification. Choosing the proper diameter of single electrode wire or wire pool as per the thickness of metal, setting the proper voltage according to properties of materials and setting the proper contact distance between the electrode and work pieces we can control the welding defects.

Index Terms – *Weldments, discontinuities, hot cracks.*

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1. INTRODUCTION

The welding is a process of joining two similar or dissimilar metals by fusion or without the application of pressure and with or without the use of filler metals.The fabrication of welded structures and their use- in service involves most of the principal face included in metallurgy of ferrous and non ferrous alloys .The physical properties of submerged arc welds are influenced by several factors. In order to produce satisfactory weldments which fulfill the requirement of quality the integrity of quality control is important in submerged arc welding. Having an understanding of the various defects, their causes and remedies can help to ensure higher –quality and longer lasting of welds. This report contains essential information of surface irregularities and weld discontinuities. Surface irregularities can be defined as "any number of surface conditions that result in notches or abrupt changes in thickness or appearance." Surface irregularities include uneven weld ripples, excessive reinforcement, concave or convex fillet welds, uneven-leg fillet welds, etc. Weld discontinuities can be defined as "an interruption of the typical structure of a material, such as a lack of homogeneity in the mechanical, metallurgical or physical characteristics of the material or weldments. Weld discontinuities include porosity, slag inclusions, incomplete fusion, incomplete joint penetration, excessive melt-through, cold cracks, and hot cracks. However, a surface irregularity or weld discontinuity is not a rejectable defect when it is within the permissible range of extent according to the relevant specification.

2. IDENTIFICATION OF WELDING DEFECTS

Lack of Fusion-This is where the new weld metal and the base metal are not fused or bonded together. This can be on the outer edges of the weld bead where it is easily seen, or it can be beneath the weld bead and cannot be seen. It occurs when the weld metal does not from a cohesive bond with the base metal or when the weld metal does not extend into the base metal to the required depth, resulting in insufficient throat thickness. These defects are usually caused by incorrect welding condition.

1. Too low welding amperage 2.Too much arc length 3.Too much weaving width 4. Too narrow groove 5. Slag remaining on the preceding layer. 6. Inclined weld axis downward to the welding direction in the flat position.

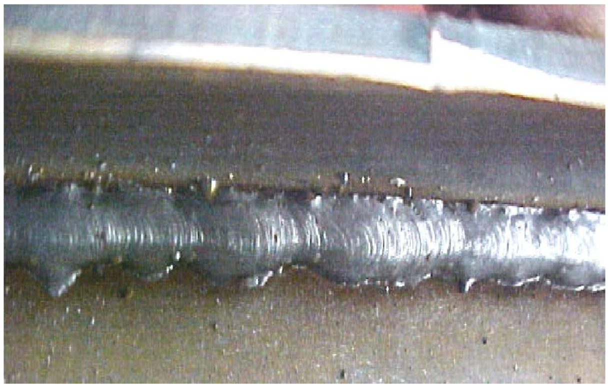

Fig-1 Lack of Fusion

Way to minimize it-
1. Use appropriate groove design.
2. Use appropriate welding amperages, arc lengths and proper electrode wire pool.

Undercut- This is where the area at the toe/edge of the weld is cut in lower than the surface of the base metal. Undercutting is one of the more severe welding defects. It is essentially an unfilled groove along the edge of the weld. It is a small notch at the weld interface.

Fig-2 Undercut

Causes-
1. Too high welding amperage 2. Too fast electrode manipulation 3. Too long arc length, or too high arc voltage 4. Too large drag angle and work angle of electrode 5. The wire tracking is too close to the groove face (SAW)

Way to minimize it- Use appropriate welding amperages, electrode manipulation speeds, arc lengths, arc voltages, and electrode drag angles.

Porosity- Cavity type discontinuities formed by gas entrapment during solidification. This is tiny holes in the weld. It can resemble a sponge and it weakens a weld. It is caused by entrapment of gases during the solidification of the welding process. The gases so entrapped mostly consist of hydrogen oxygen and nitrogen. Hydrogen is most prominent for causing porosity.

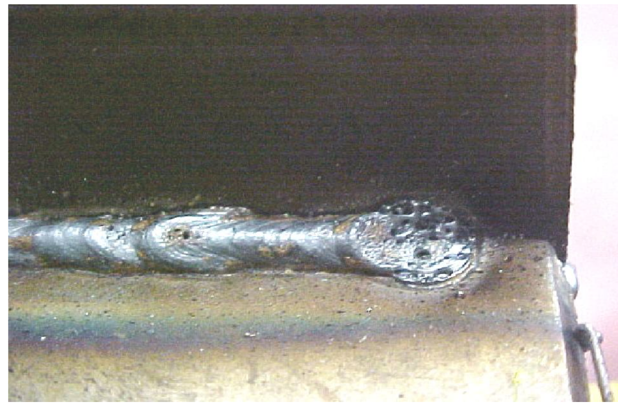

Fig-3 Porosity

Main Causes-
1. Rust, oil, paint, or moisture on the joint fusion faces and high sulphur content of the base metal. 2. Moisture in coatings, fluxes, or shielding gases 3. Too little shielding gas (GMAW) or flux-burden height (SAW) 4. Too strong wind 5. Too much welding amperage, arc length, or arc voltage.

Way to minimize it-
1. Clean the joint fusion faces. 2. Redry coatings and fluxes and use suitable shielding gases. 3. Use proper amounts of shielding gas and flux-burden height. 4. Use a wind screen. 5. Use appropriate welding amperages, arc lengths, and arc voltages

Slag Inclusions- Non-metallic solid materials entrapped in weld metals or between weld metal and base metal. These are areas where the slag and/or flux may be trapped in the weld or between the weld bead and the base metal. Slag is formed by the reaction of fluxes and is expected to float out at the top of the molten metal and be removed after solidification.

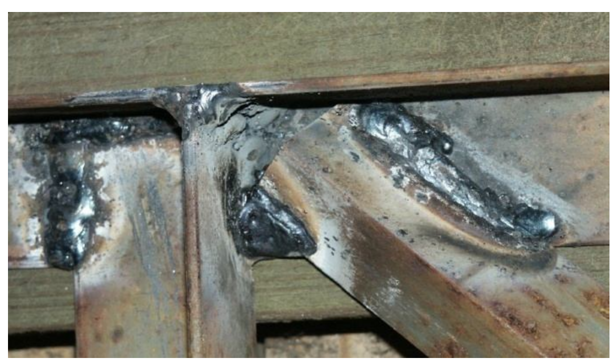

Fig-4 Slag Inclusions

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Main Causes-
1. Too low welding amperage 2. Too much arc length. 3. Too much weaving width 4. Too narrow groove. 5. Slag remaining on the preceding layer. 6. Inclined weld axis downward to the welding direction in the flat position

Way to minimize it-
1. Use appropriate welding parameters and groove angles. 2. Remove slag of the preceding layer completely. 3. Keep the weld axis in horizontal by positioning.

Overlap- This is where the edges of the weld bead is not fused to the base metal. It appears as if the weld is just sitting on top of the metal. It is the protrusion of weld metal beyond the toe or root of weld and could occur due to insufficient travel speed which permits the weld puddle to move ahead of electrode.

Fig-5 Overlap

Causes-
1. Too low welding amperage. 2. Too slow electrode manipulation.3. Too short arc length, or too low arc voltage. 4. Too small travel angle and work angle of electrode.

Ways to Minimize it-Use appropriate welding amperages, manipulation speeds, arc lengths, arc voltages and electrode positioning.

Spatter-Spatter refers to small particle or globules of metal scattered around the vicinity of the weld along its length. Metal particles expelled during welding which do not form a part of the weld.

Causes-
1. Arc blow making the arc uncontrollable. 2. Use of an excessive current.

Fig-6 Spatter

Way to minimize it-
Spatter can be minimized by correcting the welding conditions and should be eliminated by grinding when present.

3. TESTING METHODS OF WELDING JOINTS

Welded joints may be tested either destructively or non-destructively. Each technique has certain capabilities and limitations, as well as sensitivity, reliability and requirements for special equipment and operator skill.

Destructive Testing Techniques:

Tension test: Longitudinal and transverse tension tests are performed on specimens removed from actual welded joints and from the weld-metal area. The strength strain curves indicate the yield strength, ultimate tensile strength, UTS, and ductility of the welded joint in different locations and directions.

Tension-shear test: The specimens in the tension-shear test are prepared to simulate conditions to which actual Welded joints are subjected. These specimens are subjected to tension so that the shear strength of the weld metal and the location of fracture can be determined.

Bend test: Several bend tests have been developed to determine the ductility and strength of welded joints. In one common test, the welded specimen is bent around a fixture. In another test, the specimens are tested in three-point transverse bending. These tests help to determine the relative ductility and strength of welded joints.

Fracture toughness test: Fracture toughness tests commonly utilize the impact testing techniques. Charpy V-notch specimens are first prepared and then tested for toughness. Another toughness test is the drop weight test, in which the energy is supplied by a falling weight.

Corrosion and creep tests: In addition to undergoing mechanical tests, welded joints also may be tested for their resistance to corrosion and creep. Because of the difference in the composition and microstructure of the materials in the weld zone, preferential corrosion may take place in the zone. Creep tests are important in determining the behaviour of welded joints and structures subjected to elevated temperatures.

Non destructive Testing Techniques-

Welded structures often have to be tested non destructively, particularly for critical applications in which weld failure can be catastrophic, such as in pressure vessels, load-bearing structural members, and power plants. Non destructive testing techniques for welded joints generally consist of the following methods:-

° Visual
° Radiographic (X-rays)
° Magnetic-particle
° Liquid-Penetrant
° Ultrasonic.

Testing for hardness distribution in the weld zone also may be a useful indicator of weld strength and microstructure changes. In describing individual welding processes, several examples were given concerning the types of welds and joints produced and their applications in numerous consumer and industrial products of various designs. Typical types of joints produced by welding, together with their terminology. Standardized symbols commonly used in engineering drawings to describe the types of welds .These symbols identify the type of weld, the groove design, the weld size and length, the welding process, the sequence of operations, and other necessary Information.

4. SUGGESTION FOR PROPER WELDING

1. Set the proper current according to the thickness of materials.
2. Chose the proper diameter of electrode wire as per the thickness of metals.
3. Set the proper voltage according to the properties of materials.
4. Set the proper contact distance between the tools and work pieces.

5. CONCLUSION

1. Welding is a major joining process used in industries and other civil structures. Hence utmost care must be taken for carrying out the process.
2. Though this process seems easier but any negligence, ignorance or carelessness can become a cause of loss. (Includes man material and money)
3. It can be observed that cause of almost all the defects are none other than the human errors. So these defects can surely be minimised.

FUTURE SCOPE

1. Reduce energy use in pre- and post heating operations by 50%.
2. Make welded fabrications with a concern for the environment.
3. Ensure a safe and healthful working environment for workers.
4. Train more specialists in fields related to welding.
5. Make welding the preferred choice of manufacturers when materials are joined.
6. Use most advanced cost-effective material appropriate for each application.
7. Produce extremely high-quality welds and fabrications.
8. Seek new ideas from other industries applicable to welding.
9. Achieve cost-effective welding operations.

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