

Anatomy of Welding on Cast Iron to Repair the Casting

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Abstract: Cast iron is hard to weld yet not difficult to weld. In the majority of the cases, welding on cast iron includes repaired castings, not getting the casting together with different individuals. The repairs can be finished in the foundry where the castings are framed, or can be done to repair casting deficiencies that are found a short time later the part is machined. Mis-machined cast iron parts can require repair the welding, and when gaps are bored in an inappropriate site. Every now and again, broke cast iron parts are repaired by welding. Split cast iron parts are not rare, given the weak scene of most cast iron.

In spite of the fact that there are a different sorts of cast iron, the most widely recognized sort is grey cast iron. Right now, we repair the casting product by utilizing distinctive welding, which is utilized for cast iron. In which venture we checked which welding is increasingly reasonable for cast iron welding or to repair the casting product. This paper concludes about different sorts of welding utilized for cast iron welding or to repair the cast iron item and finally check which welding is progressively appropriate to repair the cast iron item or cast-iron welding.

Keywords – Cast iron, Welding, Casting Product, Electrodes.

I. INTRODUCTION

Cast Iron

Cast iron is hard for welding however not difficult to weld. In a large portion of the cases, welding on cast iron contains fixes to castings, not used to getting throwing together with different individuals. The fixes can be finished in the foundry somewhere the castings are molded, or can be done to fix throwing flaws that is uncovered after the part is machined. Mis-machined cast iron parts can require fix welding, for example, at what time holes are penetrated in an inappropriate site. A couple of realities about cast iron assistance in understanding the welding difficulties. Cast iron commonly has a carbon substance of 2% - 4%, approximately 10 fold the amount of as most steels. The high carbon content makes the carbon structure drops of graphite. This graphite gives dark cast iron its trademark appearance when broken. A basic temperature in most cast iron is around 1450 degrees F which can prompt a breaking happen. While there is an assortment of sorts of cast iron, the most well-known is gray cast iron.

Welding: -

Welding is an operation whereby at least two sections are joined by methods of heat or pressure or both. It is generally utilized on metals and thermoplastics. Welding is a high heat process which softens the base material. Commonly, with the expansion of a filler material. There are assortments of welding present for cast iron like SMAW, Oxy-Acetylene welding, MIG Welding, MAG Welding, Powder Welding, TIG Welding, Electron Beam Welding and some more. The various methods utilized in welding are as per the follows: -

Welding Techniques with Preheat

Preheating the cast iron part before welding will slow the cooling pace of the weld, and the district encompass the weld. It is constantly wanted to warm the entire casting, if conceivable. Ordinary preheat temperatures are 500-1200 degrees F. Try not to warm more than 1400 degrees F since that will place the material into the critical temperature range. Preheat the part gradually and consistently. In the wake of welding, permit the part to gradually cool. Enclosing the casting by a protecting cover, or covering it in dry sand, will help moderate cooling rates, and decrease breaking inclinations.

Welding Techniques without Preheat

The size of the casting, or different conditions, may necessitate that the repair be made without preheat. At the point when this is the situation, the part should be kept cool, however not cold. Raising the throwing temperature to 100 degrees F is useful. In the event that the part is on a motor, it might be conceivable to run it for a couple of moments to get this temperature. Peening subsequent to welding is significant with this method. Permit the weld and the casting to cool. Try not to quicken the pace of cooling with water or packed air. All pits ought to be filled.

Electrode Selection

There are variety of electrodes used for cast iron welding such as like Nickel base alloy, Copper base alloy, Cast Iron covered electrode. The Nickel Base alloy is more suitable for cast iron welding. In the event that the part is to be machined subsequent to welding, a nickel-type electrode will be required. Use Tech-Rod® 99 stick electrode for single pass, high weakening welds. Tech-Rod® 55 is favored for various pass welds. Here and there, root passes are placed in with Tech-Rod 99, trailed by fill goes with

Tech-Rod 55. For welds where machining isn't required, and where the weld is relied upon to rust like the cast iron, Lincoln Ferro weld® stick electrode can be utilized.

II. LITERATURE REVIEW

In [1], the authors found out the microstructure and wear behavior of Ni based alloy coated on to grey cast iron using a multi-step induction cladding process. In this operation, they used grey cast iron material and multistep induction cladding technique. They used Ni based alloy coating. In this analysis they observed a clear boundary between the coating and substrate with a high-quality interface and non-visible defects or crack.

In [2], they found out the optimization of wear parameter for grey cast iron under the different conditions using grey relational analysis. They used grey cast iron material with dimensions (55*6*10) mm. They used Taguchi Technique for this analysis. They used PWHT & SMAW Welding in this analysis. In which they SWR & COF multilevel value are converted into single response value. They have calculated the grey relational coefficient.

In [3], they found the characteristics of cracks in heat affected zone of Ductile cast iron in powder welding process. They used ductile cast iron dimensions (60*60*20) mm. They used powder welding process on the ductile cast iron. They used heat affected zone. High hardness & High abrasive resistance is used. There is almost no PMZ. In powder welding with nickel base self-fluxing alloys, in comparison with arc welding, there is all almost no PMZ.

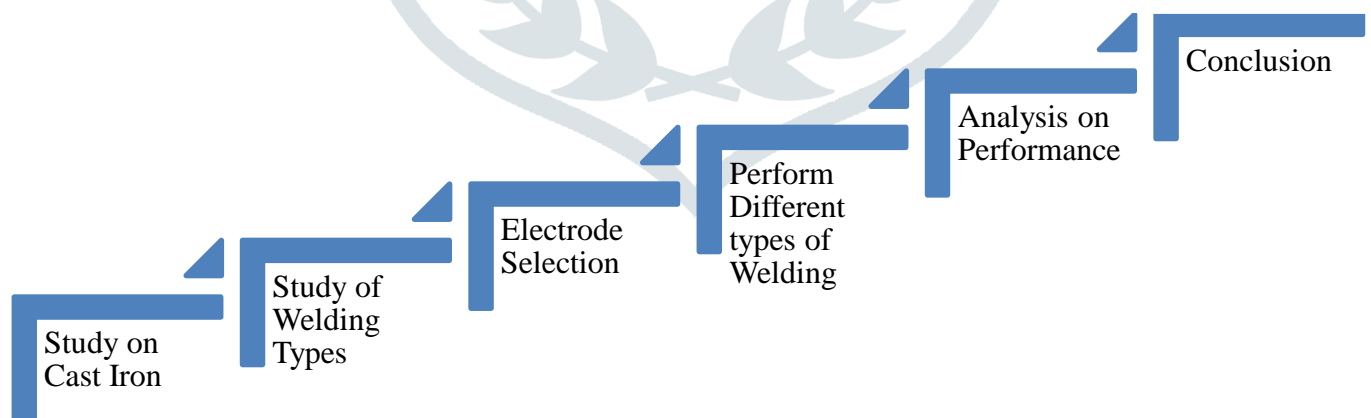
In tough facing of ductile cast iron through powder welding using a nickel improper self-fluxing alloys, the heat affected zone may cracks assumed the combination of tough deposit and more cooling rate ascending from welding thickness parts. Graphite modulus is the instigation sides for the cracks which may then promulgate in a martensitic matrix. The cracking process is mainly controlled through the residual stresses.

In [4], they performed the analysis of the weldability of Ductile Cast Iron in which they used ductile cast iron dimensions-(300*95*5) mm, & specifications-(C=3.7%, Ni=0.7%, Si=2.9%, Mn=0.7%). They used SMAW & OAW welding for this analysis. They used SMAW & OAW manual method. They used parameters for SMAW- Current=130A (When preheat is used) & Current=150A (When preheat is not used), Angle=60 degree and for OAW angle=45degree. Hence concluded that, Ductile cast Iron may be welded with or without preheat and the mechanical resistance of the joint is probable to be inferior than that of ductile cast iron.

In [5], the bonding characteristics of the spheroidal graphite cast iron and mild steel by using electron beam welding. In which spheroidal graphite cast iron dimension is 15mm thick plate which specimen name is FCD-450 & mild steel 1mm thick plate with specimen name is SS-400. In which they used Bead-on-plate method.

In this paper atm pressure=5Pa, accelerating voltage=70KW, welding speed=100mm/sec, welding voltage=40V. They used two passed welding method, 1st pass current=300A & 2nd pass current=305A. In which They also used MAG welding for comparison. Therefore, in case of bonding spheroidal graphite cast iron and mild steel bonding strength through electron beam welding process is advanced than that through MAG welding process. In the case of welding of Spheroidal Graphite cast iron and other metallic material EBW process is originate to be more beneficial than MAG welding.

III. METHODOLOGY



➤ Study on Cast Iron

It is found that there are various types of cast Iron, some of them are given below: -

- **White cast iron:** - White cast iron is hard and brittle. It has lower silicon substance and low melting point. The carbon present in the white cast iron encourages and structures enormous particles that expansion the hardness of the cast iron. It is rough safe just as financially savvy. At the point when the white cast iron is broken, white in hued splits are seen all through in view of the nearness of carbide polluting influences. With the correct carbon content and a high cooling rate, carbon particles join with iron to form iron carbide. One of the most mainstream evaluations of white iron is Ni-Hard Iron. White irons and ni-hard irons fall under an order of composites alloys referred to as ASTM A532; the "Standard Specification for Abrasion-Resistant Cast Irons".

Applications:

- Mill linings, shot-blasting nozzles, railroad brake shoes, slurry pump housings, rolling mill rolls, and crushers.
- Ni-Hard Iron is specifically used for mixer paddles, augers and dies, liner plates for ball mills, coal chutes, and wire guides for drawing wires.
- **Grey cast iron:** - Grey is the most adaptable and broadly utilized cast iron. The cracked cast iron is grayish in shading, which likewise gives it the name. The graphite drops make the dark cast iron display low stun opposition. They likewise need versatility and have low rigidity. Grey iron is described by the chip state of the graphite particles in the metal. Notwithstanding, it is a superior warm conductor and has a more significant level of vibration damping. It has a damping limit that is 20–25 times higher than steel and better than all other cast irons. Grey iron is additionally simpler to machine than other cast irons, and its wear opposition properties make it one of the most elevated volume cast iron items. The liquid form grey iron has more prominent ease and they grow well during the hardening or freezing of cast iron.

Applications: -

- Engine blocks, cylinder heads, manifolds, gas burners, gear blanks, enclosures, and housings.
- **Malleable cast iron:** - Malleable cast iron is essentially white iron that experiences heat treatment to change over the carbide into graphite. If there should arise an occurrence of malleable cast iron, the graphite structure is framed into sporadically formed spheroidal particles as opposed to drops that are normally present in grey cast iron. This make the malleable cast iron carry on like low-carbon steel. Malleable cast iron can be recognized effectively by the dull limits. White iron can be additionally prepared into malleable iron through a procedure of heat treatment. Distinctive cooling rates, and the expansion of compounds, delivers a malleable iron with a microcrystalline structure.

Applications: -

- It's iron is used for heavy duty bearing surfaces, chains, sprockets, connecting rods, drive train and axle components, railroad rolling stock, and farm and construction machinery.
- **Ductile cast iron:** - Ductile cast iron is one more sort of ferrous composite that is utilized as a designing material in numerous applications. To create ductile iron, limited quantity of magnesium is added to the liquid iron, which adjusts the graphite structure that is shaped. Like malleable iron, ductile iron is adaptable and shows a straight pressure strain connection. It very well may be casted in differed sizes and into shifting thickness. The nearness of magnesium makes the graphite structure in a spheroid shape instead of the pieces of grey iron. Various evaluations of grades of ductile iron are shaped by controlling the microcrystalline structure around the graphite spheroid. Ductile iron's effect profile makes it good cast iron for bollards close to vehicle traffic.

Applications: -

- Ductile iron may be used to make steering knuckles, Blow shares, crankshafts, heavy duty gears, automotive and truck suspension components, hydraulic components, and automobile door hinges.
- **Compacted graphite cast iron:** - Compacted graphite iron has a graphite structure and related properties that are a mix of grey and white iron. A composite, for example, titanium, is utilized to stifle the arrangement of spheroidal graphite. Compacted graphite iron has a higher tensile strength and improved ductility contrasted with grey iron. The microcrystalline structure and properties can be balanced through heat treatment or the expansion of different composites.

Applications: -

- Its suitable for diesel engine blocks and frames, cylinder liners, brake discs for trains, exhaust manifolds, and gear plates in high pressure pumps.

➤ Welding used on Cast Iron Welding

- **Shielded Metal Arc Welding:** - Shielded metal arc welding (SMAW) is a manual arc welding process that uses a consumable electrode secured with a motion to lay the weld. This procedure is flexible and its hardware and activity is basic. It rules other welding forms in the support and repair industry. SMAW keeps on being utilized widely in the development of substantial steel structures and in mechanical manufacture.

Applications: -

- It's used for stainless steels, cast iron & convinced non-ferrous alloys, infrequently used Aluminium and its alloys, copper alloys & titanium.
- Can be used on muddy metals. (i.e. rusted & painted surfaces)
- Best for repair work, make thick welds.

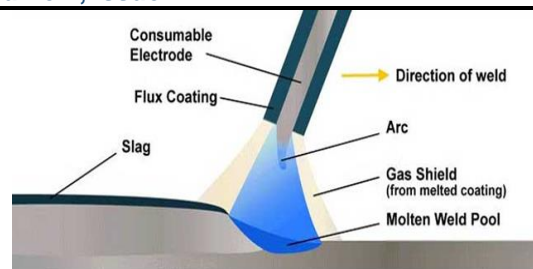


Fig: - SMAW

▪ **Oxy-Acetylene Welding:** - Oxy-acetylene welding is a typical welding process that goes back to 1890s, where in oxygen and acetylene are utilized as the two significant welding gases. The mix of oxygen and acetylene delivers a fire temperature of more than 6000 degrees Fahrenheit making it perfect for welding and cutting. Materials Suitable for Oxy Acetylene Welding is Mild Steel.

Applications: -

- Fabrication of sheet metal, Automobile and aircraft industries
- Joining ferrous and non-ferrous metal, Repair the casting.

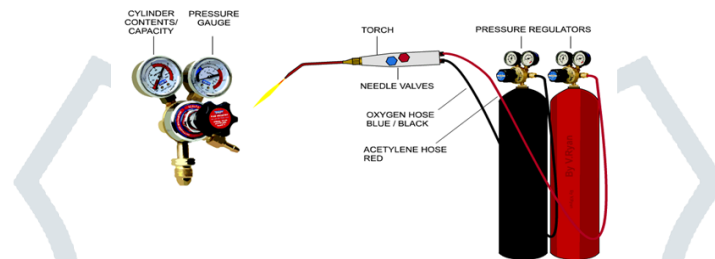


Fig: - Oxyacetylene welding

▪ **MIG Welding:** - Metal Inert Gas (MIG) welding is also known as gas metal arc welding (GMAW) process that uses a nonstop strong wire electrode which is warmed and encouraged into the weld pool from a welding gun. The two base materials are dissolved together which makes them join. CO2 and argon-CO2 blends are known as metal active gas (MAG) forms. MIG is an appealing option to MMA, offering high testimony rates and high profitability.

Applications: -

- Good suitable for fabrication of sheet metal, commonly all available metals can be weld by this process.
- It can be preferred for deep groove welding.

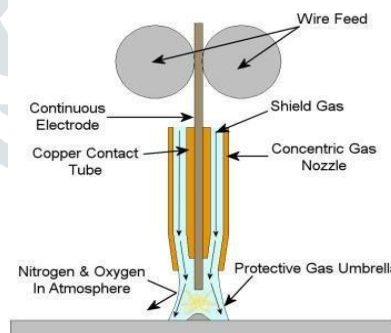


Fig: - MIG

▪ **Brazing:** - Brazing is the metal joining process in which at least two metal thing are combined by softening an exquisite filler metal in to the joint. The filler metal taking lower melting point than the abutting metal. The "welding" of cast iron is typically a brazing activity, with a filler bar made essentially of nickel. The reason behind this activity is to utilize power along the copper for keeping underground channels warm in chilly atmospheres.

Applications: -

- It's used to make joints of best strength in steel, in cast iron, and in copper and some copper alloys.

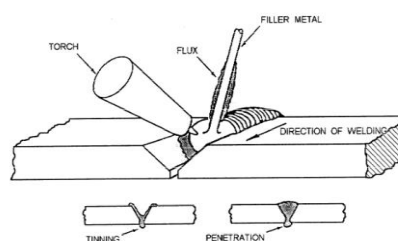


Fig: - Brazing

➤ **Electrode Selection: -**

Picking electrodes for welding cast iron commonly boils down to three things: cost, machine-capacity, and whether the weld is single or numerous pass. Tech-Rod 99 (AWS class E Ni-CI) is an ostensibly 99% Nickel anode. Nickel is costly, thus, along these lines, is this exceptional anode.

There are three types of electrode which are as follows & they have large no of subgrades: -

- Nickel base alloy Electrode
- Copper base alloy electrode
- Cast iron covered electrode

▪ **Nickel base alloy Electrode: -**

Nickel alloy electrodes are the most well known for cast iron welding. As per New Hampshire Materials Laboratory Inc., nickel-iron weld is more grounded with a lower coefficient of warm extension, decreasing welding stresses and improving protection from breaking. About 60% of the nickel on the planet winds up as a segment of hardened steel. It is chosen in view of its quality, durability, and protection from erosion. Duplex stainless steels ordinarily contain about 5% nickel, austenitic around 10% nickel, and the too austenitic over 20%. Heat safe evaluations regularly contain over 35% nickel. Nickel-based combinations by and large contain half nickel or more.

IV. CONCLUSION

Bonding spheroidal graphite cast iron and mild steel bonding strength by electron beam welding process is higher than that by MAG welding. In the case of welding of spheroidal graphite cast iron and other metallic material EBW process is originate to be more beneficial than MAG welding. Ductile Cast Iron may be welded with or without preheat. By analysis of some paper we conclude that SMAW welding is more advantageous or more beneficial for welding of cast iron. Best results or best output is obtained when welding done with low current and the lowest practical inputs. We observed the Nickel alloy electrode is more beneficial & more advantageous for cast iron welding.

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