Analysis of tensile strength properties for FG260 welded cast iron : A Review

Mahendra Waradkar[1], Prof. M. A. Sutar [2]

[1]M.E. Student, Ashokrao Mane Group of Institution Vathar-416112, Maharashtra, India
[2]Professor, PG Coordinator Department of Mechanical Engineering, Ashokrao Mane Group of Institution Vathar-416112, Maharashtra, India

---

Abstract - *Gray cast iron is most common type of cast iron and it can be successfully welded if cooling rates controlled during welding and after welding. Poor weldability of gray cast iron is due to the presence of much more carbon that is the found in flake or spherical form and silicon than other ferrous metal which results in cast iron is less ductile hence weld is subjected to more metallurgical complications in both the weld metal and the heat-affected zone. During cooling the carbon is precipitated in the form of graphite flakes which are difficult to weld, the weld metal does not fuse to the graphite flakes. The welding was carried out with oxyacetylene welding, using nickel based filler metal and cast iron rod (RCI) respectively to join grey cast iron and to analyze mechanical properties such as tensile strength and hardness of CI casting before and after salvaging. The castings can produced by varying different casting process parameters such as pouring temperature, pouring time and mould hardness and by using Taguchi method the analysis of tensile strength and hardness will be analyze. During measurement of tensile strength the castings going to break and after that the salvaging of the castings is done by Oxyacetylene welding method. The study of comparison of analysis of properties before and after salving is done. After welding Joining of cast iron FG260 piece, Tensile strength and Hardness properties increase.*

Key Words: Gray cast iron, welding, pouring time, pouring temperature, hardness and tensile strength. Taguchi method

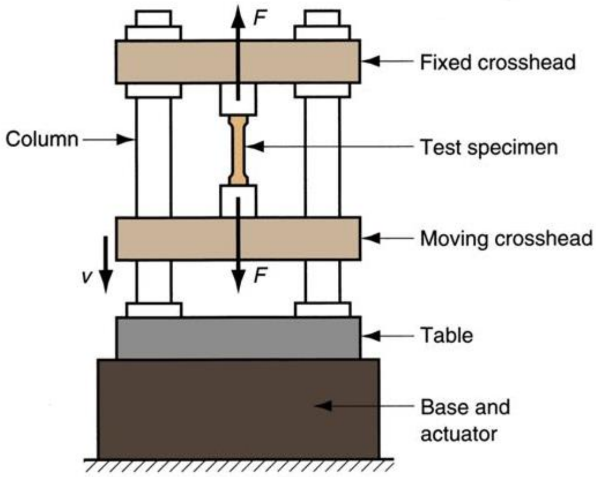
1. INTRODUCTION:

Salvaging means repairing of casting in current industry defects like cracks, blowholes are produced which are repaired by welding process. They are using tungsten inert gas welding for this, it shows that the cost and time required for this is more as compared simple carbon arc welding and its properties are better in gas or arc welding, so it is better to use oxyacetylene welding in place of tungsten inert gas welding. The main objective of any foundry or casting industry is to achieve maximum yield and quality. The yield generally expressed in terms of percentage and quality is the fitness of your casting or product according to customer needs and requirements. The quality of casting is defined in terms of casting finish, dimensional accuracy, and mechanical properties such as hardness, tensile strength etc., and casting soundness. This can be examined by various tests which are destructive or non-destructive. This test are performed to find out defects in castings and to check service life of casting also, and the defective castings are rejected. Salvaging generally is method of repairing or saving of wasted or defective casting so that it can utilize for further utilization. All castings cant produced defect free so the problem arises as whether to scrap casting or to make it serviceable by repair. In mass production of small castings defective castings can be scrapped or replaced because cost of salvaging is more compare to doing above. Salvaging is generally perform to restore properties and service performance of defective casting to a standard equivalent to that of defect free casting and to improve casting appearance.

Salvaging normally done by means of following techniques:

a) Welding
b) Brazing, braze welding, soldering
c) Burning on

Almost all castings repaired by welding with use of modern techniques repairing by welding is most common to iron and high alloy castings It is superior method than other techniques because it achieves true metallurgical characteristics between casting and filler metal Casting repaired by welding and after post heating possess properties equivalent to the new casting .Commonly used welding processes are: TIG welding, MIG, Gas welding and Flux shielded metal arc welding. In this paper it is studied the effect of casting process parameters tensile strength and hardness and analysis of this property before and after salvaging by welding method. Satisfactory joints have been obtained in gray cast iron, ductile and malleable cast irons by arc welding. The tensile strength of welded cast iron joints is usually less than that of base metal and the heat affected zone is usually harder and more brittle than the original casting. Repair welding of defects in new iron castings represents the largest single area of application of welding to cast iron. Minor defects, such as porosity, sand drop, blow holes, washout, cold shut, and shifts usually are repaired. It is the observed that most of the researchers are studied on the metallurgical and microstructure of welded cast iron in this research we are going to be work on the mechanical properties such as tensile strength and hardness of welded cast iron.



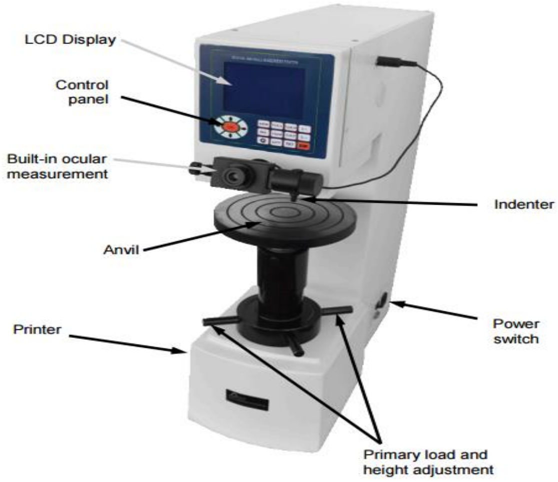


Fig-1 Hardness Testing

2. Literature review

A. Klimpel. et al. [1] "Study of properties of manual metal arc electrodes for gray cast iron defects repair works."

The researches had studied to determine influence of MMA technique and surfacing parameters of gray cast iron using CASTOLIN 27 coated electrodes on quality of deposits. Approach single layer weave bead deposits and one layer overlapped multi weave bead deposits were MMA surfaced on gray cast iron type GG25. All deposits were surfaced on no preheated gray cast iron plate. To determine quality of deposits hardness HRC measurements on the cross section of deposits, microstructure and microstructure observations were done. Findings properties of deposits strongly depend on MMA surfacing parameters and the technique of surfacing. Increase of surfacing current (dilution) provided increase of deposits hardness. One layer overlapped multi weave bead deposits MMA surfaced with no control of inter pass temperature showed higher HRC hardness then deposits MMA surfaced with inter pass temp. 20°C.

Research limitations/implications: for complete information about properties of manual metal arc electrodes for gray cast iron cladding it is needed to compare properties of castolin 27 with other coated electrodes for gray cast iron cladding Practical implications: results of this paper is to increase quality of deposits on gray cast iron. Originality value properties of deposits strongly depend on the technique of MMA surfacing.

J. Adamiec. et al. [2] "Repair of magnesium alloy castings by means of welding and pad welding"

Researcher's attempts were carried out at pad welding and welding of castings made of alloy AZ91D. Technologies were developed to repair such castings by means of welding methods encompassing the choice of weld deposit, welding parameters, heating parameters and the technique of welding. Approach: The research were focus on encompassed: pad welding and welding tests on flat plates cut out from a pig sow of the AZ91D alloy, tests of pad welding of a cast element, making holes simulating defects by means of material removal and their welding. The results of investigation were to elaborate the repairing technology of the defects in Mg alloy cast elements and selection of the welding method, weld deposit and welding parameters for castings to be made of magnesium alloys. Research limitations: The repair by the means of welding must be made after solution heat treatment. It is recommended that the solution heat treatment should be conducted for 24 hours at a temperature of 415ºC, so that the β-Mg17Al12. Massive phase is sollubilized. It has been found that when making repairs with the use of welding technologies, alternating-current sources should be applied. Practical implications: Presented results and conclusions have been applied to work out the technology for repairing of cast elements in aircraft industry. Originality value: Repairing of cast elements in aircraft industry is necessary to assure the economical results of manufacturing of huge cast Mg alloy elements as well as a good quality of it.

Pascual M., et al. [3] "Weldability of spheroidal graphite ductile cast iron using Ni / Ni-Fe electrodes"

Weldability of spheroidal graphite ductile cast iron was established using a cheap Ni-Fe and a high purity Ni electrode. A preheating treatment at 350 °C and an annealing treatment at 850 °C were carried out to improve mechanical properties of welded pieces. The pure Ni electrode showed graphite diffusion in the bead with a uniform distribution of phases, improving weldability and decreasing fragility. Preheating and annealing treatments increased ductility and improved weldability. Aim was these work is to establish a welding procedure for spheroidal graphite ductile cast iron and compare the weld quality obtained using a low priced Fe-Ni electrode with that obtained using a pure Ni electrode. The weldability is evaluated from the mechanical properties and microstructures of weldments.

Gozde S. et al. [4] "Characterization of microstructure and fracture behavior of GG20 and GG25 cast iron materials used in valves"

In this study, the materials are commonly used in high pressure safety valves. In the first stage of the study, the matrix phases (ferrite/pearlite) were determined in addition to the morphology and distribution of graphite, using light microscope and scanning electron microscope. Image analysis was done to obtain the amount of graphite which plays an important role on fracture. In the second stage, micro hardness measurements, tensile tests and Charpy impact tests at room temperature were performed to determine the mechanical properties of the matrices. In the third stage fracto graphic analysis was carried out on the fracture surfaces, using scanning electron microscope to indicate the effects of matrix phase, loading type and test temperature on the fracture behavior.

Pradeshi R, et al. [5] "A Review on metallurgy of welding of cast iron And effect of preheat"

Most of the welding of cast iron is repair welding. Carbon pickup and resulting cracks are the main concerns when welding CI. The casting process is never perfect, especially when dealing with large components. Instead of scrapping defective castings, they can often be repaired by welding. Naturally, the very high carbon concentration of typical CI causes difficulties by introducing brittle martensite in the heat-affected zone of weld. It is there for unnecessary to preheat to a temperature of 450°C, followed by slow cooling after welding to avoid cracking. The effect of preheat temperature on the microstructure obtained in the heat-affected zone and the carbide zone in the weld metal adjacent to heat-affected zone has been studied in multipass welds for the as ductile cast irons. The welding was carried out with manual shielded metal arc welding using Enife–CI filler metal. Ultrasonic, micro hardness distribution, tensile and impact tests were conducted to evaluate the quality of welded joints. Cast iron is generally considered as a difficult material to be welded. This is basically due to two reasons: (i) inherent brittleness of the cast iron and (ii) the effect of weld thermal cycle on the metallurgical structure of the cast iron.

Banna E.M [6] "Effect of preheat on welding of ductile cast iron"

The effect of preheat temperature on the microstructure obtained in the heat-affected zone (HAZ). And the carbide zone in the weld metal adjacent to heat-affected zone has been studied in multipass welds for the as-cast and ferritic ductile cast irons. The welding was carried out with manual shielded metal arc welding using ENiFe–CI filler metal. Ultrasonic, micro hardness distribution, tensile and impact tests were conducted to evaluate the quality of welded joints. According to the results reported in this paper, it Can be stated that. (1) Ductile cast iron can be welded without and with preheat and is free from cracking. (2) The widths of fusion zone and heat affected zone were in the range 0.15–0.27 mm and 0.78–1.1mm respectively, under the present conditions. (3) Preheat temperature of 3008°C or 2008°C were adequate for the as-cast and ferritic ductile cast iron respectively to. (i) Prevent martensite formation in the heat affected zone and reduce the size of the fusion. (ii) Achieve optimum mechanical properties. (4) The ultimate tensile strength expected from as cast ductile iron cannot be met on welded components while for the ferritic grade be met.

Gary J. [7] "Understanding cast iron and repairing damaged castings permanently"

High temperature pre-heat welding and brazing can be performed with 100% predictability just like other metals. If the casting is properly preheated to a high enough temperature the weld will always become completely stress free and annealed to be free from the effects of hardening. In most cases structural repairs can be successfully accomplished by brazing with bare bronze rod, acetylene torch, and flux. The welding process is done by melting the cast iron, pudding the base cast iron and adding filler iron into the puddle. This process is used mostly for buildup and cylinder header manufacturing. There is more distortion with this process than any other.

Sutar S.et al. [8] "Analysis of Mechanical Properties for Welded Cast Iron"

Gray cast iron is most common type of cast iron and it can be successfully welded if cooling rates controlled during welding and after welding. Poor weldability of gray cast iron is due to the presence of much more carbon and silicon than in steel; witch results in cast iron is less ductile hence weld is subjected to more metallurgical complications in both the weld metal and the heat-affected zone. During cooling the carbon is precipitated in the form of graphite flakes which are difficult to weld, the weld metal does not fuse to the graphite flakes. The welding was carried out with manual shielded metal arc welding and oxyacetylene welding, using nickel based filler metal and cast iron rod respectively to join grey cast iron. Welding is carried with preheating and post weld heat treatment (PWHT). A preheating temperature at 3500°C and post heating temperature 8500°C for one hour which improves mechanical properties of welded piece. Micro hardness, tensile tests were studied to evaluate the quality of welded joints.Repair welding of defects in new iron castings represents the largest single area of application of welding to cast iron. Minor defects, such as porosity, sand drop, blow holes, washout, cold shut, shifts, can usually be repaired. Thousands of tons of new automotive engine blocks are repaired annually by arc and oxy acetylene welding. Braze welding also used in application where the colour contrast of the copper base filler metal is not objectionable.

3. Conclusion

From the literature review it is observed that the tensile strength and mould hardness depends on the various casting parameters like pouring time, pouring temperature and hardness it shows that pouring time is most dominating factor that affects tensile strength. Pouring temperature is generally depends on melting point temperature of casting metal and higher value of pouring temperature affects strength and hardness and it shows there is least contribution of mould hardness on strength and hardness. Properties of casting after tensile testing are analyze and salvaging is done by welding method. Properties after welding compare with original and it is analyze that tensile strength and hardness is increased after salvaging.

REFERENCES

[1]Klimpel A., Janicki D., A. St. Klimpel, "Study of properties of manual metal arc electrodes for gray cast iron defects repair works", Journal of Achievements in Materialsand Manufacturing Engineering, volume 17 issue 1-2 July-August 2006

[2]J. Adamiec , S. Roskosz , R. Jarosz, "Repair of magnesium alloy castings by means of welding and pad welding", Journal of Achievements in Materials and Manufacturing Engineering, volume 22 Issue 1 May 2007

[3]M. Pascual, C. Ferrer, y E. Rayón, "Weldability of spheroidal graphite ductile cast iron using Ni / Ni-Fe electrodes", Instituto de Tecnología de Materiales, Universidad Politécnica de Valencia, Camí de Vera s/n. E-46022, Valencia, Spain. PascualGuillamón, Manuel, revista de metalurgia, 45 (5), septiembre-octubre, 334-338, 2009, ISSn: 0034-8570, pp: 1988-4222

[4]Zeynep taşliçukur, Gözde S. ALTUĞ, Şeyda POLAT, " Characterization of microstructure and fracture behavior of gg20 and gg25 cast iron materials used in valves", Gedik University, Faculty of Engineering, Department of Metallurgical and Materials Engineering, Istanbul-Turkey, 2012, Brno, Czech Republic, EU

[5]Pradeshi Ram, S.P. Tewari And JyotiPrakash, "A Review on metallurgy of welding of cast iron And effect of preheat", indian journal of research(2012)6,113-118, Advance Access publication 22 Jan. 2012

[6]E.M. El-Banna, "Effect of preheat on welding of ductile cast iron", Department of Metallurgy, Faculty of Engineering, Cairo UniÍersity, Giza, Egypt, Materials Letters 41 _1999. 20–26

[7]Gary J. Reed, "Understanding cast iron and repairing damaged castings permanently", White paper Presented by Gary J. Reed CEO LOCK-N-STITCH Inc. 2014

[8]Sachin B. Sutar, Dr. K. H. Inamdar, "Analysis of Mechanical Properties for Welded Cast Iron", Journal of Emerging Technologies and Innovative Research, ISSN-2349-5162, June 2015, Volume 2, Issue 6