Weldability of CG Iron

V.S.R. Murthy, Kishore and
S. Seshan*

1. Introduction

In general it is very difficult to weld cast irons mainly because of their high carbon equivalent, inability to accommodate welding stresses and deterioration of some of the mechanical properties after welding. The main source of the problem is the very hard and crack-prone heat affected zone (HAZ) produce in parts of the components which are heated to the austenitic temperature range followed by rapid cooling. Fusion welding, manual metal arc welding, metal inert gas welding and submerged arc welding are normally tried for welding cast irons. Limited amount of literature, highlighting the recent developments in the welding process as well as filler materials[1–4], is however available.

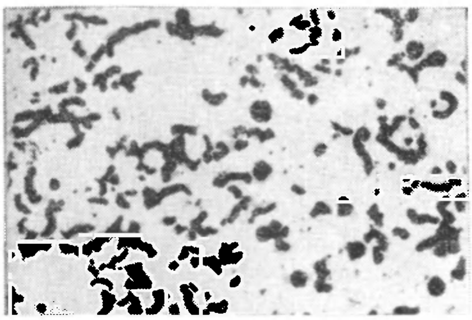

Fig 1. Structure of CG iron showing graphite shape and distribution (unetched. 150 ×)

*Indian Institute of Science
Bangalore 560 012

Recently a new type of iron, known as compacted graphite cast iron (CG Iron), has joined the family of cast irons. This iron is also referred to as vermicular graphite cast iron (VG Iron) (Fig. 1). Currently it is possible to produce CG iron by different methods viz., deliberate undertreatment with spheroidizing elements, combined treatment with spheroidizing and anti-spheroidizing elements, treatment with zirconium and blowing of gases like argon, methane, acetylene etc. into the liquid melt.[5] It is generally accepted that the vermicular graphite shape is due to the degeneration of graphite spheroids. The properties of these irons viz., tensile strength, fatigue strength, hardness, impact strength, wear resistance etc., have been found to be intermediate between those of grey and ductile irons. Data on weldability of this new cast material is totally absent, and this paper is an attempt to fill up this void.

2. Experimental

Plate shaped test castings were made adopting the method of combined treatment with magnesium and titanium. The chemical composition of the iron poured is as follows : C–3.60%, Si–2.10%, Mn–0.04%, S–0.03%, and P–0.07%. From the solidified test castings, test plates with grooves[3] were prepared and the grooves weld-filled under the following conditions :

Test block position	— Horizontal
Preheating temperature	— 250.C (maintained constant)
Filler material	— E Ni Fe Type electrode
Diameter	— 4.0 mm
Chemical composition	— C–2.00%max, Si–2.00 max, Ni–55.00%, Fe–balance.
Polarity	— D.C., Reverse polarity
Current	— 140 Amps.

The groove was filled with several passes ; precautions like slag removal, cleaning, grinding, etc. were taken after each pass. No crack was observed after the welding. Defect-free regions in the test piece were located by means of radiographic examination and these regions were used for preparation of test specimens for assessing the tensile properties and hardness, and for microstructural studies.

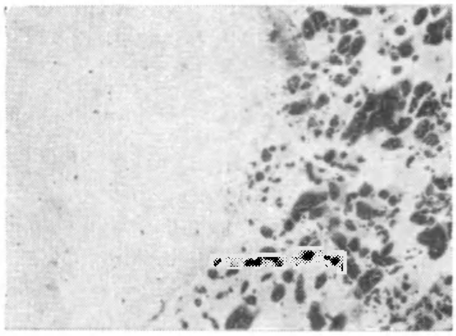

Fig 2. Structure of welded zone in CG iron (unetched ; 100 ×)

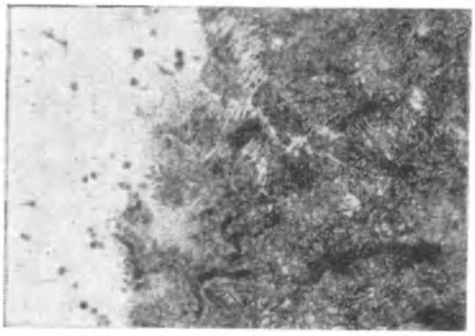

Fig 3. Structure of welded zone (Etched ; 250×)

3. Results

The unetched microstructure of welded zone of CG iron is shown in Fig. 2. It was anticipated that magnesium would evaporate in the fusion zone to result in traces of flake graphite. On the contrary, the compacted form of graphite was totally retained and the length to thickness ratio got slightly lowered. The microstructure is shown in Fig. 3, and the gradual change in the microstructure from the weldment to the parent metal is shown in Fig. 4. It is evident that the structure changed from acicular type (typical of martensite and lower bainite) to one where well-resolved pearlite is present. Even though small amount of carbide seems to be present, the test pieces were machinable without difficulty.

The transverse tensile strength of the test piece taken from the welded zone was 26 kg/mm^2 with negligible ductility. The parent metal had shown a tensile strength of 40.5 kg/mm^2 with 3% elongation. The hardness variations across the weld zone is shown in Fig. 5. After completing this investigation it is positively concluded that CG irons are weldable. Repair welding for salvaging of castings or welding to form difficult shapes is a definite possibility. However, a more detailed investigation is needed to study the influence of other parameters (heat input, filler materials, preheating temperature, section thickness, etc.) on the quality of the weld. CG iron is expected to replace several ferrous alloys in different applications in near future ; its weldability is bound to supplement its uses further.

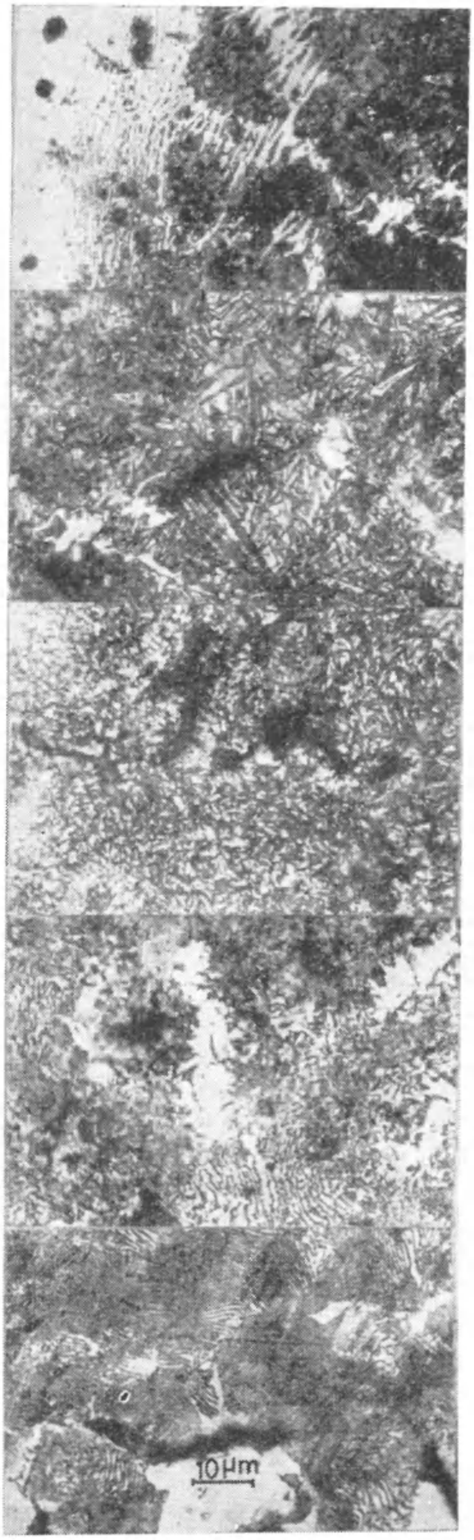

Fig 4. Variation of microstructure across the weld in CG iron section.

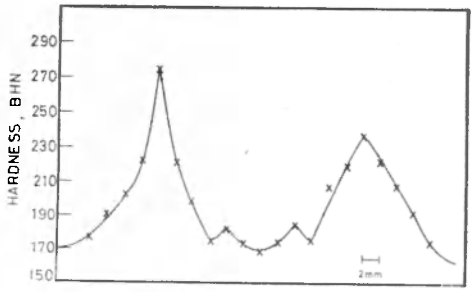

Fig 5. Variation of hardness across the welded section.

References

1. S. D. Kiser, Production welding of cast irons, Trans. A.F.S., Vol. 85, 1977, p. 37.

2. R. Medano, E. Natle and M. S. Remondino, High strength welding of ductile iron castings, Trans. A.F.S., Vol. 86, 1978, p. 611.

3. M. S. Gopalakrishna, K. S. Raman, B. S. Vaideswaran and M. R. Seshadri, New filler materials for manual metal arc welding of spherioidal graphite and malleable irons. Indian Welding Journal, Vol. 15, No. 3, July 1983, p. 77.

4. M. A. Davila, D. L. Olson and T. A. Freese, Submerged arc welding of ductile iron, Trans. A. F. S., Vol. 85, 1977, p. 79.

5. V. S. R. Murthy, Kishore and S. Seshan, Properties of cast iron with compacted graphite, The British Foundryman, Vol. 78, Part-2, Feb/March 1985, p. 71.