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Welding Nightmares – Case Study

By

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Introduction

Most grades and types of steel are weldable, even 4150RS and Stressproof. The problem is controlling the process to suite the grade or type of steel being used. The critical factor is knowing the type of steel being welded. In many cases, the type of steel is unknown, this is especially true when repairs are being made. Other critical factors are knowing the preheating and post heating requirements, and having the capacity to do them. Plain carbon steels with a carbon content of 0.05% and 12L14 are not weldable. It is also important to use the correct filler metal or welding rod or wire. Finally, having a weld operator that has the appropriate skill level to do the job. Most weld failures occur when one or more of these factors are overlooked. We usually get involved when two or more critical factors are overlooked.

Heavy Section Weldment of Medium Carbon Steel

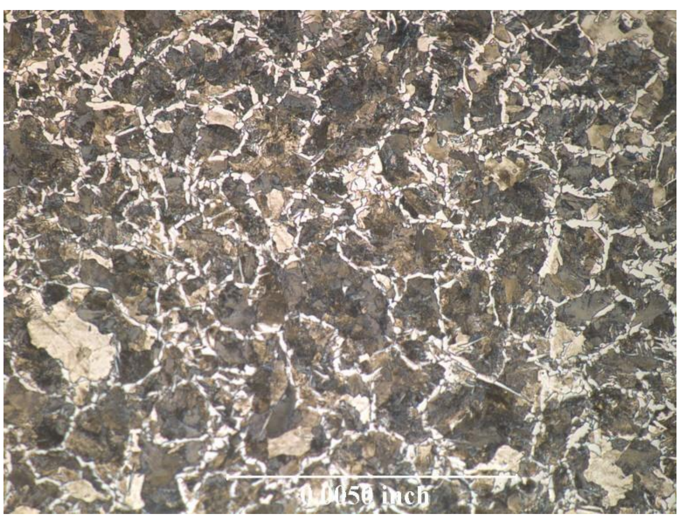

Figure 1 – 400X Microstructure of 1045/1050 Steel

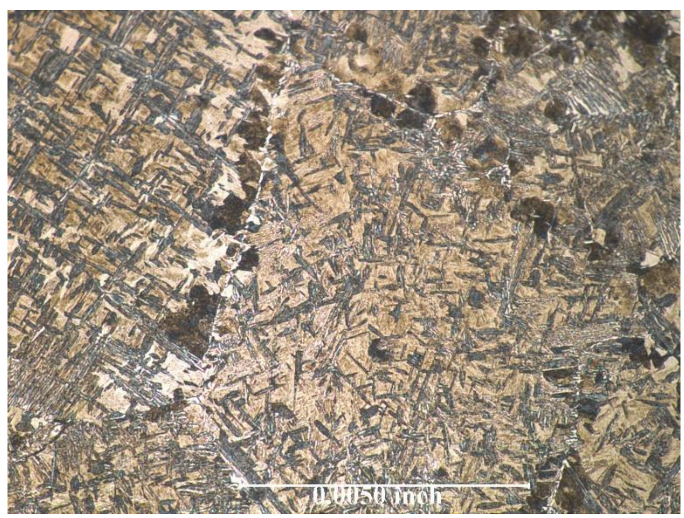

Figure 2 – 400X Coarse Grain Widmanstatten

In Figures 1 and 2, the material that was welded was a 4 inches by 4 inch heavy section channel, about 40 pounds/foot, of 1045 carbon steel. The microstructure of the channel steel consists of pearlite and grain boundary ferrite, typical of 1045 steel. This section was used as a wear bar and was welded to a steel plate with a 3/8 inch fillet weld. The welds holding the wear bar to the steel plate were failing long before the bars were wearing out.

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The other problem was the size and weight of the assemblies. The manufacturer did not have ovens big enough for preheating and post-heating the assemblies. The preheating and post-heating was done with high intensity heating lamps and welding blankets.

Figure 1 shows the normal heat affected zone of 1045 steel. The microstructure consists of tempered martensite islands surrounded by ferrite. Figure 2 shows coarse grained Widmanstatten, which is formed by very rapid cooling from temperatures just below the melting point in ferrous alloys. This microstructure was first noticed in iron meteorites in the early 1800's and is found in titanium alloys.

Widmanstatten is a very brittle microstructure in ferrous alloys, and usually results in premature weld failures, as in this case.

Re-Bar and Support Bracket Failure

In this case reinforcing bar was welded to pole shed support brackets. The shed was blown from its foundation, several months after being installed, during a winter storm with winds gusting to 45 miles per hour.

Figure 3 – Typical Weld Failure

Figure 4 – Failed Weld Joint on Bracket

Figure 3 shows a typical remaining weld on a reinforcing bar embedded in concrete. Most of the weld joints had failed prior to the windstorm, and some had failed by the time it was imbedded in the concrete.

Figure 4 shows broken weld joints on the bracket. These two weld joints failed in the reinforcing bar heat affected zone.

There was enough evidence at the failed building sight to indicate that there was a significant problem associated with the welds of the brackets to the reinforcing bar.

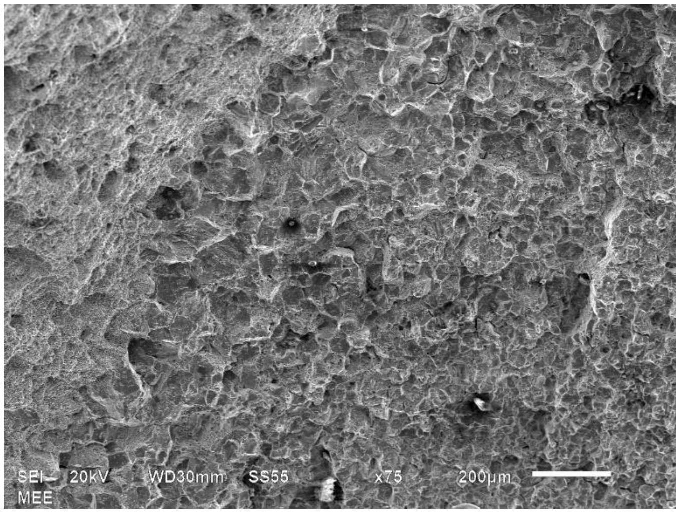

Figure 5 – 75X Brittle Fracture Rebar HAZ

Figure 6 – 400X Widmanstatten Rebar HAZ

The reinforcing bar was a Grade 80, and the material used was a medium carbon, nickel-chromium steel with a carbon equivalent of 0.55%. This steel required preheating prior to welding and post-heating after welding. Figure 5 shows that the fracture mode for the weld was intergranular brittle fracture, and Figure 6 shows that the cause of the intergranular brittle fracture was Widmanstatten. The bracket material was ASTM A36 steel.

Conclusion

In the case of the heavy 1045 steel section, the manufacturer was attempting to solve a known problem and increase their product’s life and reliability. In the case of the reinforcing bar welded to the bracket, the company doing the welding had no idea what they were doing. If the shed had not been new and the dollar loss had not been so great it is highly probable that the cause of this structural failure would never have been determined.