Code Aids in Fabrication of Subway Elevator Hoists

An ANSI/AWS-approved code for use in the fabrication of stainless steel structures helped in the production of a 41-ft-high elevator hoist

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In March 1999, the American National Standards Institute (ANSI) approved its first code for structural stainless steel welding. Prior to this published code, many fabricators referred to the ANSI/AWS B2.1 standard, or to ASME Section IX, when specifications either referenced ANSI/AWS D1.1 or did not cite a specific welding code for stainless steel welding requirements.

Project Concerns

Project specifications given to Unlimlited Welding, Inc., Winter Springs, Fla., by a client did not include any reference to the ANSI/AWS D1.6-1999 code; however, the specifications did state all welding procedures were to be qualified to ANSI/AWS B2.1. A complete review of the drawings for the welded structure, a 41-ft-high elevator hoist constructed entirely of stainless steel square or rectangular tubing (Fig. 1), was made prior to the commencement of fabrication due to the structure's design, the extensive amount of welding required, and the fabricating material's coefficient of expansion.

Review efforts focused on minimizing heat input of the welding process and procedures and took into consideration the stringent No. 4 Satin finish required on all welded surface areas for aesthetic appeal — Fig. 2. Positioning the structure for production welding was accomplished by the use of a shop fabricated, head/tail stock-type fixture made specifically for handling the hoist. The four sides of the structure had to be fabricated in fixtures to maintain alignment, then fully assembled and the remaining welding completed. The maximum out of straightness of the overall structure was ¼ in. or less over the 41-ft length of the structure.

Project Procedures

The original contract drawings contained what was desired in regard to the specifics of welding, as is customary on many contract design drawings. The weld symbols specified complete joint penetration welds in areas where partial joint penetration would suffice per the welding code. The issue was promptly clarified by suggesting to the engineer of record a further review of the requirements of Section 2 of the AWS D1.6 code with consideration to the design loads per the same. A review of this type revealed partial joint penetration and fillet welds were acceptable under the design load conditions. The client knew it wanted the all-stainless tubular structure to have complete welded flush joints where all joints meet. After a review of the drawings, it was concluded that partial joint penetration welds and fillet welds would account for all of the welding required on the hoist structure.

Fig. 1 — The completed stainless steel elevator hoist. (Photos courtesy of Unlimited Welding Inc., Winter Springs, Fla.)

Welding procedures were prepared and submitted in accordance with Section 3.1 for prequalified WPSs. Table 3.1 in the code clearly describes the prequalified variables to be specified in the WPSs. This further clarifies the misconception some WPS creators and reviewers have that writing on the WPS the welding parameters within the manufacturer's recommendations as listed on the certification or product date sheet for the consumables is not acceptable since the range(s) stated are typically outside those permitted in Table 3.5 of AWS D1.6 and thus require preparation of a separate WPS.

Flux Cored Arc Welding with E316LT-1

Prequalified welding procedure specifications were prepared for gas-shielded flux cored arc welding (FCAW-G) of the structure. The FCAW-G process provided the best overall control of heat input, deposition rate, out-of-position welding ease, and operator appeal for welding of this structure.

Although the welders on the project were ironworkers, they

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Fig. 2 — A view of the required No. 4 Satin finish weld surface.

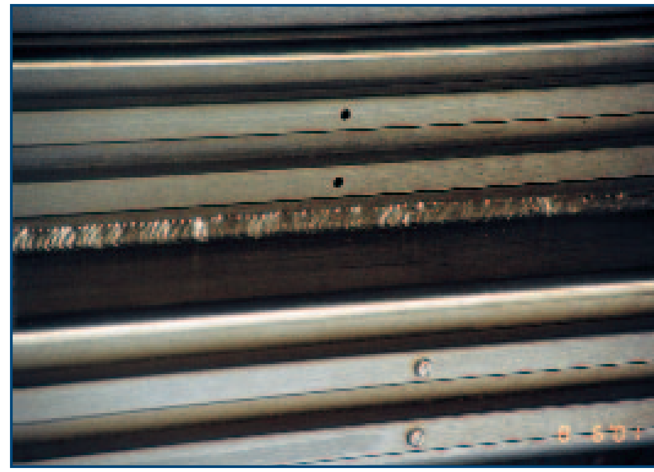

Fig. 3 — View of the FCAW-G weld deposit.

had no trouble passing the ⅜-in.-thick, 3G uphill, limited-thickness groove weld tests required using AWS A5.22, E316LT-1 wire. All 14 welders passed radiography tests on the first attempt. Exceptional performance results were achieved with this wire classification during testing and production welding — Fig. 3. Uphill progression welding accounted for approximately 30% of the fillet welds made on the structure. The back step welding sequence as well as planned welding sequences were utilized whenever possible on all welding to minimize distortion. Average heat input range was 25–28 kJ/in. Precautions were taken not to overweld any area.

Some FCAW Process Limitations in D1.6

Although the standard is clear for requirements of prequalified WPSs, Table 3.5, note 5 does limit the use of prequalified FCAW. For FCAW-G in the downhill weld progression, WPS prequalification is limited to 3⁄16-in. material and under. This becomes important to fabricators who typically conduct gas metal arc welding and FCAW-G in the downhill weld progression on miscellaneous types of handrails, stairs and stringers, or material in the ⅛–3⁄16-in. range. Self-shielding FCAW is further restricted to being qualified in only the flat and horizontal positions.

Inspection and Quality Control

Although the specifications referenced ANSI/AWS B2.1 and AWS D1.1 for all visual inspection, neither were applicable to the type of work being performed. As a result, the fabricator submitted a request for information and approval to utilize Section 6 of AWS D1.6 *Structural Welding Code — Stainless Steel*. Based upon Section 6.8 and the Annex A referenced, which provides nonmandatory recommended inspection procedures, Table A-1 gives the weld Class 1 designation, which was selected for this project because the actual visual inspection requirements were more stringent than those specified in AWS D1.1. Request and submittal to the owner to conduct inspection of the structure to ANSI/AWS D1.6-Part E, "Quality of Welds-Statically Loaded," Section 6.28, was approved.

It should be noted that D1.6 has various levels of visual and nondestructive inspection and acceptance criteria based upon weld classes, base metal thicknesses, and intended service. Users are encouraged to review the requirements of Section 6 and refer to "Recommended Inspection Practice of Annex A" in the AWS D1.6 code prior to developing an inspection plan or selecting and/or recommending acceptance criteria for welding inspection.

Finishing the welds to a No. 4 Satin was part of the project specifications and proved to be one of the most challenging parts of the project. Extreme care was required when grinding and polishing welds to avoid possible base metal weld repairs.

Conclusions

Fabricators now have an acceptable ANSI/AWS-approved code for use in the fabrication of stainless steel structures. The code permits the use of prequalified welding procedures, defines inspection criteria, and gives sound requirements for the design and fabrication of stainless steel welded structures. The fabricator's customer has now adopted the D1.6 welding code as part of the revision to its structural and welding specifications. Structural engineers and specification writers should be made aware of the ANSI/AWS D1.6-1999 welding code and specify it when appropriate on stainless steel welded structural projects.

A thorough review of specifications and contract requirements prior to any fabrication by the CWI and involved parties can often prevent much grief and confusion; in this case, it likely prevented the fabricator from unnecessarily qualifying welding procedures to ANSI/AWS B2.1, which were considered prequalified under AWS D1.6.

The owner commented the company was comfortable with the approach taken by this particular fabricator and said it found the fabricator reasonable to deal with regarding the submitted request on the project. The owner later awarded 18 additional hoists to the fabricator and said the quality program and sound welding practices employed by the fabricator played a significant role in its decision to award the remainder of the hoist to the fabricator. ❖