IMPACT TESTING OF WELDED SAMPLES

Calvin D. Lundeen

University of the Pacific
1502 Valencia Avenue
Stockton, California 95211

Telephone 209-946-2151

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University of the Pacific, Stockton, CA

KEY WORDS: impact testing, arc welding, engineering, welding practice, weld quality.

PREREQUISITE KNOWLEDGE: This laboratory is intended for engineering students with very little welding experience. Prior to attempting this laboratory the students should learn how to strike an arc and practice welding on a plate.

OBJECTIVES: To demonstrate how welding practice and joint design affect the performance of the joint. To demonstrate the importance of weld inspection to ensure quality welds.

EQUIPMENT AND SUPPLIES: 1) A Shielded Metal Arc Welder (SMAW), which is capable of supplying at least 120 amps DC current; 2) a supply of E6010 electrodes; 3) a spot light; 4) a pendulum impact tester (Charpy type); 5) 1 cm (optional 3/8 in nominal) square, hot rolled 1020 steel; 4) cut-off saw; 6) grinder; 7) plate fixture constructed as per instructions in this write-up; 8) wire brush; 9) helmet with filter plate designed for SMAW welding; 10) gloves; 11) protective clothing including apron, long pants, shirt, and closed toed shoes, preferably work boots.

PROCEDURE: During the experiment the students will practice welding bars together that will later be tested for impact strength. Begin by explaining the safety precautions necessary for shielded metal arc welding (SMAW). No more than two students should be in the designated welding area at a time. All should wear protective shields, clothing, as if they were welding. Illuminate the weld site with the spot light. Both students should watch the instructor demonstrate welding metal and finally the students should take turns welding samples together.

Each student should prepare and test six samples with a welded length of 55 mm, and approximate cross-section of 1 cm square. One of the samples may be an uncut bar, as shown in the sample data. Each of the remaining samples should be prepared from two 28 mm lengths. The

lengths should be sanded to remove any oxide coating . The students should prepare square, single-bevel, and double bevel groves in the samples. If the student has a solid bar control sample, only one square joint sample should be prepared. Otherwise two samples should be prepared of all samples. The square grove and uncut samples require no additional preparation before welding. Groves for good weld penetration should be ground or milled on a length in each of the samples. Figure 1 illustrates the different welds used.

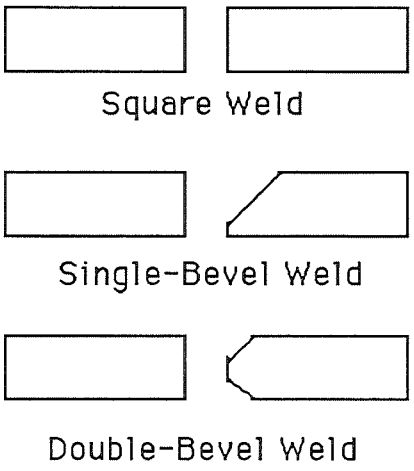

Figure 1. Welds tested for impact. The bevels should be at approximately 45° from the horizontal. The flat area should be approximately 2 mm.

Once the samples are prepared, they are fitted into a clamping fixture shown in Figure 2. The purpose of the fixture is to space the bars at 6 mm (1/4 in) intervals and to ensure that the gap between samples prior to welding is approximately 3 mm (1/8 in). At these intervals, a student can move the stick from one joint to another without breaking the arc. Where the fixture touches the samples it should be aluminum to aid removal of heat and so that the samples will not bond to the fixture. Heavy gauge steel can be placed over the aluminum sides to protect them from inadvertent damage. When the samples are prepared, the samples are welded as described earlier.

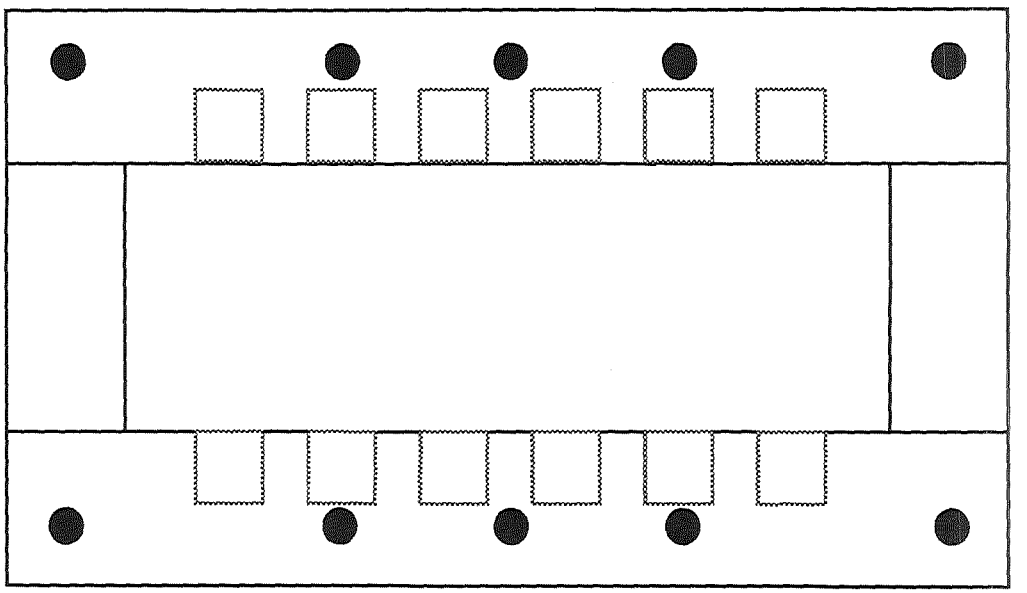

Figure 2. Clamp fixture. This fixture will hold the bars at the appropriate spacing for welding. There are only two critical dimensions, the 6 mm spacing of the samples, and the 3 mm separation distance between each half.

After all of the samples have been welded, they should be visually inspected. Because the welding will be of generally low quality, we will test welds that would normally be rejected. For this laboratory, a poor weld is a weld that does not fuse completely at one of the interfaces; a fair weld has large porosity but good interface with base metal; a moderate weld has a good interface with the base metal and a small amount of porosity in the center of the weld. Good and excellent welds show no visible defects. Excellent welds have a uniform weld surface with little splatter. Once the samples have been welded, categorized by type and quality. They should be ground to 55 mm.

Each of the samples should be tested in an impact test machine as would unnotched Charpy samples (ASTM Standard E 23). The weld is positioned so that the striking edge of the impact hammer is centered on the weld. For this laboratory experiment, the surface requirements given in the standard do not need to be met.

SAMPLE DATA SHEETS:

Sample #	Weld Quality	Groove Type	Impact Energy
B	Fair	Square	30 J (22 ft lb)
A	Poor	Single Bevel	20 J (15 ft lb)
C	Fair	Single Bevel	45 J (33 ft lb)
E	Moderate	Double Bevel	83 J (61 ft lb)
D	Poor	Double Bevel	26 J (19 ft lb)
	Solid Bar		332 J (245 ft lb)

INSTRUCTOR NOTES: When the data from several groups is combined, the benefits of bevelling, particularly double bevelling, become apparent. The differences in weld quality account for the differences in impact energies. The experiment can be repeated with heat treatment after welding to illustrate effects of heat treatment. This is best done after the students can weld at the moderate or good level as defined in the lab. The experiment has been designed so the materials are widely available. The experiment could be repeated using other material/electrode combinations. This laboratory has been focused toward the engineer with limited welding experience. As a result, we have not found it necessary to clean and grind the samples just prior to testing.

REFERENCES: American Society of Metals, Metals Handbook, Volume 6 Welding Brazing, and Soldering, Ninth Edition, 1978, p. 57, 60, 69, 76, 85, 95.

SOURCE OF SUPPLIES: The 1020 steel is available from any steel supplier. The aluminum for the plate fixture can be obtained from most metals suppliers or as scrap. E6010 electrodes for arc welding are available at any welding supplier.