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Internal Stresses in Welded Joints.

Innere Spannungen in geschweißten Stößen.

Efforts internes dans les joints soudés.

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The lecturers have given very thoroughly the disturbing effects of welding in producing distortion and internal stress. They have also spoken on the danger of cracking and of the need for further investigation on the actual weakening effect of the disturbances due to heat and of the internal stresses. Our experience is that the danger of cracking is the cause for real anxiety.

Internal Stress. The writer carried out a series of tests on mild steel and on steels of higher tensile strength (37—43 tons/in.^{2}), the increase being obtained by small additions of carbon, manganese and chromium. They were interesting in that a comparison was made of the welded specimen in the unannealed state with the specimen annealed by heating for a few hours at 600^0 C. In the latter case the internal stresses are removed so that the tests detected any effect due to internal stress.

The tensile strength and the impact value of the joint were reduced a little by annealing; the fatigue strength obtained in a machine capable of testing the complete joint, remained the same; the bend test for ductility in the butt joints showed an improvement in the annealed specimens, but several of the electrodes used gave welds satisfying the standard bend test in the unannealed state. The conclusion from these tests is that internal stresses adjacent to the weld are not a weakness, practically speaking, if good electrodes are used.

Tests on the value of residual stress.

A series of tests was carried out by the writer to find the actual value of internal stress in a severely constrained condition. The arrangement is shown in Fig. 1. Two $^1/_2''$ plates prepared for a butt weld, were first welded to a 3″ thick plate at their ends. They were then welded together. After mounting a tensometer, the plates were sawn through. The reading on the tensometer gave the release of strain and therefore the amount of residual stress. The results were as follows, as shown in Table 1.

Table 1.

Specimen	Length X ins.	Welding	Residual Stress tons/in²
1	9	With 5/16" rods	12.0
2	58	„ 3/16" „	4.2
3	9	„ 1/8" „	13.0
4	58	„ 1/8" „	7.2
5	9	Hammered hot	cracked
6	9	„ „	5.0
7	9	„ cold	4.5

The first point of interest in this table is the effect of the length of plate. Increasing the length of plate reduces the stress and emphasizes the point made by the lecturers that there should be flexibility in the part bordering on the welded seam, in this case it is the flexibility of the long plate.

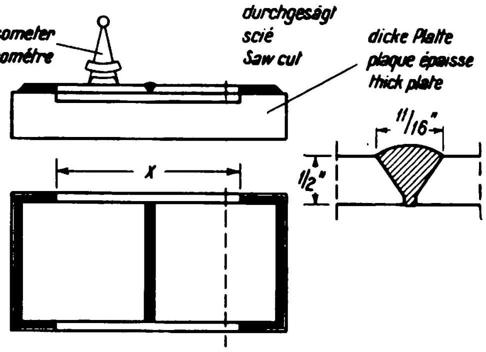

Fig. 1.

Contraction Stress in Butt Welds.
(Plates Welded at Ends Before Butt Welding.)

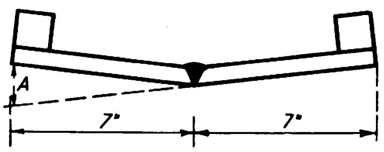

Fig. 2.

Angular Distortion in a Single-V Butt Weld.

The second point is the effect of larger compared with smaller electrodes. These results agree with those quoted by the lecturers, that the larger rods produce less residual stress.

The third point is the effect of hammering, which certainly reduces the stress, but increases the danger of cracking. From later tests using a wide variety of different makes of electrode, the writer is of the opinion (1) that only a few electrodes give weld metal capable of being hammered without the danger of cracking, (2) that the first run of welding should not be hammered as it was shown from hardness tests to be a danger spot and where welds failed, the cracks started from this part, and (3) that the outer layer should not be hammered.

Tests on angular distortion of a single-V butt weld.

These tests are of interest in showing the effect of a small amount of restraint. The restraint was obtained by placing two weights on the plates as shown in Fig. 2. The distortion "A" was measured after cooling and is given in Table 2.

Table 2.

Specimen	Welding	Current amps	Distortion 'A' ins.
1	5 runs 1/8" rod	110	0.28
2	3 „ 3/16" „	170	0.05
3	3 „ 3/16" „	220	0.044
4	2 „ 5/16" „	340	0.031

Plates 1/2" × 7" × 7"

The restraining effect of the weights is small as it produces a calculated bending stress in the weld of only $\frac{1}{7}$ tons/in^2. This test confirms the effect of the smaller rods in building up a greater distortion, and therefore where the restraint is more definite, in building up a greater stress.