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Fatigue strength of longitudinal flange-to-web welds in steel I-beams and T-sections

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THE PREPARATION OF THIS DATA ITEM

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Mr R.P. Sharp	—	Engineer.

The person with overall responsibility for the work in this subject area is Mr M.E. Grayley, Head of Strength Analysis Group.

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FATIGUE STRENGTH OF LONGITUDINAL FLANGE-TO-WEB WELDS IN STEEL I-BEAMS AND T-SECTIONS

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FATIGUE STRENGTH OF LONGITUDINAL FLANGE-TO-WEB WELDS IN STEEL I-BEAMS AND T-SECTIONS

1. NOTATION

I	second moment of area of beam cross-section	m^4	in^4
M	moment applied to beam section	N m	lbf in
N	endurance		
S_a	longitudinal alternating stress (half range) at weld	N/m^2	lbf/in^2
y_w	distance of weld from neutral axis (see Sketch 2.2)	m	in

Both SI and British units are quoted.

2. NOTES

This Item presents data on the as-welded fatigue strength of symmetrical section I-beams and T-sections built up from flat steel plate using longitudinal flange-to-web welds, see Sketches 2.1 to 2.3. Data are presented for continuous automatic and manual welds, both with and without full penetration, and for discontinuous fillet welds. The I-beams were tested in simple bending under three- and four-point loading. The T-sections were loaded axially and uniformly across their complete cross-section.

Since in all cases the depth of the I-beam was large and the dimensions of the weld relatively small in relation to the cross-sectional dimensions of the beam, the data for I-beams are presented in terms of the longitudinal stress range acting on the weld. The stress was calculated by using simple bending theory, $S_a = My_w/I$, where y_w was the distance from the neutral axis to the inside of the flange. Where three-point bending was employed the principal stresses were calculated but they did not differ significantly in either magnitude or direction from the stresses obtained from simple bending theory. Therefore the data for all beams are plotted using simple bending theory, there being no discernible difference between three- and four-point loading cases.

T-section specimens were tested under uniform axial loading at four mean stress levels with a cyclic stress range of $2S_a$. They all exhibited a fatigue strength which was indistinguishable from that of I-beams in bending, described in the previous paragraph, because the flange-to-web detail was identical. The data may therefore be taken to apply to I-beams that are subjected to uniform axial loading.

Figure 1 gives data for all continuously welded I-beams in bending and axially loaded T-sections. The mean line through the data is provided together with scatter bands which contain 95 per cent of all the data. Figures 2 and 3 give data for continuous automatic and continuous manual welds respectively showing the effects of depth of penetration and comparing the data with the 95 per cent scatter bands from Figure 1. Figure 4 shows the data for intermittent fillet welded beams and beams with cope holes and similarly compares these with the 95 per cent scatter bands from Figure 1.

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