WELD SHRINKAGE IN NON-LINEAR MATERIALS

M.P. Wong

Abstract

This dissertation is concerned with shrinkage stresses and distortions due to welding in members fabricated from stainless steel or aluminium alloy plates. The man objectives of the present study are first, to provide simple methods of predicting longitudinal compressive residual stresses in welded compression members, since these stresses reduce their resistance to buckling; secondly, to provide formulae for estimating weld distortions in these two different types of structural material.

An experimental programme has been carried out to determine the shrinkage stresses and distortions in welded members of stainless steel or aluminium alloy. Altogether, over 300 weld beads have been tested with these materials, covering bead-on-plate welds, butt welds and T-fillet welds. The bead-on-plate welds are taken as the basic type with which all other results are compared. The parameters investigated include weld process, weld eccentricity, plate dimensions, rolling direction and pre-existing stress field. Both single and multi-pass welds are studied.

Two related studies have been completed in addition to the weld shrinkage work. These are concerned with shrinkage effects due to the plasma-arc cutting process and with the loss of strength due to heat-affected-zone weakening at longitudinal welds in aluminium alloys.

A computer programme is described which models the development of longitudinal stresses and distortions during welding. The programme considers the two-dimensional distribution of longitudinal stresses in a transverse cross-section of a single or multi-pass butt-welded joint, and incorporates non-linear, elasto-plastic and temperature-dependant material properties. Good agreement has been obtained between computed results and experimental measurements with these non-linear materials.

Finally, the present investigation has demonstrated quantitatively that in welded members of stainless steel or aluminium alloys the presence of any material non-linearity or

softening is to modify the shrinkage behaviour in the longitudinal direction. But these phenomena do not affect transverse weld distortions.