LOCAL BUCKLING OF WELDED STEEL OUTSTANDS

N.A. Rogers

Abstract

The design of plain flat outstands (beam or column flanges, plain flat stiffeners in stiffened plating) is based on setting limits to the outstand slenderness. For the plastic design of beams and columns, the width-thickness ratio of the compression flanges is limited to prevent buckling and enable to fully-plastic moment of the section to be developed and maintained over considerable rotations. For conventional elastic design, the allowable slenderness is slightly higher, but must still be sufficiently low that the outstand strength in compression is equal to the material yield stress. In this stocky region, the effect of residual stresses on strength is small.

For more complex outstand shapes (bulb flats, angles, tees), past practice has been to assume these sections to be fully effective. Following the collapse of a number of box-girder bridges, and the setting up of the Merrison Committee, an allowable stress for outstands in stiffened plating can be calculated, based on the elastic critical stress for torsional buckling of the outstand. Since little was known about the effect of initial imperfections on the strength of outstands, the Merrison Committee also recommended stringent tolerances on the allowable out-of-straightness of such members.

Detailed information (both experimental and theoretical) concerning the behaviour of outstands in compression is limited, especially in the more slender range where initial imperfections and residual stresses are more important.

This dissertation contains details of a theoretical analysis for predicting the load-deflection characteristics of slender simply supported plain flat outstands in compression, including the effect of welding stresses and initial imperfections. A comprehensive experimental study of hinged plain flat outstands in compression is also described, and the results enable a design curve of strength against slenderness to be drawn. The agreement between experimental and predicted strengths is quite good.

For bulb flats, high rolling residual stresses and a considerable variation in the yield stress across the section have been found. Compression tests have been conducted on the bulb-flat cruciform columns to investigate the effect of different imperfection shapes on strength. The results indicate that a relaxation in the Merrsion fabrication tolerance could be made.

Finally, a design method is presented for outstand failure in stiffened steel compression panels. This is based on calculating an “affective slenderness” for the outstand restrained by the plating, and entering in the strength curve derived from the results of tests on simply-supported outstands.