

ABSTRACT

This thesis deals with the finite element investigations to study the effect of geometrical parameters of undercut defects on the stress distribution and hence the stress concentration and loss of fatigue strength in various types of fillet and butt welded joints subjected to external static and fatigue loadings. Analyses are carried out for fillet welded joints with undercut defects at the toes subjected to either static or fatigue parallel loading or cantilever loading. Butt welded joints with undercut defects are subjected to external static or fatigue uniform tensile loading. The joints are idealized to be in states of plane strain conditions. Materials are assumed to be homogeneous and isotropic in the base metals (BM), heat affected zones (HAZ), and the weld metals (WM). The residual stresses due to shrinkage and thermal loading have not been considered.

The fillet profiles considered for T-joints are triangular (flat), and concave (circular and elliptical). In butt welded joints (single V, equal double V and unequal double V) the bead shapes considered are elliptical. Undercuts of either V or elliptical types are assumed to be present at the toes of the profiles. Important results include identification of localized peak stresses and hence determination of SCF, variation of SCF at the critical zones with the variation of geometries of the undercut defects. The various stress contours such as σ_x , σ_y , τ_{xy} , σ_1 , σ_2 , σ_3 , τ_{max} , σ_e present the overall stress fields. Results are presented in form of nomographs for ready use by designers, fabricators and quality control personnel. The severe effects of stress concentration in reducing the fatigue lives of welded joints containing undercut defects have been analyzed through the fatigue module of the finite element programme. It is observed that fatigue lives may be improved in some cases of fillet and butt welded joints with shallow and wide elliptical undercut defects.

Some experiments have been conducted on specimens of fillet and butt welded joints with and without undercut defects in a servohydraulic dynamic universal testing machine to determine the static and fatigue strengths. The experimental results are correlated with those obtained by finite element analysis.

KEY WORDS : Butt welds, cumulative damage, discretization, fatigue life, fillet welds, finite element, fitness-for-service, notch action, stress concentration, stress raisers, undercut defects.