29-13 Damage Criterion and Safety Assessment for Welded T-Joints

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During the recent Kobe Earthquake, many steel structures were damaged owing to the initiation and growth of cracks. Ductile macrocracks often initiated at weld toes after structures sustained large plastic strain. These cracks frequently led to a premature failure of structures.Therefore, it is important to predict the macrocrack initiation in structures. Furthermore, it is essential to understand crack growth behaviour and to be able to assess the significance of defects in steel structures.

From the microscopic point of view,damage is related to the process of nucleation and growth of micro-voids and cavities. During the damage process, the accumulated plastic strain and stress triaxiality are two important factors affecting macrocrack initiation. In the present paper, based on the Lematre's damage model, a damage criterion for welded structures will be derived to predict the macrocrack initiation. Non-linear FE analyses will also be performed to investigate stress triaxiality and plastic deformation. Finally, damage criterion curves will be verified by FE results.

In elastic-plastic fracture mechanics, the J-integral can determine the singular level of the stress field near the crack tip and control crack initiation and growth on a small scale. The critical value of the J-integral, J_{IC}, is a basic fracture property of the material for fracture criterion. In terms of JSME Standard, J_{IC} will be obtained according to load vs. displacement curves measured in the fracture toughness testing.

The fracture assessment procedures introduced by the CEGB are based on the Failure Assessment Diagram(FAD)approach. The method is also developed in the EPRI handbook. However, the CEGB R6 approach does not give optimal solutions for all types of welded joints. In this paper, the assessment criterion curve will be described and the CEGB safety assessment approach will be applied to defected welded T-joints. The two assessment parameters, the plastic collapse load and the crack driving force of cracked welded T-joints,will be calculated by FE analyses. Numerical results will be compared with the assessment criterion curve of the CEGB R6 approach.

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