

Abstract

In the present work, the investigation of an early fatigue failure of steel rebar samples, of dimensions of \varnothing 14 mm, during standard fatigue tests is performed. The rebar failed after approximately 1.67×10^6 fatigue cycles, much below of the specified 5.0×10^6 cycles according to BS 4449 standard. The rebar tested sample exhibited a crack initiation site close to the root of a surface geometric discontinuity (“nipple”), which is considered as a stress concentration point. Light optical microscopy, microhardness testing, SEM/EDS, and numerical simulation were employed as the main investigation methods. Fractographic examination depicted the presence of clearly resolved fine fatigue striations elucidating the continuous crack growth period, under Paris law regime, followed by a dimpled ductile zone as the instant ultimate fracture zone. An evaluation of the steel inclusions (MnS, Fe -Si-Mn-Al-Mg-O) was achieved by optical metallography and SEM/EDS analysis. In addition, the results of the numerical analysis, verified that the existence of manufacturing imperfections or geometric irregularities, such as the “nipple” marking of the bar, imposed a significant stress raise up to 2 to 3.3 times of the applied mean stress level, leading to an effective reduction of the expected lifetime of the specimen.