STUDY ON SUPERLONG LIFE FATIGUE IN HIGH STRENGTH STEELS

Yasuo Ochi

Department of Mechanical Engineering and Intelligent Systems,
University of Electro-Communications, Tokyo
1-5-1, Chofugaoka, Chofu, Tokyo 182-8585, Japan

ABSTRACT

Recently, superlong life fatigue over 10^7 cycles whcih was assumed to be a fatigue limit of steel materials, has been noticed. One of the reason is the aged industrial structures and materials such as railways wheels and rails, engine components, load bearing parts of automobile industry, etc., have to endure up to 10^8~10^{10} load cycles, and the other is that several unexpected failure have been occurred in severe environmental use of many industrial structures and materials in superlong life fatigue regime. However, most experimental investigation have been limited to testing periods up to 10^7 cycles, and the collecting and the arrangement of the testing data of superlong life fatigue regime have been insufficient until now.

This paper firstly introduces recent several joint research projects being related with superlong life fatigue in JSME (the Japanese Society of Mechanical Engineers), HPIJ (the High Pressure Institute of Japan), JWES (the Japan Welding Engineering Society), and round robin tests of RGSAMS (the Research Group for Statistical Aspect of Materials Strength), JSMS (the Society of Materials Science, Japan) in Japan.

Then, the study of the superlong life fatigue in high strength steels were reviewed briefly, and some results of the progressing round robin tests are shown. From the results, the S-N curves in high strength steels have not clear fatigue limit, and show basically typical doubly deflected or the duplex S-N curves which have a first slope, an intermediate horizontal portion and a second slope in the superlong life regime. And, the fracture mode is divided into two types; the former is the surface fracture mode in the shorter life regime before about 10^5 cycles, and the latter is the internal fracture or the fish-eye fracture mode after about 10^7 cycles.

From SEM observations of fracture surfaces, the crack initiation sites in the surface fracture mode are the surface slip or the inclusions on/near surface, and in the internal fracture, they are mostly non-metallic inclusions, and the fracture surface gives a typical fish-eye fracture mode. The rough grander area RGA are observed in the vicinity around the inclusions, being the crack initiation sites. And lastly, some proposals which are suggested to interpret the mechanism for the formation of the RGA in the superlong life regime.