A Study on Fatigue Property of High Strength Steels in Ultra-Wide Life Region under Rotating Bending

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Due to strict economical circumstances in the industrial society, wide variety of mechanical structures have been used in a long period, sometimes, beyond the design life provided in advance. Based on the trend to require the high quality and down sizing of mechanical structures, various high strength steels have been developed and applied to the actual uses. Usually, high strength steels and surface-hardened steels have a significant fatigue property such that the *S*-*N* curve tends to come down again in the long life region of $N > 10^7$. Thus the fatigue property of metallic materials in the long life regime tends to be an important subject in the mechanical design to ensure the long-term safety of the mechanical structures.

From this point of view, fatigue tests in the ultra-wide life region of $N=0.5 \sim 10^9$ were performed for the following kinds of high strength steels;

Several high strength steels for mechanical tool use (SWRH62A, SVS, SRS60D)
High carbon chromium bearing steel (JIS:SUJ2)
Nickel chromium molybdenum steel (JIS:SNCM439)

In addition, fracture surface of each specimen was observed by SEM and discussions were made from a viewpoint of fractography. Furthermore, in order to clarify the effect of strength level on fatigue property, *S*-*N* properties of the above high strength steels and carbon steel for machine structural use (JIS: S35C) with low strength were compared with one another.

It was found that the significant *S*-*N* property for high strength steels is well explained as "Duplex *S*-*N* property" given by superposition of *S*-*N* curves for surface induced fracture and interior inclusion induced fracture. However, the *S*-*N* property of S35C steel with low strength has no longer such an aspect, and it is given as " a simple *S*-*N* property" only for the surface induced fracture. Thus the latter fracture mode is predominant for high strength steels. Another finding in this mode is a fact that a clear fish-eye inscribed in the specimen surface is usually observed and an inclusion is found at the center of the fish-eye. It was finally clarified that the fine granular area (FGA) is formed in the vicinity around the inclusion and the nucleation process of this area plays an important role to determine the fatigue life of the material.