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INFLUENCE OF RESIDUAL STRESS ON SUPER-LONG LIFE FATIGUE PROPERTIES OF HIGH STRENGTH STEEL SNCM439

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ABSTRACT

In recent years, we have been hopeful that life extension engineering will be established to enable the use of machines and structures beyond their design life. Therefore, it is necessary to investigate the fatigue properties of structural components in the super-long life range ($N \geq 1 \times 10^7$). In the case of high strength steels and surface hardened steels with improved strength properties, it has been reported that the *S-N* curve has a tendency to decrease again in the super-long life range ($N \geq 1 \times 10^7$). However, the fatigue fracture mechanism has not yet been clarified.

In the present paper, in order to investigate the fatigue properties of high strength steels and surface hardened steels in the super-long life range ($N \geq 1 \times 10^7$), cantilever type rotating bending fatigue tests were carried out for the SNCM439 high strength steel. For the fatigue tests, the grinding specimen that the notch surface was finished by grinding with a #100 grindstone and the electro-polishing specimen that the notch surface of grinding specimen was removed up to 30μm deep by electro-polishing were prepared. We investigated the fatigue properties and the fracture crack origins. In addition, the residual stresses of surface and inside of specimen were measured using an X-ray diffractometer.

On the notch bottom surface of specimen, the residual stresses in the axial direction and the circumferential direction were -571MPa and -433MPa respectively. It was seen that the compressive residual stress in the axial direction and the circumferential direction on the notch bottom surface rapidly decreased in the section to the about 8μm from the surface and that it approached about -100MPa in the depth over 8μm.

The *S-N* curve clearly has a tendency to decrease again in the super-long life range ($N \geq 1 \times 10^7$) for two kinds of specimen, as previously reported by many researchers. When the results of fatigue test by the grinding specimens are compared with that by the electro-polishing specimens, it is found that the eletctro-polishing specimens are almost equal to the grinding specimen in the fatigue life.

From the results of the observations using a SEM, it was found that the fracture crack origins could be grouped into two classes, the ‘surface crack origin type’ which means that the fracture crack initiate at the grinding flaw on the specimen surface or the pit where the inclusion came off and the ‘internal crack origin type’ which means that the fracture crack initiate at the non-metallic inclusion inside the specimen and that a fish-eye area is found on the fracture surface.