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Fatigue failure analysis of a 60T pusled magnet at the WHMFC

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Fatigue failure had recently occurred on a 60T pulsed magnet at the Wuhan National High Magnetic Field Center (WHMFC). It was designed to produce a peak field of about 63T and had practically endured a total number of 2124 shots with 573 of them above 56T. In this paper, the cause of failure is numerically analyzed using the conductors and reinforcing fibers at the mid-plane of the magnet. The damage-coupled constitutive model of conductor is applied with two failure criteria so that the mechanical behavior and fatigue life of the magnet during multiple pulses can be predicted. The analysis is divided into three steps where special attention is paid to the effects of bending pre-strain and axial pressure on conductors. The first step is about the stress distribution during the first pulse. It is found that the maximum stress of reinforcing fibers can be increased by about 600 MPa at 63T considering the axial pressure and pre-strain. The second step is failure analysis at certain level of magnetic field. It is found that the fatigue life of the magnet between 56 ~ 63T drops rapidly from about 1000 pulses to less than 100 pulses as the field increases. In this region, the main cause of failure is the axial strain of conductor reaching its critical value. The third step is failure analysis according to the practical sequence of pulses. It is found that the 573 pulses above 56T decides the failure of magnet where the axial strain keeps increasing until the critical value is reached.

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