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Effect of Specimen Shape on Eddy Current Distribution in Large Single Sheet Tester

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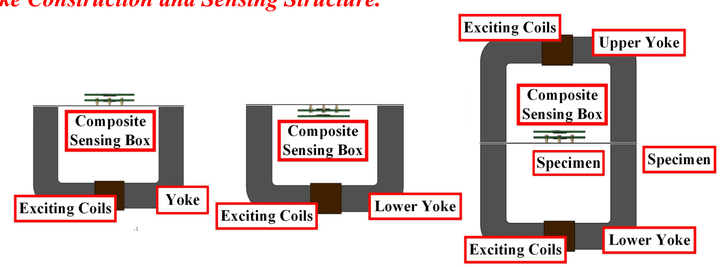
Introduction

Large single sheet tester (LSST) is a common method to investigate the magnetic properties of the silicon steels, whereas the loss measurement accuracy of LSST method is vulnerable to eddy current disturbance. To eliminate the intrinsic additional eddy current losses of LSST method, the specimen shape and flux path is analyzed and optimized. The influence of specimen shape on eddy current distribution is systematically evaluated by numerical analysis with different specimen under different frequency.

Design of Magnetic Properties Measurement System

◇*Yoke Construction and Sensing Structure.*



(a) “So-type” (b) “Ss-type” (c) Symmetrical “D-type”.

Fig. 1. Three LSST constructions. Compared with single yoke construction, the double yoke construction can achieve better accuracy.

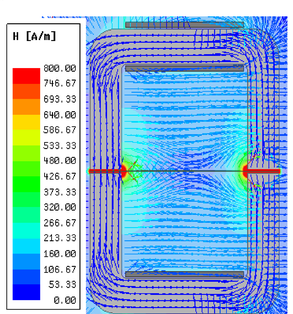


Fig. 2. Distribution of ***H*** vector.

Complicated ***H*** Distribution.

Using Double H Coils.

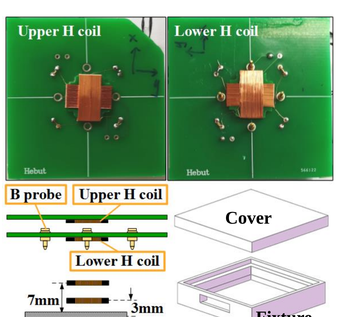


Fig. 3. Composite sensing coils

Numerical Analysis

◇*Effect of Specimen Length.*

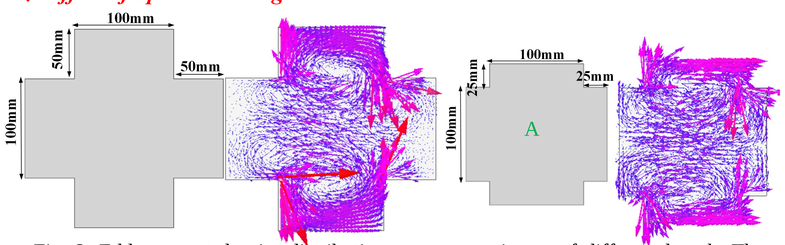


Fig. 3. Eddy current density distribution on two specimens of different length. The overhang length of specimen is zero.

◇*Effect of Specimen Shape on Eddy Current Distribution.*

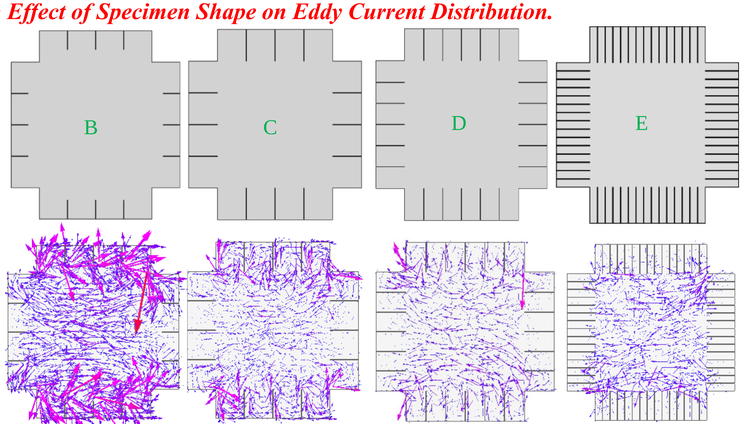


Fig. 4. Various ross-shape specimens and eddy current density distribution on the surface of the specimen in the case of “So-type” yoke.

In specimen B, as shown in Fig. 4, the eddy current density(***J***) is decrease compared with specimen A. Although the eddy current loops are still exist in specimen C, D and E, ***J*** is negligibly small in the specimen C, D and E and they can only closed in small range at low frequency. It can be concluded that slotting on the specimen obviously eliminate the adverse effect of the eddy effect in the specimen.

Experimental examination

◇*Effect of Specimen Length.*

Fig. 6 and Fig. 7 show the hysteresis loops of specimen A, B, C, D along RD at 0.1T and 0.7T when ***B*** is controlled to be sinusoidal alternating waveform at 50Hz and 200Hz. At 50Hz, there is slight difference in hysteresis ugh to eliminate additional eddy current losses at 50Hz. loops of specimen C, D and E, which means three slots in each arms is enough to eliminate additional eddy current losses at 50Hz.

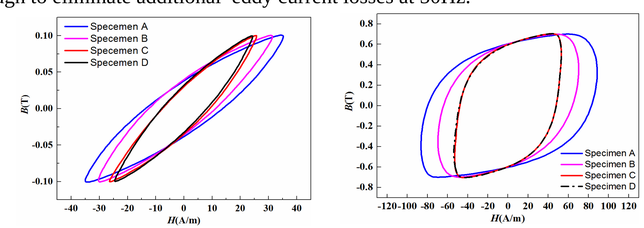


Fig. 6. B-H hysteresis loops along RD at 50Hz.

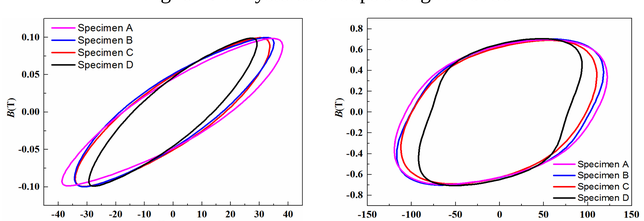


Fig. 7. B-H hysteresis loops along RDat 200Hz.

Conclusion

- Loss characteristic measurements have demonstrated that the loss measurement accuracy of the LSST is improved with the increase of the slot length and the slot number.
- The content of harmonics is also reduced and the *B* loci are much easier to be controlled as a sine wave when the adverse effect of eddy current is eliminated. “So-type” and “Ss-type” yoke measurement is more difficult to control than “D-type” yoke measurement.
- For each specific frequency, there are different minimum slots to eliminate additional eddy current losses.