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Improved Characteristic of IPMSM for High Speed Drive Using High Tensile Strength Steel

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Recently, many studies have focused on motors capable of high output and high speed drive. Due to rotor saliency, an Interior Permanent Magnet Synchronous Motor (IPMSM) is suitable for an application requiring a high power density and a wide speed range. However, excessive mechanical stress is applied to the rotor while IPMSM is working at a high speed operation. It is because that the large centrifugal force is generated at the high speed and it can cause the mechanical stress.

To release the mechanical stress, bridges between permanent magnets (PMs) have been used for the rotor design. Although the bridge makes the mechanical safety improved, it can reduce the torque performance of IPMSM as the additional paths for flux leakage are made. When the thickness of the bridge is reduced, the magnetic reluctance of the bridges increases, and thus it makes the amount of flux leakage decreases and improves torque performance. However, the torque performance is restricted by the mechanical stress increased while the bridge thickness reduces.

In this paper, a high tensile strength steel is used to secure mechanical strength of an IPMSM. Due to its high yield strength, the steel used in the IPMSM can avoid a permanent deformation.

The rotor geometry of analysis model is presented in Fig. 1. The magnetic properties of conventional steel and a high tensile strength steel in Fig. 2. When the configuration of motor is constant, structural analysis according to the steel materials are compared in Fig. 3. As a result, the high tensile strength steel improves the mechanical performance while the electro-magnetic performance of IPMSM is remained.

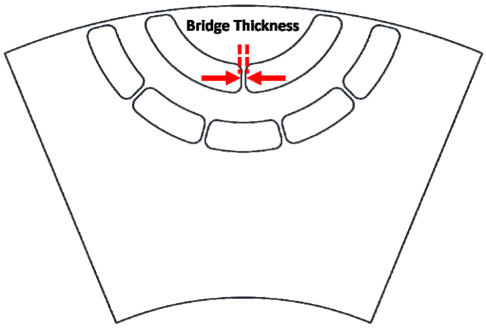


Fig. 1. Configuration of the initial model

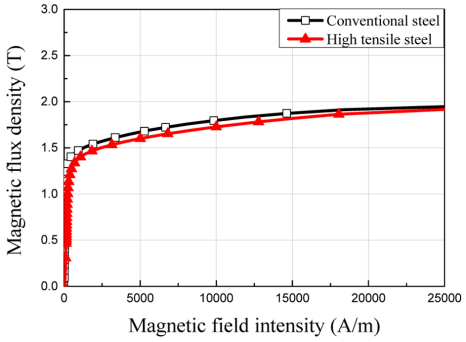
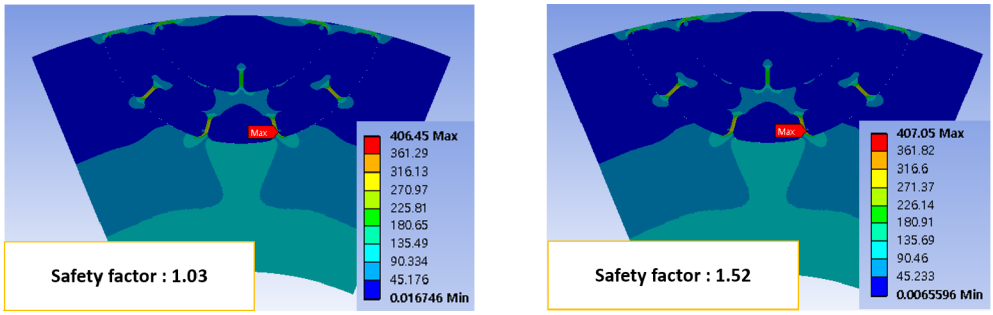


Fig. 2. Magnetic properties of steels



(a) (b)

Fig. 3. Structural analysis (a) conventional steel (b) high tensile strength steel steel