§12. Study of the Current Distribution in the Joint of the Prototype NbTi Cable-in-conduit Conductor for JT-60 EF Coil

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Superconducting fusion magnets have many joint regions that have a great influence on the performance of the magnets. Various joint types for the magnets were developed before now to reduce AC loss and electrical resistance. However, electrical phenomena in the joint region are not understood very well. In this study, magnetic field measurements on a shake-hands lap joint were conducted for the purpose of understanding the current distribution in the joint region. A shake-hands lap joint sample of cable-in-conduit conductors for JT-60SA EF coil was utilized. Fig. 1 shows the picture of the joint sample. Each conductor consists of NbTi strands and is equipped with a central spiral channel. The cross section of the joint sample is illustrated in Fig. 2. In the joint region, a saddle spacer of oxygen-free copper is located between the conductors removing Ni plating. Hall proves are lined up in the center of the joint region parallel to the conductors. By using the hall proves, vertical magnetic fields to the joint region were measured[1].

In order to investigate current distribution in the joint region, magnetic field calculation was conducted using a calculation model in which line currents were used. In the calculation, three dimensional magnetic fields were obtained with the Biot-Savart law. Fig. 3 shows the schematic view of the calculation model assuming the current distribution of the joint sample. The model had a ladder configuration in the joint region where the value of each line current was equal.

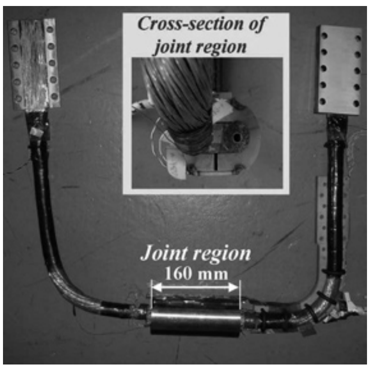

Fig. 1. Photograph of the joint sample for JT-60SA EF coil.

Fig. 4 shows the calculation result of the vertical magnetic field By in the joint region without an external magnetic field. The z-coordinate position of the magnetic field By corresponds with that of the hall probes used in the experiment. As shown in Fig. 4, the calculation result is in agreement with the experimental result. Consequently, the current distribution in the joint region is uniform in the case that the joint region is not subjected to the external magnetic field.

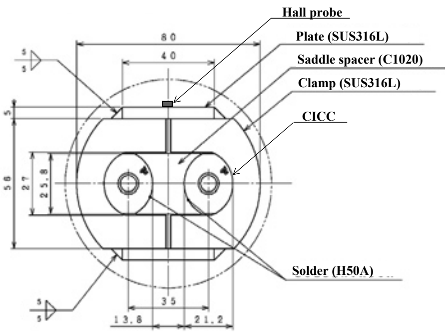

Fig. 2. Layout of the hall probes in the joint region.

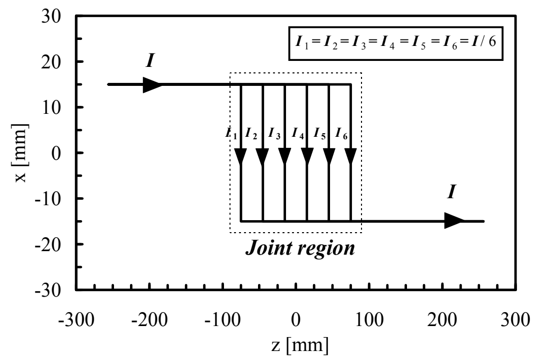

Fig. 3. Schematic view of the line current model.

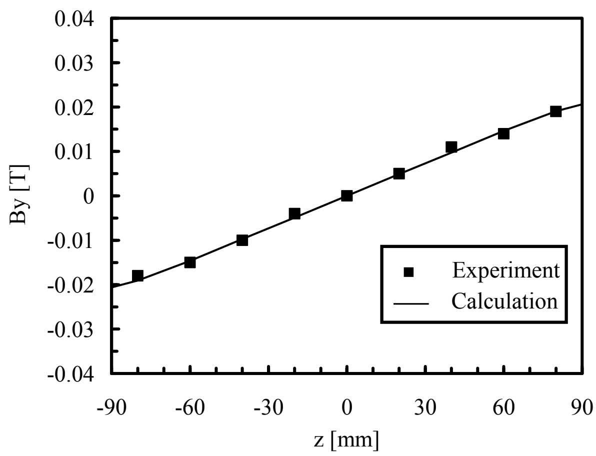

Fig. 4. Calculation and experiment results of the vertical magnetic field in the joint region when the sample current is 10 kA.

1) Obana, T., et al.: IEEE Trans. Appl. Supercond., 2010, to be published.