## §9. Study on Analysis of Joints between Cable-in-Conduit Conductors

Hamajima, T., Tsuda, M., Miyagi, D., Nakazawa, S., Arai, D. (Tohoku Univ.),
Takahata, K., Obana, T.

A large superconducting Cable-in-Conduit (CIC) conductor for fusion coils and SMES is assembled with several order sub-cable stages from three strands (triplets), for supplying a large current. However, it is observed from experimental results that the critical current or critical temperature can be deteriorated. It is partly explained that the current distribution in the CIC at coil joints is usually inhomogeneous. Therefore, it is important to analyze the current distribution in the CIC at the joint.

It is assumed in this analysis that the concept of the joint between two coils for ITER is described as Fig. 1, in such a way that two conductors are contacted through copper sleeves. The contact length between the conductors is final cable pitch. We investigate how many strands come out on the cable surface and how long they contact with the copper sleeve.

First, we measured the three dimensional trajectories of all strands in the CIC conductor, and show histogram of the strand number and their contact lengths with the sleeve in Fig. 2 and Table 1. It is found that the strand number of non-contact with the sleeve is 90, and their averaged contact length is 31.3 mm, and their standard deviation is about 23 mm[1].

We analyze the all strand trajectories by using equal area method that reflects twist pitches of all sub-cables and equal strand area, and show histogram of the contact parameters in Fig. 2 and also list them in Table 1. It is found from the analyzed results that the non-contact strand number, average contact length, the longest contact length and standard deviation are almost the same as those of the measured results. It is demonstrated that the equal area method is effective for analyzing the contact parameters such as contact lengths and standard deviation[1].

We can estimate the contact parameters by changing the twist pitches of all sub-cable stages. We research the condition that all strands come out on the surface of the cable and contact with the copper sleeve by using the equal area method. The results are shown in Fig. 3 and listed in Table 1 with those calculated from the measured trajectories. It is found that all strands come out on the surface and contact with the sleeve, and the standard deviation becomes a half of that of the measured trajectories[1].

We investigated contact behaviors of all strands by using two strand trajectories estimated from the three dimensional measurement and the equal area analysis, respectively. It is found that the contact parameters calculated from the analysis are in good agreement with those from the measurement. We can obtain the optimal contact parameters such that all strands contact with the copper sleeve in a way of small standard deviation.

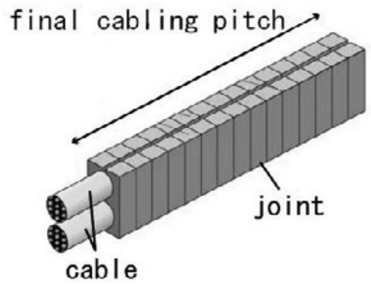


Fig. 1 Concept of Joint between coils.

Table 1 Comparison of measured, analyzed and optimized contact parameter results.

| Derived method | measured | analysis | optimization |
|---|---|---|---|
| Noncontact strands number | 90 | 88 | 0 |
| Average contact length | 31.3 mm | 32.2 mm | 32.1 mm |
| Longest contact length | 102 mm | 109 mm | 75 mm |
| Standard deviation | 23.4 | 24.8 | 11.5 |

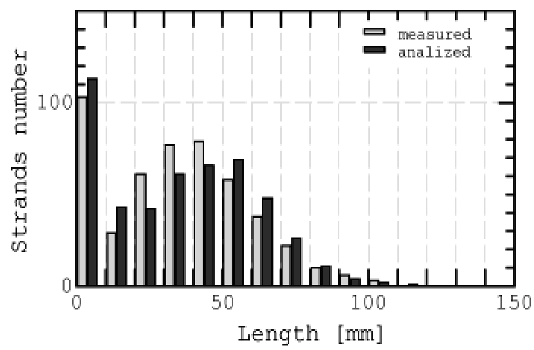


Fig. 2 Histograms of measured and analyzed contact lengths.

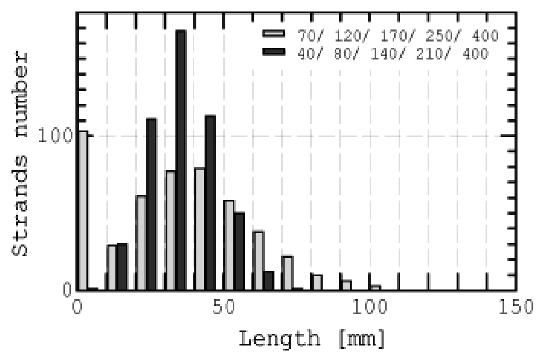


Fig. 3 Comparison of measured and optimized contact lengths.

1) Nakazawa, S., Teshima, S., Arai, D., Miyagi, D., Tsuda, M., Hamajima, T., Yagai, T., Nunoya, Y., Koizumi, N., Takahata, K., Obana, T., TEION KOGAKU (J. Cryo. Super. Soc. Jpn.) Vol. 46 No.8 (2011) pp.474-480