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ITER TFコイルのIn-boardコイル容器とOut-boardコイル容器の突合せ溶接 Study on Butt Welding of In-Board and Out-Board Coil Cases for ITER TF Coil

西村 新
Arata Nishimura

核融合研
NIFS

Introduction

The first assembly of the TF coil case was performed in 2017 as shown in Fig. 1. The in-board and out-board cases will be welded at the top and the bottom of the coil after insertion of the winding pack (WP). Then, the cover plates will be welded on the both of in-board case and out-board case. In this study, the welding joint will be discussed to reduce the ununiform welding deformation.

Conceptual Welding Joint Design

Since the WP is existing inside, the welding and non-destructive examination must be done from outside of the coil. The global configuration of the top weld joint is U-shape and the bottom part is two-plates shape. The bottom view of the coil case is shown in Fig. 2. A big rectangular shape space is designed for superconductor joints and He cooling channels. To reduce the shrinkage and the angular distortion, the joints were designed conceptually. The configuration of the bottom weld joint is shown in Fig. 3. To achieve the uniform deformation, the symmetrical welding process was assumed on both joints, and to reduce the shrinkage, the partial welding was recommended. Splice plates must be added to keep enough cross-section. The RT might be applicable with a gap between coil case and WP.

Summary

- (1) The shrinkage in the major radial direction deforms WP and degrades the I_C of the conductor.
- (2) The angular distortion will make it difficult to connect the neighboring coils with keys.
- (3) Both deformations will shift the current center of all coils and produce the different magnetic field.

The splice plate is needed to reduce the shear stress on the cross-section of the butt joint. The welding groove will have metal-touched area to reduce the shrinkage around the joint. The welding process with symmetricity must be performed to reduce the angular distortion. Non-destructive examination (UT or RT) looks not easy but it must be done to certify the soundness of the weld joint.



Fig. 1 The first assembly of TF coil case. The joints of in-board and out-board coil cases locate at the top and the bottom of the coil structure.

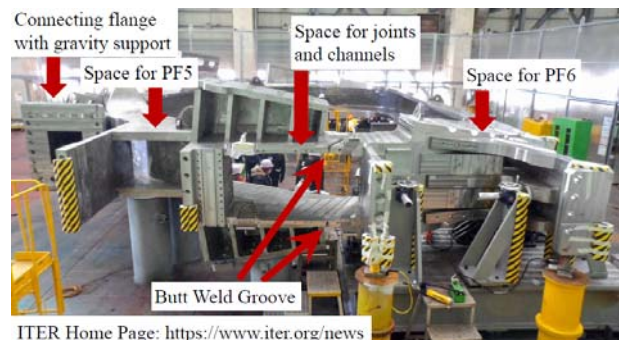


Fig. 2 Bottom view of assembled coil case. Butt joints are seen at upper and lower plates of the space for superconductor joints and cooling channels of WP.

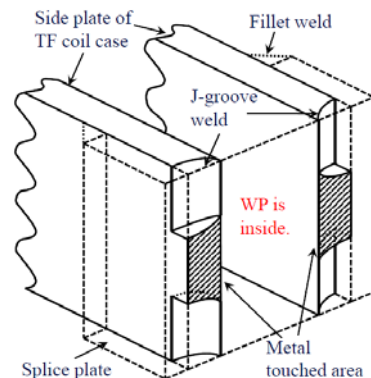


Fig. 3 Image of butt joint for the bottom of TF coil case. Partial welding and splice plates are considered to reduce shrinkage and ununiform residual deformation.