Status of Conceptual Design Progress for ITER Sector Sub-assembly Tools

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1. Introduction

The ITER (International Thermonuclear Experimental Reactor) Tokamak assembly tools are purpose-built tools to complete the ITER Tokamak machine which includes the cryostat and the components contained therein. Based on the design description document prepared by the ITER organization [1,2], Korea has carried out the conceptual design of assembly tools [3,4]. The 40° sector assemblies sub-assembled at assembly hall are transferred to Tokamak hall using the lifting tool operated by Tokamak main cranes. In-pit assembly tools are the purpose-built assembly tools for the completion of final sector assembly at Tokamak hall. The 40° sector sub-assembly tools are composed of the upending tool,

the sector sub-assembly tool, the sector lifting tool and the vacuum vessel support and bracing tools. The process of the ITER sector sub-assembly at assembly hall and status of research and development are described in this paper.

The ITER Tokamak device is composed of 9 vacuum vessel (VV)/toroidal field coils (TFCs)/vacuum vessel thermal shields (VVTS) 40° sectors. Each VV/TFCs/VVTS 40° sector is made up of one 40° VV, two 20° TFCs and associated VVTS segments. The 40° sectors are sub-assembled at assembly hall respectively and then 9 sectors which sub-assembled at assembly hall are finally assembled at Tokamak hall. As a basic assembly component, the assembly strategy and tools for the 40° sector sub-assembly and final assembly at in-pit should be developed to satisfy the basic assembly requirements of the ITER Tokamak device. Accordingly, the purpose-built assembly tools should be designed and manufactured considering assembly plan, available space, safety, easy operation, efficient maintenance, and so on. The 40° sector assembly tools are classified into 2 groups. One group is the sub-assembly tools including upending tool, lifting tool, sub-assembly tool, VV supports and bracing tools used at assembly hall and the other group is the in-pit assembly tools that include lifting tools, radial beams, central column and supports.

2. Design Progress

The function of the upending tool is to raise 40° VV sectors, toroidal field coil and Vacuum Vessel Thermal Shield sectors from a horizontal position and deliver them to the assembly hall in the vertical position, which is required for subsequent sector sub-assembly operations. The basic structure of the upending tool has been developed with the assumption that lifting will be performed with a crane which will be installed in the Tokamak building. The upending tool is mainly composed of a rotating frame, mechanical locking devices and crane lugs. The Tokamak building crane which has four synchronized 375 ton hoists performs the lifting of sector components. The upending tool is composed of main frame, components interfaces man-access interfaces and mechanical locking. Size of this tool is 15.9 m(L) x 13.8 m(W) x 6.9 m(H) and weight is about 120 ton.

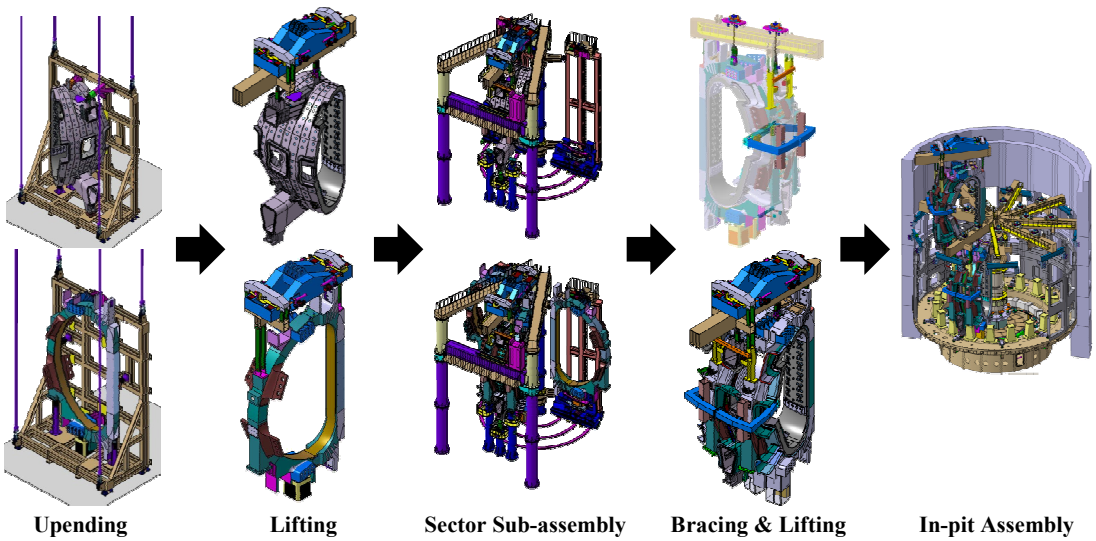

Fig. 1. Overall configuration of the sector sub-assembly and in-pit tools

The sector lifting tool, as shown Fig. 2, transfers the completely assembled 40° sector from the sector sub-assembly tool to the cryostat base which is installed in the Tokamak pit. The sector lifting tool is designed to adjust the position of a sector to minimize the difference between the centre of the Tokamak building crane and the centre of gravity of the sector. The sector lifting tool has been designed to be compatible with the Tokamak building crane so that it is able to accommodate the dead weight of the sector (about 1,200 tons) and install the sectors in a particular direction within the Tokamak pit. Size of this tool is 8.5 m(L) x 4.0 m(W) x 2.7 m(H) and weight is about 62 ton.

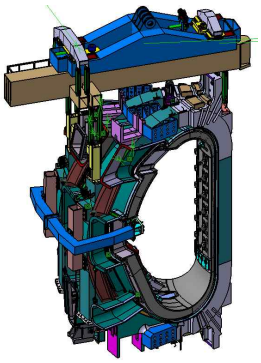

Fig. 2. Sector lifting Tool

The sector sub-assembly tool integrates the VV sector, the VVTS, the VVTS port shrouds and TFCs into the 40° sector. This tool is composed of main structure (1 inboard column and 2 outboard columns), two rotating frames, lower components supports and aligning unit. The inboard column, which is parallel to the ITER machine centre, provides the reference for aligning the components. The upper/lower aligning units of rotating frame perform the required fine position control with 6 degrees of freedom. Size of this tool is 14.5 m(L) x 18.0 m(W) x 22.0 m(H) and weight is about 700 ton.

The function of the VV support and brace tool is to support the weight of a 40° VV sector while maintaining a gap between TFCs and the sector and preventing harm from dynamic loads during handling. The tool is comprised of the following sub-systems: the vertical support assembly, the mid-plane brace assembly and the diverter level stabilizer. The mid-plane braces, as shown Fig. 3, are large horizontal C-shaped frames which have four different shapes to be compatible with the four kinds of different shapes for the equatorial ports. Size of this tool is 7.1 m(L) x 4.8 m(W) (bracing tool) and weight is about 27 ton (A-type bracing tool).

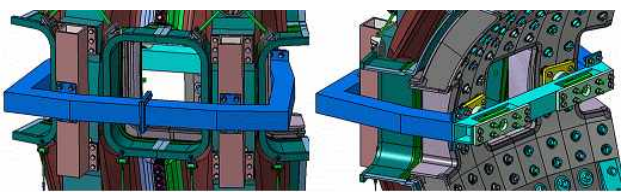

Fig. 3. Mid-plane brace tool (Type A)

The structural stabilities of ITER sector sub-assembly tools have been studied using ANSYS with an applied load that is 4/3 times the dead weight and the results of structural analyses for these tools are well within allowable limits.

3. Conclusions

The conceptual designs of the sector sub-assembly tools including upending tool, sector sub-assembly tool and lifting tool have been developed. The design of the sector sub-assembly tools developed by KO DA satisfied ITER assembly plan and technical requirements. It was verified that the structural stabilities maintain sufficiently to secure assembly tolerance and geometrical requirements requested by IO. Work continues to develop the detail design of the ITER Assembly Tools by Dec. 2011.

REFERENCES

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