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P2.142 Structural assessment based on welding distortion simulation of Vacuum Vessel PS1 Jig for in-process control

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The ITER vacuum vessel (VV) is a torus-shaped, double-wall structure with shielding and cooling water between the shells. Low distortion welding techniques are chosen in order to manufacture the 4 poloidal segments (PS) composing each sector, weld them together and then assemble on site the nine toroidal sectors to form the complete torus.
Control of the distortions during the welding process is the main technological challenges since very stringent tolerances must be fulfilled at the end of the process. Finite element analysis (FEA) tools have been developed in order to predict the mechanical behaviour of the assembly (component to be welded + supporting structure) during welding. These tools allowed on one side to optimize the welding process and on the other side to design ad-hoc supporting structure (Jigs) needed to control the distortion caused by welding and to react to the huge forces generated during the process.
The jigs are the key components during the manufacturing since their failure could jeopardize the whole process.
In this paper a novel approach is proposed to design and assess the mechanical behaviour of the Jigs and to mitigate the risk related to their failure by implementing in-process control strategies based on the coupling between finite element analysis and metrology surveys/direct measurements.
This approach has been applied on the ITER VV PS1 Jig. Experimental test have been carried out in order to validate the FE model feeding the computational tool by metrology measurements. Finally an optimize configuration of direct measurements devices (instrumented washers, strain gauges, displacement sensors) has been proposed in order to live control the behaviour of the Jig during the manufacturing process by directly computing via FEA (feeding the analysis with the measurements) all the relevant mechanical variables needed to assess the structural integrity of the supporting structure.

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