§5. Study on Standardization of Fusion Reactor System Based on an Integrated Design Code

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A platform for an integrated design code has been developed in which the detailed analysis codes for many components of a nuclear fusion reactor are compiled and incorporated into the system analysis code[1]. This platform is based on system code FUSAC[2,3]. FUSAC which includes plasma physics, reactor engineering, and cost estimation, quickly yields a rough one-dimensional (1-D) radial build for a fusion reactor.

In this research, we introduced the two-dimensional (2-D) plasma equilibrium code TOSCA [4] into the platform to analyze the optimization of the poloidal field (PF) coil positions. In addition, this 2-D magnetohydrodynamic (MHD) equilibrium analysis code makes it possible to evaluate the margin for the vertical stability of elongated plasmas because the effect of eddy currents due to passive conductors can also be calculated in this code. This new integrated design code takes the 1-D radial-build parameters from the platform to the plasma equilibrium module automatically and optimizes the position of the PF coil in one run. Individual researchers can choose the evaluation function used to determine the optimized position.

Next, to evaluate vertical instability, we use decay index n[5] and shell stabilizing index n_s[6,7]. When $n + n_s > 0$, the plasma is stable. Here we consider a simple model of a passive conductor wall. We place passive conductors in the upper and lower regions of the plasma column, as shown in Fig. 1. Figure 2 shows the calculated n and n_s values as a function of the plasma elongation for various positions of the passive conductors. The relationship between the value of n_s and the growth time of the instability is shown in Fig. 3. In this research, we demonstrated a guideline for integrated design code. Researchers can change the position or size of the passive conductor walls and perform a more detailed analysis with this code.

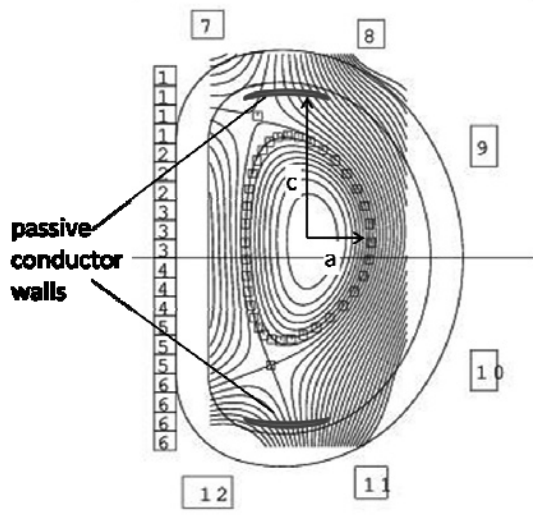

Fig. 1 Plasma equilibrium and passive conductor.

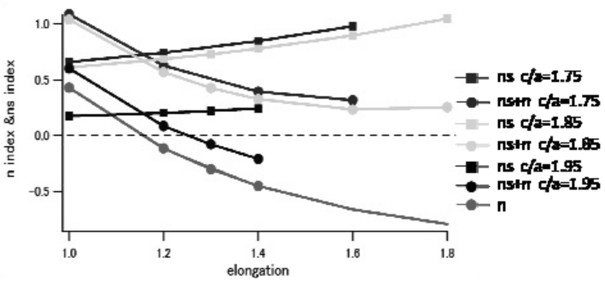

Fig.2 decay indices n and n_s for the vertical stability.

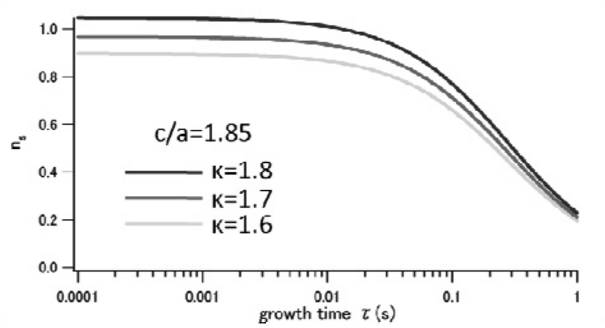

Fig.3 Growth rate of the vertical stability.

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