Modelling of wall currents excited by plasma wall-touching kink and vertical modes during a tokamak disruption, with application to ITER

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To understand plasma disruptions in tokamaks and predict their effects, realistic simulations of electric current excitation in three-dimensional vessel structures by the plasma touching the walls are required. The Wall-Touching Kink Modes are frequently excited during vertical displacement events and cause large sideways forces on the vacuum vessel which are difficult to withstand in large tokamaks like ITER [1]. The amplitude and localization of the sideways force are determined by the sharing of electric current between the plasma and the wall.

The present paper describes a wall model that covers both eddy currents, excited inductively, and source/sink currents due to current sharing between the plasma and the thin conducting wall of arbitrary three-dimensional geometry [2,3]. The developed ssec code (standing for “source/sink and eddy current” code) calculates the electromagnetic wall response to perturbation of magnetic fields and to current sharing between the plasma and the wall. The code accepts the vector $j_{\text{perp}}$ of values of current density entering/exiting the wall surface from the plasma at each vertex and the time derivative of the magnetic vector potential $\partial A_{\text{pl}}/\partial t$ at each vertex. The third input vector is the set of space points in which ssec returns the magnetic field $B_{\text{wall}}$ and its vector potential $A_{\text{wall}}$ from the wall currents. The numerical results have been checked against analytical examples [2,4] and for a high-resolution mesh (16384 triangles on the wall surface) a relative accuracy of 0.001 has been found. Figure 1 presents the results of calculation of eddy and source/sink currents in the tokamak wall.

Using this approach, JOREK-STARWALL [5,6] presently limited to eddy currents, will be extended to self-consistent non-linear MHD simulations including eddy and source/sink currents.

**References**