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P1.1096 Sideways forces on the wall during early disruption phase in tokamak

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The sideways forces acting on the conducting wall due to the n=1 kink instability are investigated. During the early phase of the disruption the plasma is considered to be isolated from the wall and halo currents do not appear. The plasma with minor radius of 1 m and almost circular shape with a large current (> 5 MA) and the safety factor of q ~ 1 close enough to the top of the ITER vacuum chamber is considered, so that the ideal n=1 kink mode is wall stabilized [1], but instead the resistive wall mode (RWM) develops. RWM growth rates, plasma displacement structure and the n=1 surface currents induced in the wall are calculated with the KINX stability code [2]. Sideways forces acting on the wall are determined as the Ampere force from the perturbed surface currents and the equilibrium magnetic field.
In [1] sideways forces produced by the equilibrium toroidal field and RWM induced currents in the wall were found to reach maximum in the ideal wall limit gamma tao w tends to infinity. The seeming disagreement with zero sideways force in the ideal wall limit for the considered inertia-less plasma model [3] is resolved by taking into account the force on the conductors inside the wall (the only possibility to make the equilibrium poloidal field at the wall vanish) balancing the force on the wall instead of the balance from the equilibrium poloidal field in case with external currents outside the wall.
The magnitudes of the sideways force for ITER early disruption plasmas are computed for several cases of free-boundary equilibria obtained with the SPIDER code [4] under plasma current variation. For inertia-less plasma the total force on the wall reaches its maximum for low values of RWM growth rate gamma tao w : 1 and vanishes in the ideal wall limit in accordance with [3]. This asymptotic behavior is attained for any inertia-less RWM perturbation once the consistent equilibrium field is used. The right balance of the toroidal and poloidal equilibrium field induced forces leads to lower magnitudes of sideways forces as compared to [1]. For m=1 dominated RWM characteristic for q<1 the sideways force is close to the estimates [3], but several times lower for the ITER-like cases with q>1 and toroidally coupled m=1 mode generating the force. All the considered models strongly suggest that possibilities of larger sideways force should be connected with plasma-wall interaction at the next stages of disruptions or with realistic 3D wall models.

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