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Preliminary structural assessment of the HELIAS 5-B breeding blanket

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The European Roadmap to the realisation of fusion energy, carried out by the EUROfusion consortium, considers the stellarator concept as a possible long-term alternative to a tokamak fusion power plant. To this purpose a pivotal issue is the design of a helical-axis advanced stellarator (HELIAS) machine equipped with a tritium breeding blanket (BB), considering the achievements and the design experience acquired in the pre-conceptual design phase of the tokamak DEMO BB. Therefore, within the framework of EUROfusion WPS2 R&D activity, a research campaign, aimed at the investigation of the structural behaviour of the HELIAS 5-B BB, has been launched at KIT in cooperation with University of Palermo. The scope of the research has been the determination of a preliminary BB segmentation scheme able to ensure, under the assumed loading conditions, that no overlapping may occur among the blanket regions. To this purpose, the Helium-Cooled Pebble Bed (HCPB) and the Water-Cooled Lithium Lead (WCLL) BB concepts, presently considered for the DEMO tokamak fusion reactor, have been taken into account.
A 3D CAD model of a HELIAS 5-B torus sector has been adopted, focussing attention on its far end regions, namely the triangular and bean shape regions. Due to the early stage of the HELIAS 5-B BB R&D activities, the considered CAD model includes homogenized blanket modules without internal details. Hence, in order to simulate the features of the HCPB and WCLL BB concepts, equivalent material properties have been purposely calculated and assumed. Moreover, proper nominal steady state loading scenarios, based on the DEMO HCPB and WCLL thermomechanical analyses, have been taken into account.
A theoretical-numerical approach, based on the Finite Element Method (FEM), has been followed and the qualified ANSYS v. 18.0 commercial FEM code has been adopted. The obtained results are herewith presented and critically discussed.

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