ON THE MECHANICAL ANISOTROPY IN SUPERCONDUCTING TOROIDAL COIL WINDINGS

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Among other activities, the European program for the development for superconducting magnets for fusion consists of the experiment TESPE[1] and the participation in the Large Coil Program[2]. In connection with TESPE the influence of the anisotropy of the coil winding on the results of the stress analysis is investigated. There are different approaches to this problem for normalconducting magnets [3,4,5]. These solutions are not directly applicable to superconducting magnets because of the greater complexity of the superconducting winding.

In a previous paper[6] a general approach is proposed for the evaluation of the correct anisotropic materials data for a FEM calculation. Detailed information of local stresses and displacements in the coil-winding is of special interest for the coil design.

One element of the idealized coil-winding can be treated as an orthotropic material if the helicality of the cabled strands is neglected. For the characterization of this material, nine independent constants are required. These constants are the direction-dependent Young's moduli, Poisson ratios and shear moduli. They can be obtained by application of the simple rule of mixture from the corresponding data of the differenct materials contained in the element. But this method gives only one-dimensional linear results which are not suffucient. In order to obtain three-dimensional results, a combination of FEM-calculation and measurement in a tensile testing machine is used. One conductor package is modelled into finite elements with very high resolution on the computer. Stress and shear loads are applied to this package in the same manner as it can be done in reality with the testing machine. A comparison between calculation and measurement ensures the quality of the FE-model. Now the conductor package is interpreted as a single new element to which the same load is applied. By fitting the material data of this new element to the measured and calculated overall displacements, the averaged data characterizing the element are found. These data are used for the calculation of the coil displacements.

References

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