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IMPLEMENTATION OF A DEFORMATION MODEL FOR PRESSURE TUBES UNDER IRRADIATION

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Abstract. Current semi-empiric deformation models for in-reactor deformation of Zr2.5Nb CANDU pressure tubes are based on the physical model of *Christodoulou et al. (Proc. 11th Int. Symp. Zirc. Nucl. Ind., ASTM STP 1295 (1996), p. 518)* and consider material texture effects via the code 'SELFPOLY' introduced by *Tomé et al. (Philos. Mag. A67 (1993), p. 917)* and *Turner et al. (Philos. Mag. A 79 (1999), p. 2505)*. This code makes use of a 'tangent' self-consistent approach proposed by *Molinari et al. (Acta Metall. 35 (1987), p. 2983)* to obtain the overall response of a viscoplastic polycrystalline system in terms of the local response of the single crystals and their microstructural morphology. More recently, *Liu and Ponte Castañeda (J. Mech. Phys. Solids 52 (2004), p. 467)* derived a 'generalized-secant' self-consistent approach which has been found to improve substantially on the earlier 'tangent' approach in some cases. In this work we study the influence of the linearization procedure on the predictions for the deformation of pressure tubes. The calculations are carried out by means of the VPSC code of *Lebensohn et al. (14th International Conference on Textures of Materials 495-497 (2005), p. 955).* It is found that the predictions based on the 'tangent' and 'generalized-secant' approaches are quite similar, and hence the use of a 'generalized-secant' approach is not recommended for this particular problem in view of its higher computational cost. Moreover, analyzing the current in-reactor deformation model reviewed by *Holt (J. Nucl. Mat. 372 (2008), p. 182)*, a restriction in the stress state was found. The stress tensor components are projected to the material axes that are not guaranteed to be principal, for that reason the constitutive laws are not valid for a general stress state neglecting in particular the gravity forces. Based on the same constitutive law structure, a modification is proposed that accounts for a general stress state via coupling VPSC-FEM codes.