8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering
(ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

Multi-scale modelling integration platform: computation of the irradiation damage on nuclear materials

Stéphane Bugat[1], Joumana El Gharib[2*], Jean-Michel Proix[2], Asmahana Zeghadi[1*]

[1] EDF *R&D*, MMC
Avenue des Renardieres
77818 Moret-sur-Loing
asmahana.zeghadi@edf.fr

[2] EDF *R&D*, AMA
1 Avenue du Gal de Gaulle
92141 Clamart
joumana.el-gharib@edf.fr

Key Words: *multi-scale modelling, irradiation effect, fracture probability, numerical platform, modules chaining.*

In the framework of the European PERFECT project [1], a numerical platform has been developed in order to estimate the toughness drop and the probability of failure due to the effect of irradiation on RPV steel. Multi-scale approaches which represent the 'state of the art' and which are devoted to simulate the physical effects observed experimentaly on the irradiated material are integrated in the platform (see Figure 1).
The numerical platform is developped in Python langage [2]. It is composed of several modules which can be chained (see Figure 2). The user can choose between more or less advanced method to provide one specific output data.
Two main modules has been already developped in the integration platform : the RPV2 module and the ToughnessModule module. The RPV2 module allows to estimate the irradiated microstructure and the microstructural hardenning from metallurgical informations about steel (carbides size distribution ...) and irradiation data.It is directly chained with the ToughnessModule module which allows to estimate the irradiated behaviour and toughness drop.
One graphical user interface (GUI) named Perspycace is proposed to the user in order to define the study, launch it, follow its execution and post-process the obtained results. It is developped in Python Qt and it can be used in a standalone mode or as a module of Salome platform [3].
In this presentation, an application of one particular study is proposed. Beginning from input data at the micro-scale (irradiated microstructure, behaviour law of the irradiated material at the bainitic scale, morphology, texture) various physical schemes are used in order to predict the fracture probability of the RPV steel, due to the irradiation effect. The different approaches are compared and a sensitivity analysis is proposed.

REFERENCES

[1] PERFECT website (2004-2008), www.fp6perfect.net/perfect
[2] Python, www.python.org
[3] Salome, www.salome-platform.org/home/presentation/overview/

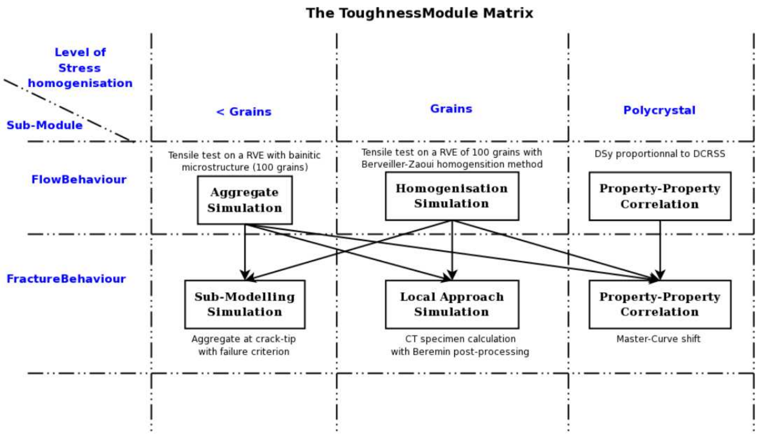

Figure 1: Matrix of the models integrated in the ToughnessModule module: three models using polycrystalline simulations, homogenisation schemes and analytical approaches are used in order to estimate the macroscopic stress-strain curve and the probability of fracture of the considered material.

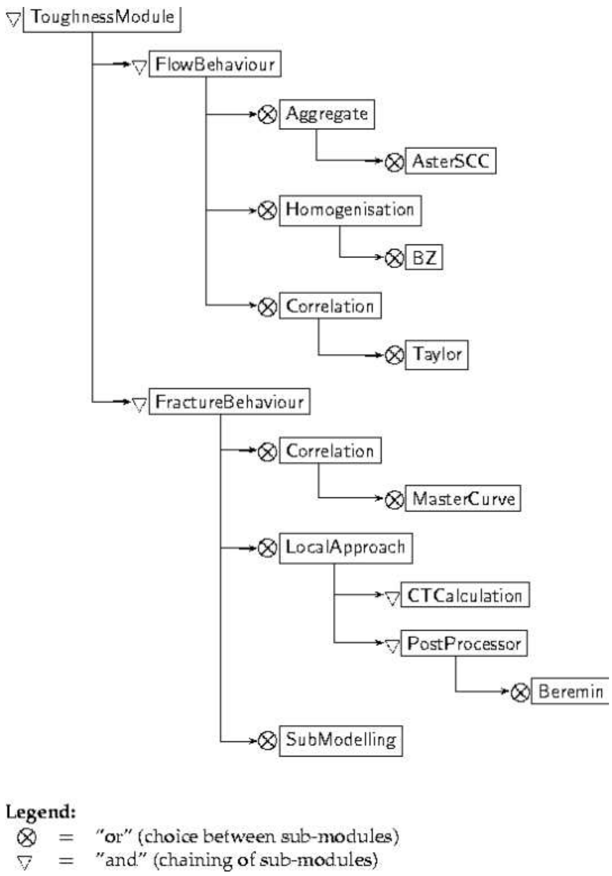

Figure 2: Tree view of the modules and sub-modules integrated in the ToughnessModule of the numerical platform: the end sub-modules or the chaining of sub-modules are defined.