Note of use of method GTP

Summary:

This document introduces advices of use of the method GTP .

It is advised to have taken knowledge of the methodological guide general in breaking process, which counts the various approaches available [U2.05.00].

1 General information on GTP

Approach GTP is a generalization of the classical approach in G [R7.02.07]; the energy taken into account for the calculation of the rate of refund is total mechanical energy [1][2]. Dissipated energy is divided on the one hand into rupture and on the other hand in plasticity without it being possible to separately quantify a priori these two types of dissipation: energy is regarded as completely dissipated in the rupture, which constitutes a pessimistic assumption.

The parameter GTP allows to analyze the nonmonotonous situations of loadings of the defect, for irreversible material behaviors [3][4].

The formulation of G for a thermoelastoplastic relation (approach G_{TP}) is valid only for one notched solid and not for a fissured solid: the principal difficulty in the establishment of this formulation is impossibility of showing the existence of the derivative of total mechanical energy for a field comprising a crack, and this mainly by the absence of knowledge of the singularities of the fields in plasticity. It is important to note that the terms taken into account in an elastoplastic calculation thermo - with the method theta are those supported by the elements between the point of crack and $R_{\sup}$ (in opposition to calculation in non-linear thermoelasticity where only the terms enters R_{inf} and $R_{\sup}$ are nonworthless).

2 Calculation of parameter GTP [R7.02.07]

Grid: the defect must be modelled by one **notch** and not by a crack. It is pointed out that the normal with the defect must be defined in DEFI_FOND_FISS. Moreover, it is necessary to use one fine grid with quadratic elements in the vicinity of the bottom of the notch to have reliable results in the cases of discharge.

The notch can have the shape of a cigar or a prolonged crack of a circle in its end, confer figure below. Such a modeling in 3D can be delicate and lead to important computing times.

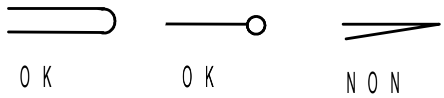

Figure 2-1 : The possible shapes of notch

Within the framework of the method theta one considers that the notch is propagated by keeping the same form (even if that does not have physical significance for a notch of the type pelletizes).

The type of the notch and the ray in bottom of notch do not affect the values of GTP provided that the thickness of the notch is low compared to dimensions of the structure.

It is **requirement** not to calculate GTP on a pointed notch (classical crack) because the results will be false! Indeed, the terms of gradient of the plastic deformations are badly calculated numerically.

Calculation: mechanical calculation is done in a classical way, with the operator STAT_NON_LINE, by using an elastoplastic law of behavior: keyword factor BEHAVIOR with RELATION = 'VMIS_ISOT_LINE' or 'VMIS_ISOT_TRAC'.. It is necessary to then recover the fields of the tensors of plastic deformation by the operator CALC_CHAMP [U4.81.04].

Postprocessing: the calculation of GTP is done with the operator CALC_G. The keyword factor BEHAVIOR (with RELATION = 'VMIS_ISOT_LINE' or 'VMIS_ISOT_TRAC', only relations of behavior authorized for the calculation of GTP) can be well informed in the order CALC_G. , in this case, it owes the being in coherence with the behavior used for mechanical calculation in

STAT_NON_LINE. If the keyword factor BEHAVIOR is not well informed in CALC_G, the behavior defined in STAT_NON_LINE will be automatically selected by the operator CALC_G.

> *notice : for the law of behavior* 'VMIS_ISOT_TRAC' *, it is currently not possible to take into thermal account it in the calculation of GTP . The material field used for calculation mechanical and resulting from the order* AFFE_MATERIAU [U4.43.03] *must thus be created without assignment of the variable of order temperature, i.e. in the absence of keyword factor* AFFE_VARC *(* NOM_VARC = 'TEMP' *).*

Interpretation of the results: Cette formulation is resulting from rather recent research tasks and the parameter GTP does not have yet experimental validity.

The principal question relates to interpretation to make results got with this parameter of rupture GTP, which does not make it possible to dissociate the energy dissipated in rupture and that dissipated in plasticity. Thus, during a discharge values of GTP are initially decreasing then increasing. If one places oneself on the assumption of Griffith, one could thus have propagation of the crack in discharge, which is problematic. The criterion of rupture associated with GTP thus remain to discuss.

An example of industrial study with the parameter GTP can be found in [5]. It acts in this case of the study of harmfulness of a defect under coating subjected to a thermal shock.

The reader will be able to refer to the case test of validation: ssnp102.

3 Bibliography

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[5] DEBRUYNE G., Study of a DSR, by an energy approach, during a transient of small primary breach 3 ' 'Notes EDF R & D HT-64/02/010, 2002