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# Review of “Fatigue crack growth under large scale yielding condition: a tool based on explicit crack growth”

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<sup>R</sup> Reviewer

<sup>E</sup> Editor

## Review of version 1

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### Reviewer 1 (Roberto BRIGHENTI)

**Authors** We would like to thank the reviewer for her/his remarks and comments. Listed below please find the detailed replies to her/his questions, with the corresponding modifications being highlighted in blue in the revised version. We hope that this revised version will finalize this discussion and will make this paper suitable for publication in JTCAM.

**Reviewer** The paper deals with the modelling of fatigue crack growth (FCG) under large-scale yielding conditions. The proposed approach takes into account plastic effects; a non-local model for FCG based on the partition of the strain energy density in elastic and plastic contributions within a FE approach is shown to provide improved results compared to classical J-based approaches.

The authors recall that the proposed FCG laws are based on a variety of aspects, such as FCG regime, constitutive relations of the material, visco-plastic effects, short and long crack regimes, etc. Within this context, the authors clearly provide a comprehensive overview of the topic and discuss their own approach.

The paper is of interest to the journal’s audience and presents a topic that is worth investigating. Sections, figures, references, and equations conform to usual standards for international journals even if some improvements in several figures are needed.

We would like to thank the reviewer for his/her positive remarks and his/her time dedicated to the previous manuscript.

In my view the paper has merit but required to be improved by considering the following points:

It is suggested to add the list of the main symbols used and the related meaning at the beginning of the manuscript.

**Authors** This list has been introduced in the revised manuscript.

**Reviewer** It is not clear why the inelastic power and the dissipated one are written separately (see Eq. 1). What is the difference since both of them are dissipative contributions? Please clarify this point.

- Authors** This decomposition was not clearly defined, a new formulation is suggested thanks to the reviewer comment, to correctly separate the plastic dissipation from the existing other irreversible phenomena: "The total potential energy  $\Pi$  of an isolated system (without external load) can be defined as the sum of its elastic energy  $\Pi_e$ , its plastic dissipation  $\Pi_p$ , and any other dissipative energy  $\Delta$ ."
- Reviewer** The projection strategy used to transfer variable values between two subsequent meshes should be better explained since it represents a key point in advancing the crack growth calculation.
- Authors** This point is clearly of importance concerning the numerical simulation strategy. A new figure and a paragraph have been added to clarify the developed approach.
- Reviewer** Fig 9 is not clear and the various curves are not clearly visible, please adjust. The same applies to Figs 11, 12 where not all the numbers are visible because they are too small. Avoid inserting multiple legends in the same figure if they are identical.
- Authors** These corrections have been achieved, with improvement of the readability of all figures.
- Reviewer** FCGR based on the partition of strain energy (sect 5.4) and the way the involved parameters are determined should be better explained. The lowest and the highest applied loading should be identified quantitatively, possibly relatively with respect to some mechanical parameter of the material (yield stress and corresponding strain, etc.) and crack size.
- Authors** This part has been fully revised. However, the question of the relationship between damage parameters (here local approach) and macroscopic values is not obvious. To avoid speculative analysis of the meaning of the chosen phenomenological approaches, these comparisons have not been introduced.
- Reviewer** A FE mesh convergence study should be provided in order to show the influence of different finite element sizes with respect to the geometry of the specimen and the yield region extension ahead of the crack tip. Is the mesh refinement required by the proposed approach in some way related also to the relative yield size extension with respect to the crack size?
- Authors** This has been introduced as an appendix to avoid too many parameters analysis, it was already achieved previously without introduction of a crack [Maurel et al, 2017]. The sensitivity to the mesh size is observed to be quite small, yielding in the most critical case, less than 5% of scatter for FCGR.
- Reviewer** In general, the scale yield condition has to be related to the crack size. According to this observation, dealing with crack growth modeling for small or large crack under constant amplitude loading should require different approaches since small-scale yielding is more likely to occur for long cracks. Please discuss on this aspect in relation to the proposed approach and how Eq (13) could be used without adjustments in its parameters for very different crack growth regimes.
- Authors** This point is certainly one of the major interests of the proposed method: for small and long crack, the non-local approach is observed to be straightforward for FCGR analysis. The different crack growth regimes have been highlighted adding comments in the text.
- Reviewer** The concept of non-local strain energy density is used as driving force in FCG; this quantity is evaluated by adopting small spherical domains with a given radius ahead of the crack front. Is such a size function of some internal characteristic length scale of the material rather than being simply related to the mesh size as stated in the manuscript?
- Authors** This question has been raised in many studies [eg Besson et al for ductile failure, Nadot et al for fatigue] with a debate about the relationship between characteristic length scale and microstructure or plasticity range. The answer could depend to some extent to the material being studied but also to the damage regime observed in the tested condition. The grain size in the case of the present study, should be of course implied in intergranular damage mechanisms. However, the intent of the developed approach is to get rid both of microstructure details and of the complex microcrack network around the major crack, by modelling a single major crack.

Thus, we assume here that only plastic range must be accounted for, in relationship to the chosen mesh size: as developed above, at least few elements should be present within the length used for averaging so as to consider gradients.

**Reviewer** Avoid using non-English words (e.g. COUPE AA in Fig. 3); please check carefully the whole manuscript.

**Authors** These corrections have been achieved.

**Reviewer** In conclusion, I suggest the authors to amend their manuscript according to the above comments in order to make it suitable for publication in Journal of Theoretical, Computational and Applied Mechanics.

### **Editor’s assessment (Anna PANDOLFI)**

The nice manuscript deals with the modelling fatigue crack growth with an explicit tool. A single reviewer can be accepted in this case, because of need of keeping decent times for the publication, and because the only received review was sound. At the first round of reviews it has been very hard to find a reviewer: the invited experts were not available or they did not provide a timely answer. We finally found a good scientist that work in the field and who provided a rather positive review, asking for a revised version. My personal impression of the review process was that the reviewer addressed the weak points of the contribution and that the authors accurately provided a revised version where all the points have been addressed and taken care of.

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