An analysis of surface crack propagation with smoothed particle hydrodynamics method

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ABSTRACT

The study of the fatigue damage is essential to ensure the safety of mechanical and civil structures. Especially, the fatigue crack propagation is one of the dominant phenomena on the fatigue damage. In this regard, some numerical analyses for the crack propagation problem such as X-FEM [1] are being investigated, where the mesh is employed.

However, in general, meshing numerical analyses are difficult to deal with such complex situations as seen in connecting plural cracks or many defects. On the other hand, mesh-less numerical analyses, like a particle method, could solve such problems easily. Nevertheless, the particle methods also have some problems, for example, the accuracy issue for the problems with stress singularity in crack tip. In addition, there has been published only a few studies about particle methods on crack propagation problems, particularly fatigue problems.

In this study, to study the applicability of the smoothed particle hydrodynamics method (SPH) [2] to the linear elastic fracture mechanics, the stress singularity at crack tip area in a single edge cracked specimen was first analysed, comparing with the available numerical result [3]. Then, fatigue crack propagation analyses with the SPH were carried, where the analysed fracture histories were compared with experimental results. From the above results, effectiveness of the SPH on fatigue crack propagation problem was shown.

Regarding the accuracy of the stress singularity analysis, we have confirmed that the stress distribution by the SPH near the crack tip was inversely proportional to the square root of the distance from the crack tip [3]. However, the SPH results have shown some numerical problems including cyclical stress fluctuations. We consider the future study is needed to clarify these problems.

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