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Interaction Effect Analysis of Two Surface Cracks using S-version FEM

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Summary

Prediction of fatigue crack growth in mechanical component is one of the most important problems to prevent catastrophic fracture accident. FEM is generally used for this purpose, but as crack shape changes during growing process, it is necessary to re-mesh for new crack shape. It is time consuming and is very difficult especially for 3-d. problem.

In this study, S-version FEM[1][2] is employed to solve this problem, and fully automatic crack growth simulation system is made by combining with automatic mesh generation system. In the 3-d. field, crack tip stress condition becomes under mixed mode condition, and three stress intensity factor, K_I, K_{II} and K_{III} are evaluated by S-FEM. Using crack growth rate criterion and crack growth path criterion, proposed by Richard et al.[3], new crack configuration is obtained. In S-FEM, crack exists in local region, and it is necessary to re-mesh the local mesh for this new crack configuration. As connectivity condition between local mesh and global mesh is unnecessary, re-meshing of local mesh is easy. After getting new local mesh, S-FEM is used to solve the stress field. By repeating these processes, crack growth simulation could be done fully automatically.

In this study, several 3-d. fatigue crack problems are solved using this system. At first, single surface crack subjected by mixed mode loading is solved. It is verified that crack growth occurs under pure mode I condition, and KII and KIII values vanish by fatigue crack growth. It is also shown that distribution of K_I value along crack front becomes nearly constant by the crack growth.

Then 2 surface cracks problem is solved in several cases by changing distances between two crack tips. Fig. 1 and Fig.2 show examples of 2 surface cracks. Crack shapes change by the interaction between 2 cracks. It is shown that the distributions of Stress Intensity Factors along crack front are largely affected by the initial crack tip distances. Results are compared with Maintenance code for Nuclear Power Plant by JSME[4].The coalescence condition of two cracks is studied and it is verified that JSME code gives conservative evaluation.

References

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Figure 1: Initial shapes of 2 surface cracks.

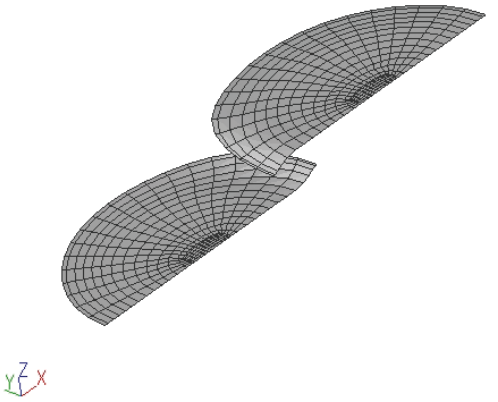

Figure 2: Final shapes of 2 surface cracks.

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