Three dimensional thermal stress analysis by using element-free Galerkin method

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The element-free Galerkin method (EFGM)[1] is one of the most practical methods in various meshfree methods. In recent years, the EFGM has been applied to crack propagation and adaptive analysis, because the remeshing that is required in the finite element method (FEM) can be unnecessary due to the special feature of the moving least square method (MLSM).

In this study, the EFGM is applied to three dimensional thermal conductivity problems and thermal stress problems including fracture mechanics problems. We use solid elements to define analysis geometry and volume integration. The crack geometry is represented by triangular elements independent of the analysis geometry generated by solid elements. At first, we solve two thermal stress problems. One has a convex geometry that is defined by tetrahedral and hexahedral elements and the other has a concave geometry to verify the accuracy. Secondly, a semi-elliptical crack in a rectangular solid subjected to uniform tension and a cracked rectangular solid imposed a temperature field are solved. Figure 1 shows the allocation of nodes and finite elements, together with temperature distribution analyzed by the EFGM. The boundary conditions are also denoted in the Fig.1. The material constants are given in the Table 1. The z-directed displacements calculated using the temperature distribution shown in Fig.1 are depicted in Fig.2. The temperature distribution and the maximum crack opening displacement analyzed by the EFGM agree well with those of the FEM.

Table 1 Material constants

Young's modulus	206GPa
Poisson's ratio	0.3
Thermal expansion coefficient	1.0×10^{-5}/K
Thermal conductivity	51.3W/m/K

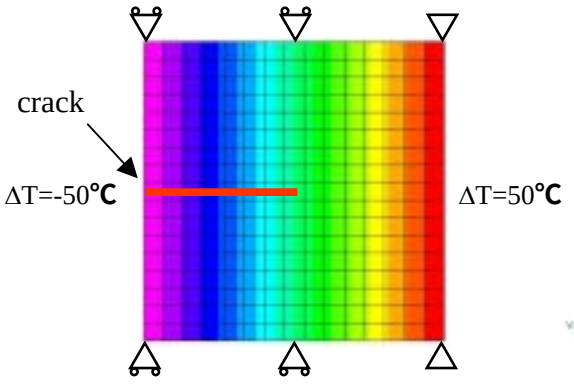

Fig.1 Analyzed model and temperature distribution with boundary conditions for thermal conductivity and thermal stress analyses

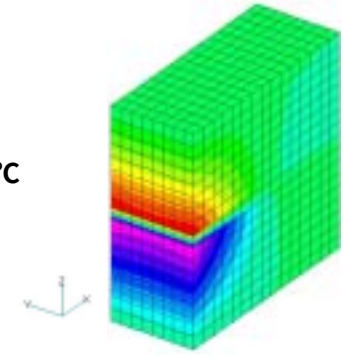

Fig.2 z-directed displacement distributions analyzed by EFGM

References

[1] T. Belytschko, Y. Lu, and L. Gu, "Element-Free Galerkin Methods," *International Journal for Numerical Methods in Engineering*, v. 37, p. 229-256, 1994.