Abstract

Structural Shape Optimization Using Boundary Element Method

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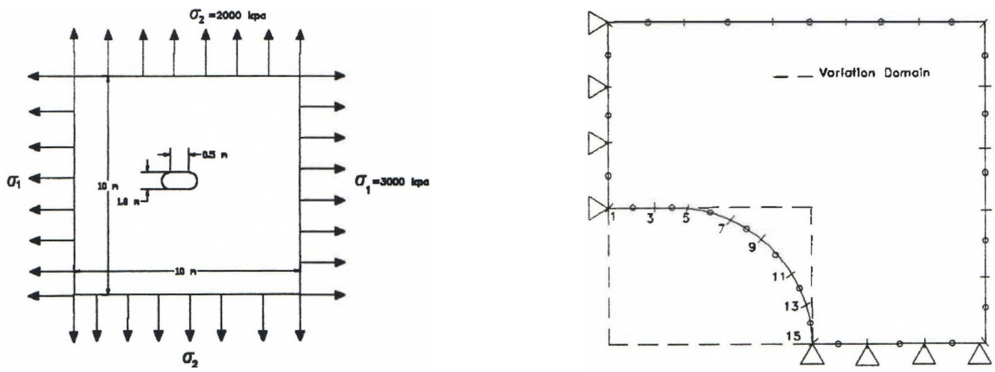
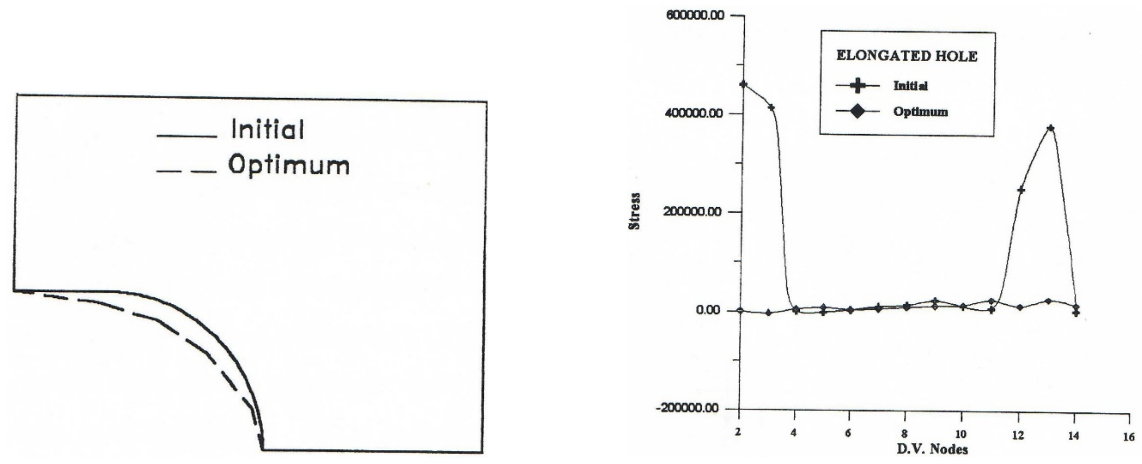
The shape optimization of structural components for smoothing the stress peak of in concentration regions is presented. The stress analysis is performed using the Boundary Element method (BEM) having the isoparametric quadratic elements. Coordinates of the boundary nodes are considered as the design variables. The design sensitivity is carried out employing the Finite Difference method (FDM). The numerical optimization algorithm utilizes the DFP (Davidon–Fletcher–Powell) Quasi-Newton method in which the Hessian matrix is numerically estimated using FDM together with the Golden Section for multi-dimensional searching. A FORTRAN based function is adopted for the stress analysis while a PASCAL program is used for the sensitivity analysis and the optimization process. It is shown that the BEM is very effective for the shape optimization compared to FEM, owing to the fact that BEM requires only the meshing of the boundary to be optimized. Furthermore, the initial mesh preparation and regeneration of the elements during the iterations is straightforward and fast. The application of the developed algorithm has been practiced for obtaining the optimum shape of fillets and holes in plate and bar structures under multi-axial loading.



(a) (b)

Fig.1: (a) Elongated hole in an infinite plate, (b) initial BEM mesh with the variation domain



(a) (b)

Fig.2: (a) Optimum shape of the elongated hole, (b) stress variation for the initial and optimal shape ate the nodal boundary elements