

## Effect of Out-Of-Plane Deformation on Relaxation Method of Stress Concentration in a Plate with a Circular Hole

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**Abstract :** In structures, stress concentration is a factor of fatigue fracture. Basically, the stress concentration is a phenomenon that should be avoided. However, it is difficult to avoid the stress concentration. Therefore, relaxation of the stress concentration is important. The stress concentration arises from notches and circular holes. There is a relaxation method that a composite patch covers a notch and a circular hole. This relaxation method is used to repair aerial wings, but it is not systematized. Composites are more expensive than single materials. Accordingly, we propose the relaxation method that a single material patch covers a notch and a circular hole, and aim to systematize this relaxation method. We performed FEA (Finite Element Analysis) about an object by using a three-dimensional FEA model. The object was that a patch adheres to a plate with a circular hole. And, a uniaxial tensile load acts on the patched plate with a circular hole. In the three-dimensional FEA model, it is not easy to model the adhesion layer. Basically, the yield stress of the adhesive is smaller than that of adherents. Accordingly, the adhesion layer gets to plastic deformation earlier than the adherents under the yield load of adherents. Therefore, we propose the three-dimensional FEA model which is applied a nonlinear elastic region to the adhesion layer. The nonlinear elastic region was calculated by a bilinear approximation. We compared the analysis results with the tensile test results to confirm whether the analysis model has usefulness. As a result, the analysis results agreed with the tensile test results. And, we confirmed that the analysis model has usefulness. As a result that the three-dimensional FEA model was used to the analysis, it was confirmed that an out-of-plane deformation occurred to the patched plate with a circular hole. The out-of-plane deformation causes stress increase of the patched plate with a circular hole. Therefore, we investigated that the out-of-plane deformation affects relaxation of the stress concentration in the plate with a circular hole on this relaxation method. As a result, it was confirmed that the out-of-plane deformation inhibits relaxation of the stress concentration on the plate with a circular hole.

**Keywords :** stress concentration, patch, out-of-plane deformation, Finite Element Analysis

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