ADHESIVELY BONDED COMPOSITE STRUCTURES HAVING DIFFERENT CONFIGURATIONS

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Introduction

Adhesive bonding has been successful in replacing mechanical fasteners in some structural applications such as machine tool structures, motor cars, airplanes and pipe lines. Adhesives have proved successful in a wide range of practical applications for bonding dissimilar materials. For example, modern gear box casings and gear unit housings are often made of aluminum alloys and large number of steel studs, plugs, rings and other components are assembled to much closer tolerances. Because of the varying coefficients of thermal expansion of these materials, these components become loose as soon as the units heat up during operation. The use of epoxy adhesives in such instances ensures strong sealed joints [1-13].

Adhesive bonding was introduced for machine tool construction in 1968.When a small milling machine was fabricated by bonding [14]. The reason behind introduction adhesive bonding for machine tool structures was its higher damping capacity. The design philosophy of that early machine tool structures was based on using the industrial double containment boned joint, to replace the original cast structure.

Adhesively bonded joints have attracted the attention of many researches, where stress analyses of the deformed joints have been carried out analytically and using numerical analysis [1-16]. Since two or more different materials are used in the adhesively bonded joints and the adhesive layer is thin when compared with the adherent thickness, boundary conditions make the problem complicated. Finite-element technique is efficient method to analysis the strength of bonded joints regardless its complicated geometry.

Structural bonded components are developed using corner joints, in which plates with different geometries and materials are bonded at right angles and T-geometry configurations. Chang et. al., are the earliest researchers in using adhesive bonded structures, where they used bonded structure with corner supports in the design and manufacturing a prototype-milling machine [14].

Khalil and Davies [12] and later Darwish [13] considered this philosophy and reported that the peak adhesive stress occurred at the junction of the cantilever plate and the support at the open end of the corner slot in the double containment cantilever joint. Davies et al. presented a new modified type of double containment joint and he was able to reduce the peak stresses in double containment corner joints. Where he keept the horizontal slot depth of corner joint as large as possible and slightly relieved the stress concentration at the adhesive free ends.

Double containment joints has been also used in the development of bonded cutting tools [9-12]. Alsamhan [16] proposed a new version of double containment joints having a circular cross-section support. This propped joint not only provides higher strength joint and weight saving (up to 45%), when compared with the regular double containment joint, but also provides saving throughout its manufacturing steps.

Strength study of different industrial T-configuration double contentment joint having similar and dissimilar materials are considered in the current study. Three types of joint configuration are considered; circular, regular and modified regular double containment joints. The

2D Finite-element technique will be used in current study.

Joint Strength Prediction

The solid model and finite element meshes were generated using the GID preprocessing program [17]. The FE computation was carried out using Tochnog FE program [18]. Tochnog is explicit-implicit FE program that can be used in the analysis of structures, thermal, elastic or elastic-plastic engineering problems. Tochnog and GID programs run under Linux operating system.

At first, the data file of the FE model was generated using GID pre-processing program and completed using a text editor. Next, Tochnog FE module was executed using the developed data file, followed by visualizing the FE results using GID post processing program based on the output files written by the Tochnog FE module.

The following assumption and boundary conditions were assumed throughout the idealization process:

2D-model formulation.

All materials are isotropic, i.e. the properties of the materials are the same in each direction.

No contact stresses assigned on adhesive layer.

Conclusions

In general, aluminum -steel joints are considered the strongest since it develops lower state of stresses, when compared with circular and modified joints.

Double containment joint with circular support has nearly equal stress concentration when using steel and aluminum support. However, the aluminum –steel joints are expected to contribute to the dynamic behavior (increased damping and natural frequency) thanks to its lighter weight.

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