論文 / 著書情報
Article / Book Information

題目(和文)	接着接合部のクリープ強度測定に関する新方法の提案
Title(English)	Development of a novel method to measure the creep strength of adhesively bonded joints
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Mechano-micro Engineering	専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	(Engineering)
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Adhesives in engineering products have recently replaced conventional fasteners (e.g., bolts, rivets, screws, welding, etc.). Adhesive bonding possesses superior advantages, including uniform stress distribution, flexibility in design, and continuous joining without holes. Because adhesive bonding not only has the capability to join homogeneous material, but it also allows for the joining of dissimilar materials; this technique is very promising, especially for the automotive industry, considering multi-material structures have advantages in terms of weight reduction. However, the long- term durability of adhesively bonded joints has not been clearly determined because long- term tests are expensive and time consuming. For instance, much time is necessary to obtain sufficient data on the durability of a joint. Therefore, more efficient techniques are required.

Before performing creep tests of adhesively bonded joints, which is the main part of this thesis, strength of adhesively bonded joints at high temperature in different environment was investigated. The motivation of this experiment is according to the application of adhesive joints for instance, in aircraft or satellites, which exposed to different environments than atmosphere such as in vacuum condition. To perform experiments in vacuum condition is difficult, therefore specimens were exposed to argon gas in order to study the behavior of adhesive joints at different environment than atmosphere. The objective of this investigation is to compare the strength of adhesively bonded joints exposed to 150°C in the atmosphere and in argon gas from 0 to 100 h. Furthermore, the color changes of adhesive at these conditions were also studied. One-component epoxy resin (main component: bisphenol A) was used to form single lap joints of SS400 as the specimens. Results indicate that the color of the bulk adhesive specimens was drastically changed by the exposure to a high temperature of 150°C in both the air and argon gas. Furthermore, the strength of adhesively bonded joints did not decrease, but slightly increased by the exposure to 150°C in both the air and argon gas from 0 to 100h.

To investigate the time-dependent behavior of adhesively bonded joints, this thesis proposes a new method to measure the creep strength of adhesively bonded joints using a hydro-pneumatic testing machine and a specimen holder, on which multi-specimens can be mounted in one testing machine. Creep tests were conducted on stainless steel butt joints bonded with an epoxy adhesive. A hydro-pneumatic loading system was introduced to avoid successive failures of multi-specimens as well as to achieve a stable and constant loading through the experiments. Even after a failure occurs in one of the joints and thus generates an impact, the loading system is capable of absorbing the shock so that the other remaining joints do not fail simultaneously. It was experimentally verified that choke valves, which were introduced in the hydraulic circuit of the system, worked as a damper when failure occurred. All five adhesively bonded butt joints are held by a testing setup, which consisting of five pairs of restraint devices. Each pair of restraint devices is designed with different length of elongated holes. Broken specimen will move towards the end of the elongation holes, therefore the displacement of all broken specimens can be distinguished, thus the sequence of fracture among those five butt joints can be recognized clearly. Additionally, it was established that automatic reloading to the remaining specimens after the failure was short enough compared with the creep-rupture time. As this new method relates to the efficiency of creep testing, the utility of the proposed approach with the multi-specimen set-up has been verified.

The creep tests were conducted on the specimens under constant and interval time loading conditions, which slightly lower than the fracture strength of butt joints bonded with Denatite 2204 under static conditions. Under constant loading conditions, the time to creep rupture of the bonded joints increased with decreasing of applied stress, i.e., the joints have longer lifetime when they are subjected to lower stresses. The lifetime can be fitted with a line on a stress-lifetime diagram. For interval time loading conditions, the creep strength of the joints depended on only the total time at high loading plateaus. Therefore, the effect of creep relaxation or viscoelastic recovery on creep rupture is trivial even if they are present. The effect of low cycle fatigue was not significant in the experimental results too.

The results and presented methods of adhesively bonded joints must be applicable to evaluation of adhesives, design of real products, or estimation of lifetime for bonding pats with adhesives, especially included in the structures of space-crafts, aircrafts and automobiles. More information can be obtained by experiments utilizing the proposed method subjected to combination of various loading conditions with different temperature and humidity level.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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