

fretting fatigue:

Advances in the
Basic Understanding
and Applications

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Foreword

This publication, *Fretting Fatigue: Advances in Basic Understanding and Applications*, contains papers presented at the symposium of the same name held in Nagaoka, Japan, on 15-18 May 2001. The symposium was sponsored by ASTM Committee E08 on Fatigue and Fracture. The symposium co-chairpersons were Yoshiharu Mutoh, Nagaoka University of Technology, David Hoepfner, The University of Utah, Leo Vincent, Ecole Centrale de Lyon, Toshio Hattori, Hitachi LTD., Trevor Lindley, Imperial College of Science, and Helmi Attia, McMaster University.

Overview

The Third International Symposium on Fretting Fatigue was held in Nagaoka, Japan on May 15–18, 2001. This symposium is a follow-up to the First International Symposium on Fretting Fatigue held at the University of Sheffield in April 1993 (see Fretting Fatigue, ESIS Publication 18, edited by Waterhouse and Lindley, 1994) and the Second International Symposium on Fretting Fatigue held at the University of Utah on August 31, 1998 (see Fretting Fatigue: Current Technology and Practices, ASTM STP 1367, edited by Hoepfner, Chandrasekaran and Elliott, 2000). Fretting is well known to degrade fatigue strength significantly. Fretting fatigue failure has been increasingly disclosed in service components because those components have suffered more severe loading conditions than before due to the demands of save-energy and environment-preservation. One of major magic behaviors in fretting fatigue problems will be that a micro-slip between two combined components occurs under service loading, while such a slip is never expected at the designing stage. Great efforts have been devoted for understanding the fretting fatigue phenomenon and for developing the fretting fatigue design. This symposium was organized to focus on the progress in basic understanding and application and to continue the extensive interchange of ideas that has recently occurred.

Fifty-seven delegates from seven countries attended the symposium to present papers and participate in lively discussions on the subject of fretting fatigue. Dr. Waterhouse, who did pioneering research since the 1960s and is well known as a father of fretting research, was invited to this symposium. Technical leaders in the area of fretting fatigue were in attendance from most of the leading countries that are currently involved in fretting fatigue research, development, and engineering design related matters, as well as failure analysis and maintenance engineering issues. ASTM International Committee E8 provided the ASTM International organizational support for the symposium. The collection of papers contained in this volume will provide as an update to a great deal of information on fretting fatigue. This volume surely serves engineers that have a need to develop an understanding of fretting fatigue and also serves the fretting fatigue community including both newcomers and those that have been involved for some time.

The Symposium was sponsored by the following organizations as well as ASTM International: 1) Materials and Processing Division of JSME, 2) MTS Systems Corporation, 3) SHIMADZU Corporation, 4) HITACHI Ltd., and 5) JEOL Ltd.

All of the above organizations provided valuable technical assistance as well as financial support. The Symposium was held at Nagaoka Grand Hotel in the center of Nagaoka city, which is famous for fireworks and excellent rice and related products, such as Japanese sake and snacks. Many of the delegates would enjoy them.

The organizing committee members were: Dr. Yoshiharu Mutoh, Chair (Japan), Dr. David Hoepfner (USA), Dr. Leo Vincent (France), Dr. Toshio Hattori (Japan), Dr. Trevor Lindley (UK), and Dr. Helmi Attia (Canada). At the conclusion of the symposium, the organizing committee announced that the next symposium would be held a few years after this symposium in France with Dr. Vincent as coordinator and chair.

Editing and review coordination of the symposium was done with the outstanding coordination of Ms. Maria Langiewicz of ASTM International. The editors are very grateful to her for her extensive effort in assisting in concluding the paper reviews and issuing this volume in a timely manner.

The symposium opened with remarks by the symposium chair. Subsequently, Dr. Robert Waterhouse gave the distinguished invited lecture on Fretting in Steel Ropes and cables. Six keynote lectures were given in the following sessions, which were "Fretting wear and crack initiation", "Fretting fatigue crack and damage", "Life prediction", Fretting fatigue parameter effects", Loading condition and environment", Titanium alloys", "Surface treatment", and "Case studies and applications". Forty-three papers were presented and this volume contains twenty-nine of those papers.

The new knowledge about the process of fretting crack nucleation under fretting wear was provided through both detailed in-situ observations and mechanical models, which included not only fracture mechanics but also interface mechanics. Fretting fatigue crack propagation under mixed mode was discussed based on fracture mechanics approach. However, small crack problems, especially those related to threshold and under mixed mode, are still remained for future efforts. Fretting fatigue life estimations were attempted based on various approaches including fracture mechanics, notch fatigue analysis and multiaxial fatigue parameters. A number of factors are well known to influence on fretting fatigue behavior and strength. Effects of those parameters, which included contact pressure, friction coefficient, contact pad geometry, mating material and so on, were discussed. Effect of loading conditions including block loading, high frequency and service loading was also presented. The knowledge about loading wave effect has been limited until now. Improvements of fretting fatigue strength by using coating techniques were presented. Titanium alloys have been typically used for structural components suffering fretting fatigue, such as turbine components and bio-joints, due to their lightweight as well as excellent corrosion resistance. A lot of works on this material including a review paper were presented to understand fretting fatigue behavior in various conditions. Case studies on electrical cables, dovetail joints, pin joints and rollers were introduced. Methods for bridging between specimen-based research works and case studies are required, when a fretting fatigue test method would be standardized. These topics will be also important future work.

This publication is only one aspect of the symposium. The sessions and discussions contribute greatly to the mission of the symposium. The effort of the co-chairmen of the sessions is acknowledged and appreciated. The editors are thankful to the attendees of the symposium for interesting points and useful comments they made during the discussions that followed the paper presentations. Their enthusiasm to follow up this symposium with the next symposium in France is appreciated and well taken. The editors hope that those concerned with the subject of fretting fatigue will find this publication useful and stimulating.

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