Experimental Mechanics (2022) 62:1245–1246
https://doi.org/10.1007/s11340-022-00900-3

EDITORIAL

Advances in Residual Stress Technology in Honor of Drew Nelson

A. T. DeWald[1] · M. R. Hill[2]

Published online: 2 September 2022

The Special Issue of *Experimental Mechanics* on *Advances in Residual Stress Technology in Honor of Drew Nelson* recognizes Dr. Nelson on becoming emeritus after 40 years of research contributions and teaching on the experimental determination of residual stresses and their effects on fatigue.

Dr. Nelson received a PhD in Mechanical Engineering at Stanford University, worked six years in industry, mainly for General Electric, then returned to the university, where he is a Professor of ME. His research with students on residual stresses has included extension of the hole drilling method by use of optical methods, development of an eigenstrain method, use of fiber optic strain sensors embedded in composites, as well as modelling effects of residual stresses on crack growth using a crack closure approach, development of a surface acoustic wave method for monitoring the crack closure of microcracks, and studies of residual stress effects from shot peening and carburizing on fatigue. He received the Hetényi award from SEM in 1996.

Topics covered in this special issue include:

- New approaches for (a) computational modelling of the hole drilling method, (b) incorporating residual stress data from complementary measurement techniques such X-ray diffraction (XRD) into the method and (c) correcting for plasticity effects when stresses uniform with hole depth approach yield stress levels
- Application of the hole drilling method to fiber-metal laminates
- A new computational framework for evaluating residual stresses and uncertainties in use of the contour method plus a comprehensive reproducibility study of the method
- Application of the contour method to smaller size parts using scanning white-light interferometry
- Mapping heterogeneous residual stresses from XRD averaged measurements plus residual strain mapping with high energy dispersive XRD in thick specimens
- Use of a slitting method to measure residual stresses in a radioactive component plus a measurement repeatability study using a slotting method and XRD applied to shot peened specimens
- Studies of (a) residual stresses and warpage in a thin-walled aluminum structure processed by uphill quenching, (b) residual stresses/strains and fatigue behavior of a laser clad repaired titanium alloy and (c) the effect of bulk residual stresses on residual stresses and distortion induced by milling of thin-walled aluminum specimens
- A computational approach for predicting machining-induced residual stresses using calibration from digital image correlation (DIC) analysis of in-situ sub-surface displacement fields
- Use of neutron diffraction to investigate the internal stress distribution from confinement forces in a bridge cable strand model and accompanying analysis
- Measurement of residual stresses in bi-layer thin films by a ring-core method using focused ion beam milling and digital image correlation
- A system-level thermo-mechanical finite element study of nuclear reactor cooling components to investigate residual strains and their effects on cyclic hardening and associated environmentally assisted fatigue

Guest Editors,
Dr. Adrian DeWald, Hill Engineering,
Prof. Michael Hill, University of California, Davis.

Foreword

I am grateful to the authors who provided articles for this special issue. Their valuable contributions and willingness to devote the time needed to prepare them are greatly appreciated. I also wish to thank the reviewers and especially the editors of the issue, Adrian DeWald and Mike Hill, for

✉ A. T. DeWald
atdewald@hill-engineering.com

M. R. Hill
mrhill@ucdavis.edu

[1] Hill Engineering, Rancho Cordova, CA, USA

[2] University of California, Davis, CA, USA

the considerable effort involved in making the special issue possible.

I feel fortunate to have experienced the friendship and helpful advice provided by SEM colleagues, for whom I have developed a deep respect and admiration over the years. I am also grateful for the opportunity to have conducted research with highly capable graduate students. Working with them has been a joy, and I learned much from them.

In recent years, much progress has been made in the development of experimental methods for determining residual stresses, new processes to increase fatigue strength, and improved computational models for predicting residual stresses generated by manufacturing processes and their influence on fatigue performance. Examples of that progress are in this special issue. Much remains to be done, though.

For instance, methods that can determine residual stresses present in certain stress concentration geometries and other potentially challenging shapes are needed, as are improved methods for determining residual stresses in engineering polymers, composite materials, biomaterials, etc. Current experimental methods for finding residual stresses have been applied primarily to "macroscopic" engineering components centimeters in size and larger. Methods for finding residual stresses at microscopic size scales, such as use of ring coring within scanning electron microscopes, have been developed. Since an increasing assortment of miniature mechanical components are being made, methods that could be applied in the size regime between microns and centimeters could be useful. Computational models for accurately predicting residual stresses generated by a wide variety of manufacturing and fabrication processes are needed, as well as improved models for predicting effects of residual stresses on the formation and growth of fatigue cracks, especially small cracks unsuited to analysis by linear elastic fracture mechanics. Long term monitoring of how residual stresses in various engineering components may change during service could provide useful information as well.

As a final note, I'm glad to report that during four decades of teaching, residual stresses and their effects on fatigue performance have tended to spark more interest and follow-on questions than nearly any other topic in courses on experimental stress analysis and fatigue design. I hope that many others will have opportunities to educate engineering students or practicing engineers about residual stresses and their important role in structural performance, a subject that certainly deserves a widespread familiarity in the engineering community.

Prof. Drew Nelson