Modeling Wood-Plastic Composites Using Nonlinear Uniaxial Data

Nathan J. Bechle and John C. Hermanson

Abstract

Biofiber-plastic composites are known to exhibit nonlinear load-displacement behavior when loaded at small-scale standardized test rates (1% strain/min.). The observed nonlinear behavior in tension, compression, and shear is unique to each mode of loading. Flexural loading incorporates all three aforementioned loading modes; therefore, in accordance with conservation of energy, each unique behavior must combine to yield the observed flexural behavior. As part of a broader study to determine the large-scale behavior of wood-plastic composites (WPC), the small-scale mechanical properties of six diverse formulations of extruded WPCs were established using small coupons cut from full-size structural components. To determine the nonlinear stress-strain relationships for the six different formulations, testing was conducted in tension (ASTM D638), compression (method developed by the authors), and flexure (ASTM D790 to obtain the shear modulus as described in ASTM D198 Appendix IV). A function of strain with both linear and inverse-hyperbolic sine terms accurately represented the observed stress-strain behavior. The resulting equations were included in a user-defined material model within a finite element analysis to verify the functional representation of the different loading modes with the conservation of energy. The load-displacement output from the finite element analysis of full-size members in flexure accurately depicted the load-displacement measured for the corresponding specimens. Having verified the stress-strain relationships for small-scale, they will be utilized as a basis for large-scale model development.

Bechle:
Research Assistant, Department of Civil & Environmental Engineering, University of Wisconsin, Madison, Wisconsin, USA
Hermanson:
Research Engineer, USDA Forest Products Laboratory, Madison, Wisconsin, USA

9th International Conference on Wood & Biofiber Plastic Composites

May 21-23, 2007
Monona Terrace Community & Convention Center
Madison, Wisconsin, USA

The conference was hosted by the USDA Forest Service, Forest Products Laboratory and Forest Products Society. In cooperation with the Canadian Natural Composites Council, IUFRO Composites & Reconstituted Products Division, Luleå University of Technology, University of Tennessee's Forest Products Center, and University of Toronto's Faculty of Forestry and Centre for Biocomposites & Biomaterials Processing.

Forest Products Society
2801 Marshall Court
Madison, WI 53705-2295
phone: 608-231-1361
fax: 608-231-2152
www.forestprod.org

The opinions expressed are those ofthe authors and do not necessarily represent those ofthe USDA Forest Service or the Forest Products Society.

Copyright © 2007 by the Forest Products Society.
Proceedings No. 7224
ISBN 1-892529-50-5

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission of the copyright owner. Individual readers and nonprofit libraries are permitted to make fair use of this material such as to copy an article for use in teaching or research. To reproduce single or multiple copies of figures, tables, excerpts, or entire articles requires permission from the Forest Products Society and may require permission from one ofthe original authors.

Printed in the United States of America.

0711300