

Composites Institute's
49th Annual Conference &

E X P O

February 7-10, 1994

Cincinnati Convention Center

Cincinnati, Ohio

1994



Proceedings

Marketing/Technical Sessions

of the Composites Institute's

49th Annual Conference & EXPO '94

February 7-9, 1994

TUESDAY MORNING—FEBRUARY 8

SESSION 1

REVOLUTIONIZING THE WATERFRONT WITH COMPOSITES

Room 200

Session Manager/ Moderator: Douglas S. Barno, *Composites Institute*

9:00 a.m.-12:00 noon Emerging opportunities and technologies in the marine/ports/waterfront were discussed, including reports on two funded Construction Productivity Advanced Research (CPAR) awards from the U.S. Army Corps of Engineers on piling, sea wall and structural components, the all composite demonstration pier project at the Navy facility in Port Hueneme, CA, and the Navy pipe hanger testing and specification development programs. John J. Cecilio, Chief Engineer, Naval Facilities Engineering Service Center (NFESC) was the keynote speaker. He was joined by industry experts and civil engineering practitioners in presenting the latest information on current and planned opportunities in these markets.

SESSION 2

PULTRUSION I

Room 206

Session Manager/ Moderator: Jeffrey D. Martin, *Composite Window Technologies*

Vice Moderator: Terry McQuarrie, *Glasforms, Inc.*

2-A 9:00 a.m. "Determination of Shear Properties for RP Pultruded Composites", S. S. Sonti, E. J. Barbero, *Constructed Facilities Center (CFC), West Virginia University (WVU)*, T. Winegardner, *Creative Pultrusions, Inc.*

2-B 9:30 a.m. "Durability of Concrete Reinforced with Pultruded Fiber Reinforced Plastic Grating", Gary R. Anderson, Eric Munley, *Federal Highway Administration*, Lawrence C. Bank, *Department of Civil Engineering, Catholic University*

2-C 10:00 a.m. "Experimental Behavior of Concrete Bridge Decks Reinforced with Reinforced Plastic (RP) Rebars", Salem S. Faza, Hota V.S. GangaRao, Sanjeev V. Kumar, *Constructed Facilities Center, West Virginia University*, Ronald W. Allison, *Creative Pultrusions Inc.*

2-D 10:30 a.m. "Design Optimization of FRP Universal Connectors", Aymen S. Mosallam, Nabih E. Bedewi, *The George Washington University, Civil, Mechanical, and Environmental Engineering Department*, Evan Goldstein, *Interstel, Inc.*

SESSION 3

FILLERS & ADDITIVES

Room 214

Session Manager: Mark Corbin, *J.M. Huber Corporation, Solem Division*

Moderator: Tom McMahon, *J.M. Huber Corporation, Solem Division*

Vice Moderator: Robert Baker, *ECC International*

3-A 9:00 a.m. "Comparison of Mineral-Based Low Profile Additives (MLPA's) with Conventional Shrink Control and Low Profile Additives", David A. Skelhorn, Robert A. Baker, *ECC International*

3-B 9:30 a.m. "The Influence of Thermoplastic Additives on the Performance of Organic Peroxides in Up-Molding Compounds", Bryce A. Milleville, *Akzo Chemicals Research Laboratory*, Nol Groenendaal, Wim Bladergroen, André van Swieten, *Akzo Chemicals by Research Center Deventer*

3-C 10:00 a.m. "A New Wetting Additive for Improved Processing and Performance in Body Putty", E. L. Dolson, Donald E. Cope, Holger Heilmann, *BYK-Chemie USA*

3-D 10:30 a.m. "Alumina Trihydrate in Polyester Resin-Improving Fire Retardant Properties by Particle Packing and Surface Modification", Donald W. Green, *J. M. Huber Corporation, Solem Division*

3-E 11:00 a.m. "Fracture Toughness of Low Profile Additive Modified Unsaturated Polyester and Vinyl Ester Resins", Jill S. Ullett, Richard P. Chartoff, *The Center for Basic and Applied Polymer Research, University of Dayton*

3-F 11:30 a.m. "The Dimensions of Interfacial Separation by Organosilanes in Composites", Thomas H. Ferrigno, *Improde*

TUESDAY MORNING—FEBRUARY 8 (CONTINUED)

SESSION 4

RESIN TRANSFER MOLDING I

Room 201

Session Manager/ Moderator: Kenneth A. Jacobs, *Liquid Control Corporation*

Vice Moderator: Peter Vaccarella, *Ashland Chemical, Inc.*

4-A 9:00 a.m. "Phenolic RTM—A Boon to Mass Transit", Aram Mekjian, *BP Chemicals Inc., Phenolics Division*

4-B 9:30 a.m. "The Design and Control of Resin Transfer Molding Equipment", Mac Larsen, *Liquid Control Corporation*

4-C 10:00 a.m. "Resin Transfer Molding for High Fiber/Low Void Content", Gray Fowler, Steve Phifer, *Texas Instruments Incorporated*

4-D 10:30 a.m. "Development of Polyurethane RTM Systems for High-Performance Applications", Neil H. Nodelman, David D. Steppan, John H. Perry, Sanjeev Madan, *Polymers Division, Miles Inc.*

4-E 11:00 a.m. "Optimization of Filler Particle Size for Resin Transfer Molding", Dean H. Wiseman, *Reichhold Chemicals, Inc.*

4-F 11:30 a.m. "Effects of Processing Conditions on the Formation of Voids During Advanced RTM Processes", Heon Ki Hwang, Young Roak Kim, Jae Won Lee, Mun Jo Jung, Yohan Rew, *Samsung Heavy Industries Co. Ltd., Daeduk R&D Center*

SESSION 5

SMC/BMC I

Room 213

Session Manager/ Moderator: Jon Collister, *Premix/E.M.S., Inc.*

Vice Moderator: Laurent Suspene, *Cook Composites & Polymers*

Vice Moderator: Shin Dosho, *Takeda America, Inc.*

5-A 9:00 a.m. "Design and Molding of Large Vessels for On-Site Sewage Treatment Facilities with Thick Molding Compound (TMC)", Eiichi Soma, Masataka Takasugi, *Yamasho Sangyo Co., Ltd., Yuuzou Hayakawa, Nobuyuki Nakagawa, Takeda Chemical Industries, Ltd.*

5-B 9:30 a.m. "Experimental Verification on Simulating Shrinkage and Warpage of Thin Compression Molded SMC Parts", Tim A. Osswald, Esther M. Sun, Shi-Chang Tseng, *Polymer Processing Research Group, Department of Mechanical Engineering, University of Wisconsin-Madison*

5-C 10:00 a.m. "Analysis of LPA Mechanism by Dilatometry Study", Mark Kinkelaar, Shailesh Muzumdar, L. James Lee, *Department of Chemical Engineering, The Ohio State University*

5-D 10:30 a.m. "Effect of Adding Particle and Fiber Recycle to SMC on Mechanical Properties and Structure", J. Schiebisch, G. W. Ehrenstein, *Institute of Plastics Technology, D-Erlangen Lehrstuhl für Kunststofftechnik*

5-E 11:00 a.m. "Application of Finite Element Structural Analysis to Evaluate the Rigidity of A Sewing Machine Frame Injection-Molded from Bulk Molding Compound", Makoto Saito, Osamu Otani, Tomokazu Nakagawa, *Mechanical Engineering Research Laboratory, Kobe Steel, Peter Bucco, B. Sedlatschek, Glaslic Corporation, Bow San Lin, Singer Industries*

5-F 11:30 a.m. "High-Pressure/High-Temperature Dilatometry", Hamid G. Kia, *Polymers Department, NAO Research and Development Center, Paul V. Visconti, Composites Department, NAO Manufacturing Center*

SESSION 6

CORROSION

Room 210

Session Manager/ Moderator: Dr. James Chevalier, *Baltek Corporation*

Vice Moderator: Robert J. Dieterle, *Sterling Consulting Group*

6-A 9:00 a.m. "Factors Affecting the Fabrication of Corrosion Barriers for RP Equipment in Bleaching Environments", Lisa M. Adkins, Don W. Daniel, Dwight A. Rust, *Ashland Chemical Company*

6-B 9:30 a.m. "A Newly Developed Low Odor Resin for Flooring", Kazuyuki Tanaka, Koiji Arakawa, Etsuji Iwami, Kanemasa Nomaguchi, *Hitachi Chemical Co., Ltd*

6-C 10:00 a.m. "Proper Cure of Vinyl Ester Resins", David J. Herzog, Todd B. Brown, *Interplastic Corporation*

6-D 10:30 a.m. "Behavior of Glass-Fiber Composite Pipes Under Internal Pressure as a Function of Composite Cohesion Parameters", J. Pabiot, P. Krawczak, C. Monnier, *Polymers and Composites Technology Department Ecole des Mines de DOUAI*

6-E 11:00 a.m. "Acoustic Emission Characteristics of GFRP Laminates Under Corrosive Environments", Y. Fujii, *Seikow Chemical Engineering & Machinery Company, H. Hamada, S. Ramakrishna, Z. Maekawa, Kyoto Institute of Technology, A. Murakami, T. Yoshiki, Himeji Institute of Technology*

TUESDAY AFTERNOON—FEBRUARY 8

SESSION 7

Room 200

COMPOSITES: PROVIDING SOLUTIONS TO INFRASTRUCTURE CHALLENGES

Session Manager/

Moderator:

Douglas S. Barno, *Composites Institute*

1:00 p.m.–

4:00 p.m.

Major General John Sobke, Deputy Commander, U.S. Army Corps of Engineers, was the keynote speaker for this session discussing opportunities in the structural construction market. He was joined by other industry experts and government officials to present the latest information on the largest development opportunity ever undertaken by the composites industry. These discussions included concrete reinforcing applications such as dowel bars, reinforcing rods, pre-stressing and post-tensioning tendons, cable trays, etc., as well as composites in primary civil engineering load-bearing structures such as bridge decks and formwork.

WEDNESDAY MORNING—FEBRUARY 9

SESSION 8

CONSTRUCTION I

Room 207

Session Manager/ Moderator: Douglas S. Barno, *Composites Institute*

Vice Moderator: Earl M. Zion, *EMZ Associates*

8-A 9:00 a.m. "Structural Efficiency of Pultruded FRP Bolted and Adhesive Connections", Sotiris N. Sotiropoulos, Hota V.S. Gangarrao, *Constructed Facilities Center, West Virginia University*, Ronald W. Allison, *Creative Pultrusions Inc.*

8-B 9:30 a.m. "Fatigue Characterization of Pultruded Box and Wide Flange Sections with Lap Joint", Hota V. S. Gangarrao, V. Nagaraj, *Constructed Facilities Center, West Virginia University*, Rodney A. Ritchey, *Creative Pultrusions Inc.*

8-C 10:00 a.m. "Tests on Deep I-Shape Pultruded Beams", A. Zureick, L. F. Kahn, *Georgia Institute of Technology, School of Civil Engineering*, B. J. Bandy, *Walter F. Moore and Associates*

8-D 10:30 a.m. "Local Buckling of Pultruded FRP Beams—Analysis and Design", Lawrence C. Bank, T. Russell Gentry, Murali Nadipelli, *Department of Civil Engineering, The Catholic University of America*

8-E 11:00 a.m. "Connection and Reinforcement Design Details for Pultruded Fiber Reinforced Plastic (FRP) Composite Structures", Ayman S. Mosallam, *Civil, Mechanical, and Environmental Engineering Department, The George Washington University*

SESSION 9

PULTRUSION II

Room 206

Session Manager/ Moderator: Jeffrey D. Martin, *Composite Window Technologies*

Vice Moderator: Joseph E. Sumerak, *Pultrusion Dynamics*

9-A 9:00 a.m. "A Process Model to Describe Matrix Flow and Heat Transfer in Thermoplastic Pultrusion", Petri J. Hepola, Suresh G. Advani, *Center for Composite Materials, University of Delaware*, R. Byron Pipes, *Rensselaer Polytechnic Institute*

9-B 9:30 a.m. "Cure System Design for Highly Filled Pultrusions", Nelson H. Douglass, Sean P. Walsh, *Reichhold Chemicals, Inc.*

9-C 10:00 a.m. "Pultrusion Die Design Optimization Opportunities Using Thermal Finite Element Analysis Techniques", Joseph E. Sumerak, *Pultrusion Dynamics, Inc.*

9-D 10:30 a.m. "Phenolic Pultrusion: Innovations for an Emerging Technology", T. H. Dailey, Jr., *INDSPEC Chemical Corporation*, Michael W. Klett, *PPG Industries, Inc.*

9-E 11:00 a.m. "Improved Pigmentable Low-Profile Pultrusion System", Mitsunori Ikezoe, *Dainippon Ink and Chemicals, Inc.*, Nelson H. Douglass, *Reichhold Chemicals, Inc.*

9-F 11:30 a.m. "A Comparison of Properties and Processing of Epoxy Resins Used in Pultrusion", Ellen Lackey, Denise Theobald, James G. Vaughan, *The University of Mississippi*

SESSION 10

RESIN TRANSFER MOLDING II

Room 201

Session Manager: Kenneth A. Jacobs, *Liquid Control Corporation*

Moderator: Kevin Aalbregeitse, *Liquid Control Corporation*

Vice Moderator: Dean Wiseman, *Reichhold Chemicals, Inc.*

10-A 9:00 a.m. "Structural Resin Transfer Molding with Twin Injection System", Hiroyuki Hamada, Naoto Ikegawa, Zenichiro Maekawa, *Kyoto Institute of Technology*

10-B 9:30 a.m. "Laminate Temperature Distributions During Non-Isothermal Impregnation of Fiber Preforms", G. Lebrun, R. Gauvin, *Ecole Polytechnique, C. D. Rudd, University of Nottingham*

10-C 10:00 a.m. "Flow Properties of Resin in a Vacuum Assisted Resin Transfer Molding Process", Kazunori Watahiki, *Hitachi Chemical Mold Co., Ltd.*, Munehiro Ichimura, *Hitachi Chemical Kozai Co., Ltd.*, Hidekatsu Goto, Yoshitaka Abe, *Hitachi Chemical Co., Ltd.*

10-D 10:30 a.m. "Void Formation and Removal in Liquid Composite Molding", N. Patel, V. Rohagi, L. J. Lee, *Department of Chemical Engineering, The Ohio State University*

WEDNESDAY MORNING—FEBRUARY 9 (CONTINUED)

SESSION 11

REGULATORY

Room 210

Session Manager/ Moderator: John Schweitzer, *Composites Institute*

9:00 a.m.–12:00 noon

11-A “Update on Air Regulations”, John Schweitzer, *Composites Institute*

11-B “Solid Waste Regulations of Concern to the Composites Industry”, J. Bradley, *Eagle-Picher*

11-C “Update on Ergonomics and Worker Safety Standard”, S. Howe, *Society of the Plastics Industry, Inc.*

11-D “OSHA-Reform”, Styrene Classification and PEL Update”, P. de la Cruz, *Keller & Heckman*

11-E “Case Study: Complying with Title V Permitting Requirements”, D. Omoto, *CH2M Hill*

11-F “Update on Study of Emissions from Open Molding Processes”, Stephen McNally, *Composites Fabricators Association*

Panel Discussion/Question & Answer Session

SESSION 12

MARINE

Room 204

Session Manager/ Moderator: David Herzog, *Interplastic Corporation*

Vice Moderator: Ronnal P. Reichard, *Structural Composites, Inc.*

12-A “Sandwich Core Creep at Three Temperatures and Fatigue Properties of End-Grain Balsa and PVC Foams”, James L. Chevalier, *Balttek Corporation*

12-B “Continuing Study of Polyester Marine Coatings”, Jeffrey L. Wilcoxson, Walter H. Brueggemann, Lope C. Estomina, James T. Kempthorn, Alexander D. McMaster, *Ferro Corporation*

12-C “A Case Study of Structural Core Application in Marine Vessels”, Marco Zvanik, *Divinycell International Inc.*

12-D “Development of Composite Construction in Passenger Craft”, Jorge Nasseh, *Dow Chemical, Brazil*

12-E “The Application of Hybrid Resins as a Barrier Coat in Unsaturated Polyester Lamination”, Chih-Pin Hsu, Gary E. Wilde, Mike D. Marquez, Steven L. Voeks, *Cook Composites and Polymers, Composites Division*

12-F “Shared Risk/Shared Manufacturing—Partnerships Between Government and Industry”, Ronnal P. Reichard, *Structural Composites, Inc.*

SESSION 13

SMC/BMC II

Room 213

Session Manager: Jon Collister, *Premiz/E.M.S., Inc.*

Moderator: Jim Phipps, *Aristech Chemical Company*

Vice Moderator: Steve Morris, *PPG Industries, Inc.*

13-A “Materials Advances for Under-the-Hood Applications”, Joseph Michaels, *Reichhold Chemicals, Inc.*

13-B “Low Cost Molding with Low Pressure Molding Compound (LPMC)”, John A. Neate, Warren Robins, *National Composites, Inc.*, Steven P. Hardebeck, John J. Young, *Owens-Corning*

13-C “Compression Molded Sheet Molding Compound in a Clinical/Hospital Laboratory Environment”, Timothy D. Simko, *Molding Products Division/Interplastic Corporation*, Ronald C. Mathia, *Miles, Inc.*

13-D “Internal Pigmentation of Low Profile Composites, Part III”, K. E. Atkins, G. C. Rex, *Union Carbide Corp.*

13-E “Product Development Team Innovation in Design and Process Engineering for the New GENESIS-70 Series Ford New Holland Tractor Body Panels”, R. D. Kurtz, D. B. Stauffer, *Ford New Holland*, L. Pitt, P. Emrich, *Molded Fiberglass Co.*

WEDNESDAY AFTERNOON—FEBRUARY 9

SESSION 14

CONSTRUCTION II

Room 207

Session Manager/ Moderator: Douglas S. Barno, *Composites Institute*
Vice Moderator: Earl M. Zion, *EMZ Associates*

14-A
2:00 p.m.
 "Design and Construction of Fiberglass Truss for a Long-Span Fiberglass Building", Ed (Ahmed) Morsi, *IMCO Reinforced Plastics, Inc.*, J. Larralde, *Civil Engineering Department, Drexel University*

14-B
2:30 p.m.
 "Tension Rod End Attachments Formed via Reforming Pultruded Thermoplastic Composite Rods", Scott R. Taylor, *Thermoplastic Pultrusions, Inc.*, Ever J. Barbero, *West Virginia University*

14-C
3:00 p.m.
 "Compression-Molded Cultured Onyx Using a Newly Developed Low-Profile Agent", Yukiko Fujita, Tetsuya Harada, Tomomasa Mitani, Hirokazu Yamada, *Dainippon Ink and Chemical, Inc.*, Gwilym Owen, *Reichhold Chemicals, Inc.*

14-D
3:30 p.m.
 "Crack Resistance of GFRP Waterproofing Structures", Charles R. McClaskey, *Reichhold Chemicals, Inc.*, Syuya Tsuji, Akio Sagawa, *Dainippon Inc. and Chemicals, Inc.*

SESSION 15

RECYCLING

Room 210

Session Manager/ Moderator: David Graham, *Owens-Corning*
Vice Moderator: Erin Millerschin, *SMC Automotive Alliance*

15-A
2:00 p.m.
 "Recycling Post-Consumer Glass Reinforced Composites—The Role of Glass Fibers", W. D. Graham, R. B. Jutte, D. L. Shipp, *Owens-Corning*

15-B
2:30 p.m.
 "Recyclability of Long Glass Mat Reinforced Thermoplastic Composite", Hiroyuki Hamada, Susumu Yamaguchi, Gabriel O. Shoniake, Zenichiro Maekawa, *Faculty of Textile Science, Kyoto Institute of Technology*, Teruo Kimura, *Department of Engineering, Fukui University*

15-C
3:00 p.m.
 "Solvent Separation: A Method for Recycling Uncured SMC", J. C. Bradley, *Eagle-Picher Plastics*, W. D. Graham, *Owens-Corning*, R. Forster, *Chemical Solvents*

15-D
3:30 p.m.
 "SMC Recycling: An Update—ERCOM's Experience in Production and Application", Peter Schaefer, *ERCOM*, Alan G. Plogwian, *Owens-Corning*

15-E
4:00 p.m.
 "Recycling Composites in Canada: An Update", Basil Darrah, *The Society of the Plastics Industry of Canada*

15-F
4:30 p.m.
 "Market Development for Recycling Thermoset in Japan", Tatsundo Kitamura, *The RTC (RP Waste Recycling and Treatment Council) of The Japan Reinforced Plastics Society (JRPS)*

SESSION 16

RESINS

Room 204

Session Manager: Bruce Curry, *Owens-Corning*
Moderator: Gwilym Owen, *Reichhold Chemicals, Inc.*
Vice Moderator: Terry Sprow, *Owens-Corning*

16-A
2:00 p.m.
 "The Role of Interactions at Interfaces of Glass-Fiber Reinforced Composites", I. Ulkem, H. P. Schreiber, *Department of Chemical Engineering, Ecole Polytechnique*

16-B
2:30 p.m.
 "Effect of Styrene Emission-Inhibiting Additives on the Interfacial Fracture Toughness of a Laminated Glass Fiber Reinforced Polyester Matrix Composite", Thomas J. Mackin, *Department of Mechanical and Industrial Engineering, The University of Illinois at Urbana-Champaign*, Mikael O. V. Skrifvars, *Neste Oy, Technology Center*

16-C
3:00 p.m.
 "Toughened Polyester: A Novel System", R. Subramaniam, F. J. McGarry, *Department of Materials Science and Engineering, Massachusetts Institute of Technology*

16-D
3:30 p.m.
 "Strategic Price Indifference Analysis of Major UP Resin Raw Materials Marine UP Resin (A Case in Point)", Dr. Balaji B. Singh, Mihir I. Patel, *Chemical Market Resources*

16-E
4:00 p.m.
 "Analysis and Applications of Urethane-Unsaturated Polyester IPN", Y. C. Chou, B. Wang, L. James Lee, *Department of Chemical Engineering, The Ohio State University*

16-F
4:30 p.m.
 "Unique Sprayed Low-Density Coring and Laminating System", John Raymer, Claire Niland, *Venus-Glasmer*

WEDNESDAY AFTERNOON—FEBRUARY 9 (CONTINUED)

SESSION 17

REINFORCEMENTS

Room 205

Session Manager: David E. Diana, *PPG Industries, Inc.*

17-A
2:00 p.m.
"Design of Preforming Process for a Thermoformable Fiber Mat", Jingyi Xu, L. James Lee, *Department of Chemical Engineering, The Ohio State University*

17-B
2:30 p.m.
"Contribution of Interfacial Strength and/or Woven Structure on Composite Mechanics", Hiroyuki Hamada, Zenichiro Maekawa, *Faculty of Textile Science, Kyoto Institute of Technology, Hideki Ichihashi, Kyoto Institute of Technology, Ube Industries Ltd., Nobuo Ikuta, Osaka Municipal Technical Research Institute*

17-C
3:00 p.m.
"The Effect of Silane Structure on Glass Fiber Performance in Reinforced Composites", J. A. Gomez, J. A. Kilgour, *OSI Specialties, Inc.*

17-D
3:30 p.m.
"Design of Knitted Fabric Reinforced Composites", Wei-Lang Wu, *Asahi Fiber Glass Co., Ltd., Hiroyuki Hamada, Masaya Kotaki, Zenichiro Maekawa, Kyoto Institute of Technology*

17-E
4:00 p.m.
"Natural Fibers Used in Composite Materials", A. Balestrini, R. Giannetti, *Centro Ricerche Fiat, Strada Torino, F. Magaraggia, Comer S.p.A., H. Wolff, Dan Web-Dan Webforming INT. LTD.*

SESSION 18

SMC/BMC III

Room 206

Moderator: Jon Collister, *Premix/E.M.S., Inc.*

Moderator: Sean Walsh, *Reichhold Chemicals, Inc.*

Vice Moderator: Rob Seats, *Union Carbide Corporation*

18-A
2:00 p.m.
"Development of a Modular, Automatic SMC Charge Pattern Cutter", Troy A. Richey, *Buckeye Machine Fabricators, Inc.*

18-B
2:30 p.m.
"Recent Advances in Structural Adhesive Technology for Bonding SMC and Other Forms of Reinforced Plastics", Jeff Housenick, Vince Pascarella, *Ashland Chemical Company, Specialty Polymers & Adhesives Division*

18-C
3:00 p.m.
"ZMAP: A System for Measuring Surface Height", Frank Karpala, *Diffraacto Ltd.*

18-D
3:30 p.m.
"Applications of Dielectric Analysis for Cure Monitoring and Control in the Polyester SMC/BMC Molding Industry", David D. Shepard, Kelly J. Craven, *Micromet Instruments, Inc.*

18-E
4:00 p.m.
"LPMC—The Alternative in Composite Molding", Bryan Jacobson-Reighter, *National Composites, Inc.*

STUDENT POSTER SESSION

Exhibit Hall B

"The Effects of Pultrusion Parameters on Mechanical Properties of Shell EPON 862/W/537 Resin System", Jack A. McClurg, *University of Mississippi*

"The Effects of Processing Parameters on the Mechanical Properties of an Epoxy Resin/Graphite Composite", Denise Theobald, *University of Mississippi*

"Screw Threading of Graphite Composite Rods by a High Pressure Abrasive Waterjet", Matthew D. Sheridan, *University of Rhode Island*

"Slender Doubly Symmetric Fiber-Reinforced Plastic Columns", David William Scott, *Georgia Institute of Technology*

The 49th Annual Composites Institute Conference formally closes at 6:00 p.m.
Thank you for attending and helping us have a successful conference.

Please join us next year for the 50th Annual Conference & EXPO '95, January 30–February 1, 1995,
at the Cincinnati Convention Center.

SESSION MANAGERS



JAMES L. CHEVALIER
Baltek Corporation

SESSION MANAGER FOR:
Corrosion

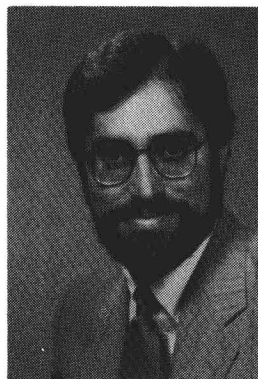


BRUCE CURRY
Owens-Corning

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Resins

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SESSION MANAGER FOR:
SMC/BMC I, II and III



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PPG Industries, Inc.

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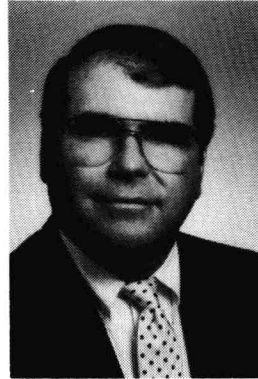


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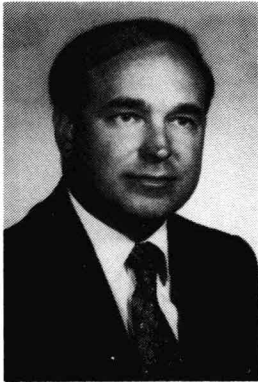
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Recycling



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Interplastic Corporation
SESSION MANAGER FOR:
Marine



JEFFREY D. MARTIN
Composite Window Technologies
SESSION MANAGER FOR:
Pultrusion I and II



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SESSION MANAGER FOR:
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Corporate PR Services

RAYMOND L. MILLER
Northern Fiber Glass Sales, Inc.

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Product Design Center

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Sikorsky Aircraft

ENVIRONMENTAL/RECYCLING

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Menasha Corporation

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MATERIALS PAPERS

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Interplastic Corporation

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R.J. Marshall Company

PROCESSING PAPERS

B. D. PRATT, Sub-Chairman
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JOSEPH S. McDERMOTT
Composites Services Corporation

GERALD D. SHOOK
Consultant

RESEARCH PAPERS

K. TELFORD MARSHALL,
Sub-Chairman
Consultant

JON COLLISTER
Premix, Inc.

LEONARD M. POVEROMO
Grumman Aircraft Systems

TESTING PAPERS

DOUG DENTON, Sub-Chairman
Chrysler Engineering

H. R. EDWARDS
Amoco Chemical Company

ROBERT J. NARSAVAGE
Anhydrides & Chemicals Inc.

Session 1

REVOLUTIONIZING THE WATERFRONT WITH COMPOSITES

NOTE: Session 1 was a panel discussion, and therefore there were no technical papers for this Proceedings Book.

Session 2

PULTRUSION I

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Determination of Shear Properties for RP Pultruded Composites

ABSTRACT

A complete understanding of the behavior of a structural system comprising RP components necessitates the determination of material properties for these components. Properties of interest include tensile, compressive, shear and bending stiffness and strength. This study focuses on the identification of a reliable test method for the determination of in-plane shear modulus and strength. Iosipescu shear tests and torsion tests were conducted on coupon samples. Results indicate that the torsion test is an easier and reliable method for the determination of shear modulus whereas the Iosipescu test should be used for the determination of shear strength.

INTRODUCTION

Shear properties are needed in the design of RP structures when considering local buckling, web crippling and connections in thin-walled structural members. Manufacturers' literature generally tend to overlook the shear properties and concentrate on in-plane moduli and strength, flexural moduli and strength, full-section moduli etc. The in-plane shear modulus G_{12} and shear strength S need to be established since these properties can control the behavior of the system. At times, a high longitudinal modulus can be obtained at the expense of a low in-plane shear modulus. The objective of this study was to identify an easy and reliable test method while producing material property data needed for design purposes.

In this study, two test methods were used for the determination of shear stiffness: 1) Iosipescu shear test method; and 2) Torsion test. The growing use of the Iosipescu shear test method for composite materials motivated us to use this test method for our experiments and thereby establish its reliability for pultruded materials. A redesigned Wyoming fixture was built for this test. Manufacture of the test samples was cumbersome and laborious. Also, a large scatter was observed in the test results. To overcome the problems encountered during the Iosipescu test a torsion test setup was used for the determination of shear modulus. Manufacture of the samples was easier and this test allowed us to use a larger sample thereby providing us with an average value of shear modulus for the composite laminate. For the prediction of shear modulus, an elasticity solution with contiguity was used. The predicted values did not correlate well with the experimental data. Therefore, a stress partition parameter ' η_s ' was used. The stress partition parameter was obtained

using experimental data for currently produced pultruded materials and assuming that it remained constant while varying the fiber volume and resin properties during material optimization studies.

IOSIPESCU SHEAR TEST METHOD

There has been an increasing trend in the composite materials community to use the Iosipescu shear test method for the determination of shear properties. The Iosipescu shear test method, originally developed by Nicolae Iosipescu for metals and isotropic materials (Iosipescu, 1967) is being widely used in the composites community for the characterization of shear properties. Many researchers in recent years have used this test method and presented their results (Spigel et al., 1987; Adams and Walrath, 1987; Bank, 1989). The growing use of the Iosipescu test method for composite materials motivated us to use this method for our experiments and thereby establish its reliability for pultruded materials.

Specimen Geometry and Preparation

Specimens were obtained from the web and flanges of an 8 × 8 × 3/8 in. I-beam (Vinyl ester 1525, CP stock WFI-beam, Creative Pultrusions, 1988). The specimen is 3 in. long, 0.75 in. wide, 0.375 in. thick. Initially, the specimen had a planar rectangular shape before notches were cut on the longitudinal sides of the specimen at a depth equal to 20 percent of the specimen width, i.e., to a depth of 0.15 in. and a notch radius of 0.05 in. This was done by drilling a hole using a 0.1 in. diameter drill bit to a depth of 0.15 in. at the midsection of the specimen. The notch was ground using a 60 grit abrasive wheel while the specimen was fixed at a 45 degree angle. The depth of the cut was increased gradually in small steps in order to obtain a notch with an angle of 90 degrees merging smoothly into the notch radius of 0.05 in.

Test Procedure

The test fixture (Figure 1) was fabricated at West Virginia University on the lines of the redesigned Wyoming fixture. The shear test fixture was used in a testing machine set up in a compression mode to test specimens 0.75 in. wide allowing a variation of 0.04 inch on that width. The fixture comprises two identical halves of which the left half is fixed to the base and the right half moves up and down on four posts and a recirculating ball bushing. The right half of the fixture is so designed to be easily attached to the crosshead of a testing machine. The crosshead holds and positions the fixture and the specimen can be easily installed. The advantage of using this fixture

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