

BIOGRAPHIES & ABSTRACTS

WOODFRAME HOUSING DURABILITY AND DISASTER ISSUES

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Las Vegas, Nevada, USA



A F & P A ®



The conference is sponsored by the Forest Products Society in cooperation with the USDA Forest Service, Forest Products Laboratory Advanced Housing Research Center and the Coalition for Advanced Housing and Forest Products Research; Forintek Canada Corporation; American Forest & Paper Association; and APA – The Engineered Wood Association.

PLANNING COMMITTEE

Conference Chair

Frank C. Beall, Ph.D.

Professor

University of California at Berkeley

Berkeley, California

Dr. Frank Beall is a Professor at the University of California at Berkeley and expert in wood science and technology. His areas of expertise includes evaluation of housing and nearby vegetation for vulnerability to fires in the urban-wildland interface and the identification of possible mitigation. His areas of interest include: 1) developing better knowledge of the fire scenarios that lead to loss of structures; 2) designing and conducting fire tests to lead to new fire performance protocols; and 3) transfer fire mitigation technology to homeowners, builders, architects, and fire authorities. His professional activities include: Past President, Forest Products Society; Past President, Society of Wood Science and Technology; Fellow and Past Secretary-Treasurer, International Academy of Wood Science; Fellow and Past Chair, Acoustic Emission Working Group; Past Chair, ASTM Committee D7 on Wood; Coordinator, Research Group S5.02, Physiomechanical Properties of Wood, International Union of Forestry Research Organizations; and Member, American Society for Nondestructive Testing. He is the author of 130+ publications, including 12 patents. He received a B.S. in Wood Utilization from Pennsylvania State University, and M.S. and Ph.D. degrees in Wood Products Engineering from State University of New York at Syracuse.

Planning Committee Members and Session Moderators

Arthur B. Brauner

Executive Vice President

Forest Products Society

Madison, Wisconsin

Arthur Brauner received B.S. and M.S. degrees in Wood Science & Technology from the University of Michigan. He has been Executive Vice President of the Forest Products Society since 1976. He came to the Society in 1968 as Editor of Publications and Director of the Society's computerized information retrieval system. Previously, he was on the staff of West Virginia University's School of Forestry as a Research Assistant and Assistant Professor.

Ian de la Roche, Ph.D.

President and CEO

Forintek Canada Corporation

Vancouver, British Columbia, Canada

Dr. Ian de la Roche became President and Chief Executive Officer of Forintek Canada Corporation in January 1992. Forintek was established in 1979 as Canada's national wood products research institute, and is a partnership of industry, the federal government, and seven provincial governments. It has laboratories in Vancouver, British Columbia, and Sainte-Foy, Quebec, and regional offices in Edmonton, Alberta; Prince Albert, Saskatchewan; and Ottawa, Ontario. It delivers programs in information, technology, and training, which are geared to help the wood products industry increase its productivity, create new value-added products, and protect and extend its markets in North America and around the world. Dr. de la Roche brought to Forintek over 20 years of experience in research, strategic planning, and the building of industry-government partnerships. In his previous positions, he played a key role in the establishment of programs to facilitate commercialization of new technology and the development of joint R&D ventures with industry, government, and universities. During 1990-91, he held the position of Assistant Deputy Minister of Consultation and Communications, Agriculture Canada. He headed up the Communications Branch and was a senior advisor to the Minister of Agriculture Canada. Prior to that, he held the position of Assistant Deputy Minister of the Department of Western Economic Diversification Canada, Saskatchewan. At Western Diversification, he was responsible for the Diversification Fund in the province and was

the senior federal coordinator on Economic issues. Previous to this appointment, he was a scientist and Senior Research Manager with Agriculture Canada for 18 years. He received a B.S. from McGill University, M.S. from the University of Massachusetts, and Ph.D. from the University of Illinois. He has published 75+ articles, 50 of which have been in the area of plant genetics, physiology, and biotechnology. Committees which Dr. de la Roche is currently serving on include: President, Forest Products Society; Adjunct Professor, Nanjing Forestry University and Beijing Forestry University; National Forest Strategy Coalition; National Forest S&T Forum; University of British Columbia, Faculty of Forestry, Dean's Advisory Committee; University of California at Berkeley, Faculty of Forestry, Advisory Committee; Forest Products Research Network Forum; Government of Canada, Forest Sector Advisory Council - Sub-Committee Working Group on Science & Technology; and Vancouver Board of Trade, Advanced Technology Task Force.

Greg C. Foliente, Ph.D.

Principal Research Scientist/Team Leader

CSIRO Manufacturing & Infrastructure Technology

Highett, Victoria, Australia

Dr. Greg Foliente is a Principal Research Scientist and Team Leader with CSIRO Manufacturing & Infrastructure Technology in Highett, Victoria, Australia. The team's research focus is on whole-of-life performance and governance of built assets, including: sustainable build-ings and life-cycle analysis; life-time engineering, service life modeling, and asset and facility management; structural mechanics, nonlinear dynamics, system identification, and random vibrations; structural performance against natural and man-made hazards and extreme events; probabilistic modeling and simulation, risk and reliability analysis; and performance approach in building and construction. Before joining CSIRO, Dr. Foliente worked as a Researcher and Instructor at Virginia Tech and as a Researcher at the University of California (UC) Berkeley. While at CSIRO, he has also been a Visiting Researcher at Japan's Building Research Institute (Tsukuba) and at UC Berkeley's Engineering Systems Research Center. He has received numerous awards and has an extensive publications record, contributing a chapter in a book published by ASTM (2000) and an article in the *Encyclopedia of Materials: Science and Technology* (Elsevier, London, 2001), and editing and co-editing two specialty publications for the Forest Products Society. His professional activities include: National Program Director, Australian Performance Based Building Network (Aus-PeBBu); Program Leader, Australian EVERGEN Program - a national collaborative program with industry to create the built environment through excellence, innovation, and high performance; International Coordinator, CIB Program on Performance Based Building, International Council for Research Innovation in Building and Construction (CIB), Rotterdam, The Netherlands; and Keynote presentations at the 2004 PeBBu Conference, 2001 CIB World Building Congress, and 1999 SWST Annual Meeting. He received a B.S. in Civil Engineering in the Philippines, and M.S. in Forest Products, M.S. in Civil Engineering, and Ph.D. from Virginia Tech, Blacksburg, Virginia.

Stephen L. Quarles, Ph.D.

Cooperative Extension Advisor

University of California at Berkeley

Richmond, California

Dr. Stephen Quarles is a wood performance and durability Cooperative Extension Advisor at the University of California at Berkeley in Richmond, California. His areas of expertise include performance and durability of wood and wood-based products subjected to wildfire and moisture exposures and physical properties of wood. He is responsible for developing and implementing the outreach and applied research program on durability issues related to the in-service performance of wood and wood-based products and woodframed structures. Dr. Quarles joined the University of California in 1985, and prior to accepting the CE Advisor position in the fall of 2000, was Head of the Wood Building Research Center and the Service to Industry Program. He worked at a particleboard plant in southern Georgia, operated by Weyerhaeuser, initially through participation in a cooperative education program while an undergraduate, and then full-time from 1978-1980. He has published 50+ articles in refereed and non-refereed outlets, and numerous technical reports. He received a Ph.D. in Wood Science & Forest Products from the University of Minnesota and an undergraduate degree from Virginia Tech.

Michael A. Ritter, P.E.
Assistant Director, Wood Products Research
USDA Forest Service
Forest Products Laboratory
Madison, Wisconsin

Michael Ritter is the Assistant Director for Wood Products Research at the USDA Forest Products Laboratory in Madison, Wisconsin. In this position, Mr. Ritter provides program oversight for several units conducting research in the areas of forest mycology, wood anatomy, wood engineering, biodeterioration of wood, protection from decay, fire, and weathering, and evaluation of the economics of wood utilization. He heads the Advanced Housing Research Center at the Forest Products Laboratory, which evaluates and develops technology for both new and existing housing, and is co-chair for the Coalition for Advanced Housing and Forest Products Research and for the Residential Moisture Management Network. He is a registered Professional Engineer in the State of Alaska and Wisconsin.

John H. "Buddy" Showalter, P.E.
Director, Technical Media
American Forest & Paper Assn. /
American Wood Council
Washington, D.C.

Buddy Showalter joined the American Forest & Paper Association staff in 1992, and serves as Director of Technical Media for the American Wood Council (AWC). Mr. Showalter is a graduate of Virginia Tech, with a B.S. in Agricultural Engineering. His responsibilities at AWC include development of design tools like the *Allowable Stress Design (ASD) Manual for Engineered Wood Construction*, which includes the *National Design Specification® for Wood Construction (NDS®)*, and other technical media. Mr. Showalter coordinates the efforts of AF&PA's Agenda 2020 Wood and Wood Composites Task Group, which is responsible for development of industry research RFP's and review of research conducted by government agencies like the USDA Forest Service and Department of Energy. He also serves as the Editorial Board Chairman for *Wood Design Focus*, which is published by the Forest Products Society.

Steven C. Zylkowski
Director, Quality Services Division
APA - The Engineered Wood Association
Tacoma, Washington

Steve Zylkowski is Director of the Quality Services Division at APA-The Engineered Wood Association in Tacoma, Washington. He is responsible for determining, formulating plans, and establishing policies for grading and testing of member mills; and responsible for training and development of staff to execute the programs and convey the requirements of the standards to manufacturers. His professional activities include: Chair, Subcommittee on Structural Panels, American Society of Testing and Materials; U.S. delegate to ISO TC 89 on Panels and Chair of Work Group on Standards for OSB, International Standards Organization; and member of the American Wood Preservers Association, Building Envelope Research Consortium, Canadian Standards Association, Forest Products Society, and National Institute of Building Sciences. He received a B.S. in Forest Products from the University of Minnesota, and M.S. in Forest Products from Oregon State University.

Session Speakers and Poster Presenters

Terry L. Amburgey, Ph.D.
Professor
Department of Forest Products
Mississippi State University
Mississippi State, Mississippi

Dr. Terry Amburgey is a Professor in the Department of Forest Products at Mississippi State University (MSU) in Starkville, Mississippi. In a cooperative project now under way at MSU, Dr. Amburgey and others are seeking to solve climate-related housing

construction problems endemic to the Deep South: high heat, humidity, decay fungi, mold, high-wind events, and a variety of insects that include beetles and termites. The idea is to make sure newly constructed homes in this part of the country have a chance of surviving to a ripe old age. Funded by an initial \$126,000 grant from the U.S. Forest Service's Forest Products Laboratory, the project Dr. Amburgey directs is a part of the Coalition for Advanced Housing and Forest Products Research that is associated with the Advanced Housing Research Center of the USFS FPL. The MSU housing project includes faculty members in forest products, civil and mechanical engineering, landscape architecture, and architecture. Dr. Amburgey received a B.S. in General Forestry and M.S. in Forest Pathology from the State University of New York, College of Environmental Science & Forestry, and Ph.D. in Plant Pathology from North Carolina State University.

William Asdal
Managing Member
University for Contractors, LLC / Asdal Builders, LLC
Chester, New Jersey

Bill Asdal is Managing Member of University for Contractors, LLC and Asdal Builders, LLC in Chester, New Jersey. With an Undergraduate degree in Industrial Education, a Master's in Administration and Supervision, and 6 years of experience teaching high school behind him, Mr. Asdal suddenly gave up teaching in 1978 when presented with the opportunity to build a new custom home. He is also involved in property management, rejuvenating and leasing undervalued or depressed properties. Engaged to speak at numerous seminars about codes, estimating, diversification and business management, Mr. Asdal has, over the past decade, talked not about his own achievements but about the industry, its systems and methods by which construction professionals can improve their businesses. Asdal Builders, LLC received the 2000 Remodeler of the Year Award by the National Association of Home Builders-Remodelers Council.

Mikael Bergström
Ph.D. Student
School of Technology & Design
Växjö University
Växjö, Sweden

Mikael Bergström is a Ph.D. Student in the School of Technology & Design, Växjö University, Växjö, Sweden. He received a M.S. in Chemical Engineering from Umeå University, Sweden.

Daniel W. Cautley, P.E.
Owner
Cautley Engineering
Washington, D.C.

Dan Cautley is the Owner of Cautley Engineering in Washington, D.C. The firm provides consulting services on moisture and mold, energy, comfort, and materials failures. Mr. Cautley's expertise is in housing technical research, construction, consulting, program operation, and small business management, with 25+ years of practical experience. His work history includes: Housing technical research - Development and execution of contract research projects, including detailed moisture monitoring in a Wisconsin test home, collection of foundation wall moisture data in several homes, collection of maintenance and reliability data from homes in the Southwest, analysis of energy savings in a large window replacement project, and participation in a project investigating soot accumulation in homes. Consulting work with builders and owners - Investigation of excess moisture accumulation and mold growth using inspection, moisture testing, occupant interviews, short-term monitoring, and laboratory evaluations. Investigation of soot staining problems, materials failures, comfort complaints, and other building performance problems, and expert witness testimony in legal cases. He is a registered Professional Engineer in the State of Wisconsin and the author of numerous publications. He received a B.S. in Mechanical Engineering from Stanford University, Palo Alto, California.

Jim Cheng, Ph.D., ARM
Senior Research Analyst, Building Technology
Research Unit
State Farm Insurance Companies
Bloomington, Illinois

Dr. Jim Cheng is a structural engineer and research analyst with a certification in risk management for State Farm Insurance Companies. He has been conducting research and testing of residential construction systems and components at the State Farm Building Technology Laboratory, and providing technical support to P&C underwriting and claims, in the areas of building technology, risk management, and loss mitigation. Dr. Cheng received a Ph.D. from the Wood Materials & Engineering Laboratory at Washington State University, and M.S. in Wood Technology from the University of Illinois. He is a member of the Forest Products Society, American Society of Civil Engineers, and a committee member of the AF&PA Wood Design Standards Committee.

Marilou Cheple
Extension Educator/Instructor,
Cold Climate Housing Program
Department of Wood & Paper Science
University of Minnesota
St. Paul, Minnesota

Marilou Cheple is an Extension Educator and Instructor, Cold Climate Housing Program, Department of Wood & Paper Science, University of Minnesota, St. Paul, Minnesota. Her background includes home inspection, real estate, and home building. She returned to the University of Minnesota and completed a M.S. degree in 1996 with a housing major and building science minor. Her thesis work and continued research is in the area of moisture control and indoor air quality. She has been teaching for 5 years in the departments of Wood & Paper Science and Design, Housing & Apparel.

Carol A. Clausen
Research Microbiologist
USDA Forest Service
Forest Products Laboratory
Madison, Wisconsin

Carol Clausen, Research Microbiologist at the USDA Forest Products Laboratory in Madison, Wisconsin, has conducted research on biodeterioration and protection of wood for the past 20 years. Ms. Clausen received a B.S. in Microbiology from Western Illinois University and M.S. in Bacteriology from the University of Wisconsin. Her research has led to the development of new detection methods for decay and mold fungi, including a patented method for the early diagnosis of fungal decay in wood. Ms. Clausen also studies copper tolerance in brown-rot fungi, inhibition of mold growth on wood-based building products, and recycling methods for treated waste wood with the ultimate objective of increasing the service life of wood products. She is a member of the American Society for Microbiology, the International Research Group on Wood Preservation, and the International Biodeterioration and Biodegradation Society.

Jay H. Crandell, P.E.
Owner/Consulting Engineer
Applied Residential Engineering Services
West River, Maryland

Jay Crandell is a Consulting Engineer and Owner of Applied Residential Engineering Services (ARES) in West River, Maryland. Mr. Crandell is a registered Professional Engineer and the author of numerous publications. His professional memberships and activities include: American Society of Civil Engineers, Member; International Conference of Building Officials, Member; Committee Member, ASCE 7 Standard, Minimum Design Loads for Buildings and Other Structures; Secretary, ASCE 32 Standard, Design and Construction of Frost-Protected Shallow Foundations; Secretary, ASCE Special Project on Residential Building Loads; National Earthquake Hazard Reduction Program, Member of Wood Design Technical Subcommittee; ASTM D7 Committee on Wood; and ASTM E6 on Building Performance. He received a B.S. in Agricultural Engineering from Virginia Tech, Blacksburg, Virginia.

J. Daniel Dolan, Ph.D., P.E.
Professor
Department of Civil & Environmental Engineering
Washington State University
Pullman, Washington

Dr. J. Daniel Dolan is a Professor in the Department of Civil & Environmental Engineering at Washington State University in Pullman, Washington. His research focuses on dynamic loads on low-rise buildings (seismic and wind); dynamic response of light-frame buildings (seismic, wind, and vibration); full-scale static, cyclic, and dynamic testing of structural assemblies (walls, floors, and roofs); response of dowel connections; and numerical modeling of structural and material response to static and dynamic loading (finite element analysis and closed-form numerical modeling). Courses taught include: Design of timber structures, Advanced mechanics of materials, and Advanced design of timber structures. He is a registered Professional Engineer in the State of Wisconsin and Virginia and the author of numerous publications. He received a B.S. in Civil Engineering from Montana State University, M.S. in Civil Engineering from the University of Washington, and Ph.D. in Civil Engineering from the University of British Columbia.

Rose Geier Grant, AIA
Program Director, Building Technology Research Unit
State Farm Insurance Companies
Bloomington, Illinois

Rose Geier Grant is the Program Director for State Farm's Building Technology Research Unit. The unit consists of architectural and engineering staff who work to identify insured losses and potential mitigation initiatives. The performance of building materials and assemblies as well as appliances and other devices that affect State Farm's customers are studied by the unit. Members of the unit share their research in professional forums as well as contribute to policyholder and public education programs on risk mitigation. Additionally, Ms. Grant serves as State Farm's liaison to the construction and disaster research communities. Ms. Grant holds Bachelor's and Master's degrees in Architecture from the University of Illinois (UI) at Urbana-Champaign and is a licensed architect. Previously, she was a Research Architect at the University of Illinois, School of Architecture, Building Research Council, where she managed the "Energywise Homes" (HERS) program for the State of Illinois. She was also involved in a variety of research projects and regularly lectured on building codes and energy efficient design. Prior to her service at UI, she was a building code official for the City of Urbana, Illinois. Ms. Grant sits on the Consultative Council of the National Institute of Building Sciences. She is a member of the American Institute of Architects, the National Consortium of Housing Research Centers, the ICC, NFPA, NAHB, ASTM, and the Illinois Protective Officials Conference. She served on the drafting and code development committees of the ICC's (International Code Council) International Residential Code (IRC) 2000 edition. In 2004, she was invited to participate in the National Science Foundation's (NSF) Partnership for Advancing Technology in Housing (PATH) Housing Research Agenda Project.

Frederick Green III, Ph.D.
Research Microbiologist
USDA Forest Service
Forest Products Laboratory
Madison, Wisconsin

Dr. Frederick Green is a Research Microbiologist in the Biodeterioration Work Unit at the USDA Forest Products Laboratory in Madison, Wisconsin. His professional experience includes: Bench scientist working on the mechanisms of brown-rot fungal decay; collaborated on Patent for immunological early detection of brown-rot decay; principal investigator for USDA-NRI competitive grant: Inhibition of brown-rot decay by selective precipitation of calcium ions by NHA (1996-1999); and collaborated on 2004 Patent: "Naphthalenic Compounds as Termite Bait Toxicants." He received a B.S. in Biology from Muhlenberg College, Allentown, Pennsylvania; a degree in Veterinary Science from the University of Wisconsin-Madison; and a Ph.D. in Medical Microbiology from the University of Wisconsin Medical School-Madison.

Rakesh Gupta, Ph.D.
Associate Professor
Department of Wood Science & Engineering
Oregon State University
Corvallis, Oregon

Dr. Rakesh Gupta is an Associate Professor in the Department of Wood Science & Engineering at Oregon State University in Corvallis, Oregon. He conducts research in the area of wood engineering/mechanics and teaches courses in wood design/mechanical behavior of wood. He received a B.Tech. from G.B. Pant University, Pantnagar, India; M.S. from the University of Manitoba, Winnipeg, Canada; and Ph.D. from Cornell University, Ithaca, New York.

Mick Hedley, Ph.D.
Senior Scientist, Wood Processing & Products
New Zealand Forest Research Institute Ltd.
Rotorua, New Zealand

Dr. Mick Hedley is Senior Scientist of Wood Processing & Products at the New Zealand Forest Research Institute Ltd. in Rotorua, New Zealand. His responsibilities include research in wood protection and wood performance enhancement.

Shane C. Kitchens
Ph.D. Student
Department of Forest Products
Mississippi State University
Mississippi State, Mississippi

Shane Kitchens received a B.S. (1993) and M.S. (1997) in Forest Products from Mississippi State University and is currently working on a Ph.D. in Forest Resources at Mississippi State University. Following graduation, he accepted a position with Buckman Laboratories (1995) located in Memphis, Tennessee. While working for Buckman, he oversaw hardwood and softwood sawmill accounts in a three state southeastern region, summarized the Wood Technologies section in the Bulab technical forum, and edited the *Sawmill Times*, a quarterly publication produced by the Wood Technologies group. Mr. Kitchens took a job with Corley Manufacturing Company (1998) in Chattanooga, Tennessee. With Corley, he was a Product Manager with primary duties consisting of the commercialization of the TASK Process, overseeing the Corley/Lewis optimized edger program, and coordinating all advertising efforts. He has authored and coauthored 15+ publications and has given many formal and numerous informal presentations in the last 10 years on the subject of lumber discolorations and wood preservation. He has codeveloped two U.S. patents and currently holds memberships in the Forest Products Society and the Railway Tie Association.

Vladimir G. Kochkin
Research Engineer
NAHB Research Center
Upper Marlboro, Maryland

Vladimir Kochkin is a Research Engineer at the NAHB Research Center in Upper Marlboro, Maryland. He conducts analytical and experimental research related to the structural performance of residential construction with a focus on high seismic and wind issues, and participates in the code development process related to regulation of design and construction methods. He received a B.S. in Civil Engineering from Vyatka State Technical University, Kirov, Russia; and M.S. in Wood Science & Forest Products from Virginia Tech, Blacksburg, Virginia.

Robert H. Leicester, Ph.D.
Research Fellow
CSIRO Manufacturing & Infrastructure Technology
Highett, Victoria, Australia

Dr. Robert Leicester is a Research Fellow at CSIRO Manufacturing & Infrastructure Technology in Highett, Victoria, Australia. He has accepted more than 50 overseas invitations to present conference keynote papers, workshops, and technology transfer events. His pioneering research work resulted in several national and international

prized and awards. While at CSIRO, he has been heavily involved with the Australian timber industry and the use of timber in construction. In particular, he developed many of the concepts now used to engineer the performance of timber structures, particularly with respect to understanding the risk of attack by cyclones, fire, bushfires, decay, and termites, and to developing methods of addressing this risk. He has been credited for technical concepts and solutions that have been considered world firsts in a number of areas. He also established a reputation of developing simple and practical solutions out of very sophisticated mathematical, statistical, and numerical solutions to complex problems. As part of his activities, he drafted many national standards (for Standards Australia) and international standards (for the International Standards Organization) for the use and trade of structural timber. He was Chair of the first joint meeting (1992) of the Australian and New Zealand Standards Associations, following the Closer Economic Relations agreement between these two countries to include such activities. In 1995, the Australian Department of Primary Industry, Science & Technology and the Japanese Ministry of Construction initiated a long series of inter-country meetings to discuss ways of overcoming technical barriers to trade in building products between these two countries. Dr. Leicester has been an active member of these meetings and was the leader of the technical group for the first meeting. During his career, he has maintained an active interest in assisting in the technological development of developing countries, through participation in technical aid projects such as those funded by Australian aid agencies and international aid agencies. This has included participation in numerous projects and workshops in South America, Africa, and South East Asia. He has studied in India, Seychelles and England, studied and worked in Perth, and obtained his Ph.D. from the University of Illinois at Urbana-Champaign.

Robert J. Leichti, Ph.D.
Associate Professor
Department of Wood Science & Engineering
Oregon State University
Corvallis, Oregon

Dr. Robert Leichti is an Associate Professor at the Department of Wood Science & Engineering, Oregon State University, Corvallis, Oregon. His expertise includes timber engineering and mechanical properties of wood. His current research programs include glulam flexural members reinforced with high-strength fiber laminate; three-dimensional structural behavior of light-frame buildings; connections for heavy timber systems; and finite-element modeling. He is the author of numerous publications. He received B.S. and M.S. degrees from the University of Illinois, and M.S. and Ph.D. degrees from Auburn University.

Yue Li
Ph.D. Candidate
School of Civil & Environmental Engineering
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Yue Li is a Ph.D. Candidate in the Department of Civil & Environmental Engineering, Georgia Institute of Technology, Atlanta, Georgia. His thesis topic is fragility methodology for performance-based engineering of light-frame wood residential construction subjected to wind and earthquake hazards.

John "Rob" Melton, P.E.
Project Engineer
Bracken Engineering, Inc.
Tampa, Florida

John "Rob" Melton is a Project Engineer at Bracken Engineering in Tampa, Florida. His responsibilities include forensic investigations and precast concrete design. Previously, he was Project Engineer/Manager at Barcon, Inc. He received a BSCE (Civil/Structures) from the University of South Florida, Tampa.

Chuck Murray
Energy Specialist
Washington State University Energy Program
Olympia, Washington

Chuck Murray is an Energy Specialist with the Washington State University Energy Program in Olympia, Washington. Mr. Murray has 13 years experience in developing, implementing, and evaluating energy efficient construction strategies. He has served as research lead for projects evaluating residential heating systems, ventilation systems, and currently heads a major study evaluating the heat and moisture transport characteristics of building envelopes. Mr. Murray is also active in the development of state and national energy codes and provides implementation training for these standards.

Jennifer O'Connor
Research Scientist
Forintek Canada Corporation
Vancouver, British Columbia, Canada

Jennifer O'Connor is a Research Scientist at Forintek Canada Corporation in Vancouver, British Columbia, Canada. She has a background in both architecture and engineering, with a career that includes teaching and research in addition to design practice, in the U.S. and Canada. This experience enables her to serve the Markets and Economics Group, performing market research and providing a link between the wood industry and the building industry. She additionally has technical responsibilities in building science, durability, and environmental research. She received Bachelor of Architecture and Master of Architecture degrees from the University of California-Berkeley.

Martin Ohlmeyer, Ph.D.
Research Scientist/Project Leader
Department of Wood Physics & Mechanical
Technology of Wood
Federal Research Center for Forestry & Forest Products
Hamburg, Germany

Dr. Martin Ohlmeyer is a Research Scientist and Project Leader in the Department of Wood Physics & Mechanical Technology of Wood, Federal Research Center for Forestry & Forest Products, Hamburg, Germany. His responsibilities include research projects in wood technology, wood-based panel process technology, surface technology, and wood-based panels as a building product. He is also a Lecturer at the University of Hamburg. He received a Dr. rer. nat. degree in 2002 and a Diplom-Holzwirt (diploma in Wood Science & Technology) in 1997; both from the University of Hamburg, Germany.

Philip O'Sullivan
Building Consultant/Director
Prendos Ltd.
Auckland, New Zealand

Philip O'Sullivan is a Building Consultant and Director of Prendos Ltd. in Auckland, New Zealand. He is a registered Building Surveyor, BRANZ Accredited Adviser, and is well-known for his weathertightness expertise. He is also President of the Cladding Institute of New Zealand, Member of E2 (External Moisture) Advisory Group for Building Industry Authority, and Committee Member for Durability and Weathertightness Standards. He received a Bachelor of Engineering (Civil) from Auckland University, Auckland, New Zealand.

Marjan Popovski, Ph.D., P.E.
Research Scientist/Quality Assurance Manager
Forintek Canada Corporation
Vancouver, British Columbia, Canada

Dr. Marjan Popovski is a Research Scientist and Quality Assurance Manager in the Wood Engineering Department at Forintek Canada Corporation's Western Laboratory in Vancouver, British Columbia, Canada. He is a project leader for several research projects in the area of performance of wood-based structural systems (tall woodframe shearwalls, braced frames, and moment resisting frames) subjected to

gravity, wind, and earthquake loading. As a Quality Assurance Manager for the Wood Engineering Department, an accredited laboratory by the standards Council of Canada, Mr. Popovski makes sure that the research process in the Department complies with all requirements of the International Standard ISO 17025. He received a Structural Engineering degree from the Department of Structural Engineering, University "St. Cyril & Methodius", Skopje, Republic of Macedonia; a Master of Technical Sciences from the Institute of Earthquake Engineering & Engineering Seismology (IZIIS), University "St. Cyril & Methodius", Skopje, Republic of Macedonia; a Doctor of Philosophy from the Department of Civil Engineering, University of British Columbia, Vancouver, British Columbia, Canada; and his Post-Doctoral Fellowship with Forintek Canada Corporation, Vancouver, British Columbia, Canada.

Alexander A. Robertson, P.E.
Principal
Robertson & Associates
Huntington Beach, California

Alexander Robertson is a Consulting Professional Engineer at Robertson & Associates in Huntington Beach, California. He is responsible for the design of commercial, industrial, and large custom residential projects. His professional history includes: Captain, Civil Engineer Corps (Retired), United States Naval Reserve (1975-2001); Director of Engineering Design, Engineering Division, Tetra Tech, Inc. (1980-85); Civil/Structural Engineer, Department of Engineering & Construction, Southern California Edison Company (1975-80; 72-73); and Civil/Structural Engineer, Department of Civil Engineering, Bechtel Corporation (1973-75). He was also a faculty member at California State University-Long Beach, where he taught subjects in civil/structural engineering design, land surveying, and construction management. He also taught subjects in military engineering and provided leadership training to junior officers at the U.S. Naval Civil Engineer Corps Officers School. He is a registered Professional Civil Engineer in the States of California, Washington, Arizona, Colorado, Wyoming, North Carolina, and a member of several professional organizations. He received B.S. and M.S. degrees in Civil Engineering from California State University-Long Beach.

Alan S. Ross, Ph.D.
Vice President/Technical Director
Kop-Coat, Inc.
Pittsburgh, Pennsylvania

Dr. Alan Ross is Vice President and Technical Director of Kop-Coat, Inc. in Pittsburgh, Pennsylvania. His responsibilities include directing Kop-Coat's global research and development efforts in wood preservatives and specialty coatings. Previously, he was Manager of Product Development, Protection Products Division, Koppers Company, Inc., Pittsburgh, Pennsylvania; Manager of R&D, Wolman Wood Preservative Division, Koppers Company, Inc., Pittsburgh, Pennsylvania; and Technical Director, Darworth Company, Avon, Connecticut. He received a B.S. in Chemistry from Case Western Reserve University, Cleveland, Ohio; and a Ph.D. in Organic Chemistry from Yeshiva University, New York, New York.

Åsa Rydell
Ph.D. Student
Department of Forest & Wood Technology
Växjö University
Växjö, Sweden

Åsa Rydell is a Ph.D. Student in the Department of Forest & Wood Technology, Växjö University, Växjö, Sweden. He received a M.S. in Biology from Växjö University, Sweden.

Elmer L. Schmidt, Ph.D.
Professor
Department of Wood & Paper Science
University of Minnesota
St. Paul, Minnesota

Dr. Elmer Schmidt is a Professor in the Department of Wood & Paper Science, University of Minnesota, St. Paul, Minnesota. He is the pro-

ject leader for wood deterioration, preservation, and biological process improvements in forest products. His current focus is on moisture and deterioration problems in millwork. He received a B.S. in Forest Science, M.S. in Plant Pathology & Microbiology, and Ph.D. in Plant Pathology & Forest Products from the University of Minnesota.

*Todd F. Shupe, Ph.D., FIWSc.
Associate Professor, Wood Science
Louisiana Forest Products Development Center
School of Renewable Natural Resources
LSU AgCenter
Baton Rouge, Louisiana*

Dr. Todd Shupe is an Associate Professor of Wood Science at the Louisiana Forest Products Development Center, School of Renewable Natural Resources, LSU AgCenter, Baton Rouge, Louisiana. His research focus is on treated wood recycling, wood quality, and wood composites. He is the current Chair of the Forest Products Society Midsouth Section and is a past member of the SWST Board of Directors. He is the author of numerous publications. He received a B.S. and M.S. in Forestry from the University of Illinois at Urbana-Champaign, and Ph.D. in Forestry from Louisiana State University.

*Ian Smith, Ph.D., P.Eng., FIWSc.
Acting Dean, University Research Scholar, and
Professor of Structural & Timber Engineering
Faculty of Forestry & Environmental Management
University of New Brunswick
Fredericton, New Brunswick, Canada*

Dr. Ian Smith is Acting Dean, University Research Scholar, and Professor of Structural & Timber Engineering, Faculty of Forestry & Environmental Management, University of New Brunswick, Fredericton, New Brunswick, Canada. His areas of expertise include wood products and engineering (structural and timber engineering). His research interests include structural mechanics, fracture and fatigue in wood, mechanical connection systems, and serviceability and ultimate load behavior of large structural systems. He received a B.S. in Civil Engineering from the University of Sunderland, Sunderland, England; M.S. in Structural Mechanics from the University of Durham, Durham, England; and Ph.D. in Timber Engineering from London South Bank University, London, England.

*W. Ramsay Smith, Ph.D.
Professor
Louisiana Forest Products Development Center
School of Renewable Natural Resources
LSU AgCenter
Baton Rouge, Louisiana*

Dr. W. Ramsay Smith is a Professor of Wood Science & Technology at the Louisiana Forest Products Development Center, School of Renewable Natural Resources, LSU AgCenter, Baton Rouge, Louisiana. His current research interests include wood product durability in residential construction with emphasis on Formosan subterranean termites, physical properties of wood and wood products, and international wood construction. Previous research efforts have included wood products in international trade, energy from forest biomass, and wood drying and drying systems. Dr. Smith is Past President of the Society of Wood Science & Technology and is active in numerous professional societies and organizations. He is currently serving as President-Elect of the Forest Products Society. He has organized a number of workshops and symposia and has authored 100+ publications. He was an Invited Professor at ENSTIB, University of Nancy for 6 months and has made numerous trips to Europe, Africa, Caribbean, South America, Asia, South Seas, Australia, Eastern Europe, and the former Soviet Union to study international trade in forest products, wood construction practices, and softwood and hardwood wood products industries and markets. In addition, he has been a consultant to FAO of the United Nations and the World Bank. He received a B.S. degree in Wood Science & Technology from North Carolina State University, and M.S. and Ph.D. degrees in Wood Science & Technology from the University of California-Berkeley.

*John F. Straube, Ph.D.
Assistant Professor and Director, Building
Engineering Group
University of Waterloo
Waterloo, Ontario, Canada*

Dr. John Straube has been deeply involved in the areas of building enclosure design, moisture physics, and whole building performance as a consultant, researcher, and educator. He is a faculty member in the Department of Civil Engineering and the School of Architecture at the University of Waterloo, where he teaches courses in structural design and building science to both disciplines. Research interests include driving rain measurement and control, pressure moderation, ventilation drying, energy, and full-scale natural exposure performance monitoring of wall systems. Energy-efficient, healthy, durable, and sustainable building designs are a general interest. He has broad experience in the building industry, having been involved in the design, construction, repair, and restoration of buildings in Europe, Asia, the Caribbean, United States, and Canada. As a structural engineer, he has designed with wood, hot-rolled and cold-formed steel, concrete, masonry (brick, concrete, aerated autoclaved concrete, natural stone), aluminum, polymer concrete, carbon and glass FRP, fiber-reinforced concrete, and structural plastics (PVC, nylon). He has consulted to many building product manufacturers and several government agencies (NRCC/IRC, NRCAN, CMHC, DOE, ORNL, PHRC) and is familiar with building-related codes (e.g. NBCC, CSA, NECB, ACI, DIN, etc.) and standards (e.g. CSA, CGSB, ASTM, AAMA, ASHRAE) as well as the measurement and testing procedures of the performance of buildings and their components. He received a B.A.Sc., M.A.Sc. (Civil Engineering), and Ph.D. (Civil Engineering) from the University of Waterloo, Ontario, Canada.

*George A. Tsongas, Ph.D., P.E.
Consulting Engineer and Professor Emeritus
Department of Mechanical Engineering
Portland State University
Portland, Oregon*

Dr. George Tsongas is a building scientist specializing in moisture problems in buildings and construction defects and water intrusion. He has inspected over 10,000 dwelling units as a researcher and expert witness. He has undertaken computer simulation and numerous laboratory tests to better understand water intrusion and its effects in residential walls. He received a B.S. in Mechanical Engineering, M.S. in Aeronautical Engineering, degree in Aeronautical & Astronautical Engineering, and Ph.D. in Aeronautical & Astronautical Sciences from Stanford University, Stanford, California.

*John W. van de Lindt, Ph.D.
Associate Professor
Department of Civil Engineering
Colorado State University
Fort Collins, Colorado*

Dr. John W. van de Lindt received a Ph.D. in Structural Engineering from Texas A&M University in 1999. He was an Assistant Professor in the Department of Civil & Environmental Engineering at Michigan Technological University, where he focused his research program on coupling nonlinear dynamics and structural reliability during extreme loading events such as earthquake and wind. This included the development of new nonlinear numerical models and experimental investigations to calibrate those models and support research hypotheses. A related focus was reliability-based design code calibrations for LRFD and performance-based design methodologies, the former focusing on strength-based assessments and the latter developing and applying damage-based models. He has successfully led federal, state, and one industry sponsored project, published in scholarly journals such as the *Journal of Structural Engineering*, *Engineering Structures*, and the *International Journal of Modeling & Simulation*, and presented at national and international conferences. He has experience teaching both undergraduate and graduate structural engineering courses, and he developed a graduate Structural Dynamics II semester course in 2002, which focused primarily on methods in earthquake engineering analysis. He is also active on ASCE/SEI Committees and currently chairs the Committee on the Reliability-Based Design of Wood Structures. In the summer of 2004, Dr. van de Lindt joined the faculty

at Colorado State University as an Associate Professor, where he is continuing his research in seismic reliability of woodframe structures.

John A. VavRosky
Structural Panels Marketing Manager
Potlatch Corporation
Spokane, Washington

John Vavrosky is the Structural Panels Marketing Manager at Potlatch Corporation in Spokane, Washington. His responsibilities include coordinating advertising and promotional activities for seven wood products manufacturing facilities, which includes media networking for trade publication content, trade show management, and promotional literature generation, as well as supervising five field based marketing representatives who call on builders, architects, and other industry professionals. He also serves as a resource to answer technical questions on Potlatch's products and provides installation advice. He received a B.A. in Management from the University of Portland, Portland, Oregon.

Robert L. Wendt
Research Architect
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Robert Wendt is a Research Architect at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. His research areas include: energy efficient residential building systems; repair and renovation of existing homes; energy efficient residential products, appliances, and equipment; flood and wild fire damage resistant housing systems; very low-cost housing; healthy housing; and residential hot water distribution systems. He is a registered Architect in the State of California. He received a Bachelor of Architecture from the Illinois Institute of Technology in Chicago, and a Master of Art in Industrial Design from Stanford University, Stanford, California.

Dan L. Wheat, Ph.D., P.E.
Professor
Department of Civil Engineering
University of Texas at Austin
Austin, Texas

Dr. Dan Wheat is a Professor of Civil Engineering at the University of Texas at Austin, where he has been since 1980. His teaching and research are in structural analysis and in the behavior and modeling of light-frame wood structural systems. He is the author of numerous publications. He received a B.S. in Civil Engineering from the University of Colorado, M.S. in Civil Engineering (Structures) from the University of Denver, and Ph.D. in Civil Engineering (Structures and Solid Mechanics) from Colorado State University.

R. Sam Williams, Ph.D.
Senior Scientist
USDA Forest Service
Forest Products Laboratory
Madison, Wisconsin

Dr. R. Sam Williams is a Senior Scientist in the Wood Surface Chemistry Research Work Unit at the USDA Forest Products Laboratory (FPL) in Madison, Wisconsin. The mission of the work unit is to determine the basic mechanisms of wood surface deterioration outdoors, develop treatments for improving performance characteristics, and develop innovative products and processes for chemically modifying wood surfaces. Dr. Williams is responsible for a broad research program in wood surface chemistry, properties, modification, and protection. Dr. Williams' graduate studies and thesis dealt with the synthesis and properties of new organotin polymers. He showed that the final polymer properties could be controlled by subtle changes in the organotin pendants grafted to thermoset polymers. His research at FPL included studies of the performance of chemically treated wood surfaces exposed to ultraviolet (UV) radiation. The studies involved the investigation of chemical treatments to inhibit UV induced degradation of wood surfaces. Knowledge gained through these studies showed that grafted UV stabilizers to wood could protect wood from UV degradation and that stabilizing the wood coating interphase was

critical to the performance of clear coatings on wood. He received a B.S. in Chemistry from Westminster College, New Wilmington, Pennsylvania; and Ph.D. in Engineering Science from Washington State University, Pullman, Washington.

Thomas G. Williamson, P.E.
Vice President, Quality Assurance & Technical Services
APA - The Engineered Wood Association
Tacoma, Washington

Thomas Williamson is Vice President of Quality Assurance & Technical Services at APA - The Engineered Wood Association in Tacoma, Washington. He is responsible for overall management of all APA Quality Services Division and Technical Services Division activities. Quality assurance and technical services are provided to APA members who manufacture plywood, OSB, glulam, I-joists, and LVL. He received BSCE and MSCE degrees from Purdue University, West Lafayette, Indiana.

Dian-Qing Yang, Ph.D.
Research Scientist
Forintek Canada Corporation
Sainte-Foy, Quebec, Canada

Dr. Dian-Qing Yang is a Research Scientist at Forintek Canada Corporation in Sainte-Foy, Quebec, Canada. His current position at Forintek is targeted on the protection of wood and fiber products - through studies of physiology and ecology of various fungi that are responsible for mold, stain, and decay of wood products, to develop environmentally acceptable alternatives to currently used toxic wood protectants, and to develop products and processes that increase the value of Canadian forest products by physical, chemical, or biological methods. He is the author of 70+ publications in forest pathology, mycology, fungal molecular biology, biological control, and wood protection. He received a B.S. in Forest Protection, and M.S. in Forest Pathology from the Northeast Forestry University, Harbin, P.R. China; and Ph.D. in Forest Pathology from the University of Toronto, Toronto, Ontario, Canada.

Vina W. Yang
Research Microbiologist
USDA Forest Service
Forest Products Laboratory
Madison, Wisconsin

Vina Yang is a Research Microbiologist at the USDA Forest Products Laboratory in Madison, Wisconsin. She is responsible for conducting several research projects related to mold inhibition on wood products. Previously, she was a Research Specialist in the Department of Biochemistry, University of Wisconsin-Madison. She received a M.S. from Occidental College, Los Angeles, California.

Dean Youngkeit
Retired Aerospace Materials Engineer
Willard, Utah

Dean Youngkeit is a Retired Aerospace Materials Engineer from Willard, Utah. As a retired engineer, he wants to link aerospace optimization principles to woodframed housing technology. Previously, he was Senior Engineer for Composites at Thiokol Corporation. He has developed ideas yielding 22 patents (10 U.S. and 12 International). One patent was the basis for Thiokol's only non-aerospace spin-off at the end of the cold war. He has 4 years of university training in engineering and business.

ABSTRACTS

MONDAY, OCTOBER 4, 2004

SESSION I: Overview of Demonstration and Research Structures

Keynote Address: FPL Advanced Housing Research Center Partnerships and Activities

Michael A. Ritter, P.E., Assistant Director for Wood Products Research, USDA Forest Service, Forest Products Laboratory, Madison, WI

The USDA Forest Service, Forest Products Laboratory (FPL) was established in 1910 as the Federal wood utilization research laboratory. A key component of FPL programs has historically been partnerships with universities, industry, and other government agencies. Beginning in the late 1990's, several partnerships have focused on woodframe housing research and technology transfer. This presentation will overview the development and operation of these partnerships with an emphasis on areas related to durability and disaster mitigation. Included will be discussions of the Coalition for Advanced Housing and Forest Products Research, the Residential Moisture Management Network, and the Federal Agency Housing Partnership.

Washington State University Natural Exposure Test Facility

Chuck Murray, Energy Specialist, Washington State University Energy Program, Olympia, WA

To improve the methods for developing design criteria of woodframe building that are both energy efficient and moisture tolerant, Washington State University (WSU) and Oak Ridge National Laboratory (ORNL) have implemented a hygrothermal research protocol. This includes development of hygrothermal modeling tools, advanced material property testing, and testing of full size wall systems in the natural environment. WSU will present the results of the first year of data collected at their Natural Exposure Test Facility. Over the past year, WSU has collected data on 12 woodframe wall assemblies that demonstrate a variety of details that effect thermal and moisture transport through the test assemblies. A discussion of the use of this data for validation of computer models will also be included.

The BEG (Building Engineering Group) HUT: Durability Research in Canada

John F. Straube, Ph.D., Assistant Professor and Director, Building Engineering Group, University of Waterloo, Waterloo, ON, Canada

The durability and energy-efficiency of woodframe buildings is a topic of great interest to many stakeholders in the building industry and society. The inter-connected flows of heat, air and moisture, the dynamically varying and poorly understood exterior conditions, the poorly quantified and highly variable material properties, and the complexity of the three-dimensional woodframe structures combine to create a problem that is very difficult for analysis to solve. Measuring the performance of full-scale building enclosures exposed to realistic exterior conditions is one experimental technique that can be very useful. This presentation will describe the role of full-scale field test huts in the experimental investigation of building enclosures. The spectrum of material lab and climate chamber testing, analysis, and field studies will be introduced. Specific case studies including the University of Waterloo BEGHUT test facility and other commercial test huts and buildings around the world will be presented. Experimental techniques and methods for field monitoring of hygrothermal performance of woodframe structures will also be discussed. Finally, lessons learned about woodframe durability will be briefly summarized.

Australian Houses: Monitoring and Predicting Microclimates and the Durability of the Building Envelope

Robert H. Leicester, Ph.D., Research Fellow, and *Greg C. Foliente*, Ph.D., Principal Research Scientist/Team Leader, *W. Ganther*, X. *Wang*, C-H. *Wang*, and *M. Nguyen*, CSIRO Manufacturing & Infrastructure Technology, Hightett, Victoria, Australia

In order to predict the service life performance of woodframe building envelopes, measurement and prediction of microclimate in protected environments such as wall cavities, sub-floors and roof spaces are needed. Two sets of measurements are currently being logged from Australian houses in various locations. One set of measurements is

being made on two model houses located in Melbourne (cool and damp) and Innisfail (wet and hot). The houses are about 5x5m square and can be modified to give a variety of configurations. These include wall systems with and without cavities, a variety of cladding and vapor resistant barriers and various ventilation openings in each section of the envelope. The houses are monitored for temperature, humidity, solar radiation, surface wetness, air flow, mold and decay fungi transport, salt transport, and wind pressure effects. The primary purpose of these model houses is to act as a check on our prediction equations based on the application of building physics. The second set of measurements are similar in type to those made on the model houses, except that these are undertaken on existing occupied houses. For these houses complete sets of instrumentation are not possible, because of the potential for inconvenience to the occupants. However measurements on these houses are extremely important as they provide a link between the mathematical models and reality. Two houses that are nominally the same type may perform completely differently in service because of factors such as differences in the air flow openings within the building envelope, differences in occupant usage, and differences in the local environment. About 30 occupied houses have been monitored. These houses were typical of the types constructed in Australia and included brick veneer, timber cladding, slab-on-ground and suspended floor construction. The locations of these houses covered the major climate zones of Australia, including the tropical, subtropical, temperate, Alpine, and dry inland zones. On the basis of the statistical data obtained from these occupied houses, empirically derived building envelope microclimates have been derived quite independently of the application of physics models.

The Louisiana House: Research and Demonstration Structure for the Deep South

W. Ramsay Smith, Ph.D., Professor, Louisiana Forest Products Development Center, School of Renewable Natural Resources, and *Claudette Reichel*, Professor and LaHouse Project Chair, Louisiana Cooperative Extension Service, LSU AgCenter, Baton Rouge, LA

The Louisiana State University AgCenter is leading a partnership project to create the Louisiana House - Home and Landscape Resource Center (LaHouse). It will be a permanent, yet evolving, showcase and hub of educational outreach and applied research. The facility is now under construction and is being funded through gifts and donations. The partnership involves 12 university departments, six state and federal agencies, industry, and nationally recognized building scientists. A 7-acre site on the LSU campus will include an exhibit house with a distance education classroom, offices, and exhibit room; extensive environmental landscape exhibits with trails, and space for research projects. LaHouse will demonstrate a range of products, systems, and technologies at various price-performance points that integrate and balance the five LaHouse criteria of sustainability - resource-efficiency, durability, health, practicality, and convenience. The house will be constructed with four different building systems, four foundation systems, three HVAC systems, and numerous product and material alternatives. Each will showcase integrated systems that are hurricane resistant (meeting Fortified for Safer Living guidelines), flood resistant, termite resistant, decay resistant, and moisture managed for durability and indoor air quality as well as resource-efficiency. The LaHouse facility will also be used as a research structure to investigate and track moisture and stress loading fluctuations including wind and day-to-day activities. Data collected will be used to help verify laboratory testing of structural designs to resist high heat and humidity, heavy rains, and severe decay conditions found in the deep south. LaHouse seeks to stimulate change and demand for solutions that address regional challenges, conditions, and resources. It will combine and balance environmental stewardship with economic benefits and quality of life for the mutual benefit of consumers, industry, and communities - both now and in the future.

Demonstration and Test Structures for Urban-Wildland Interface Fire and Termites

Frank C. Beall, Ph.D., Professor and Conference Chair, *Stephen L. Quarles*, Ph.D., Cooperative Extension Advisor, and *Vernard Lewis*, Cooperative Extension Specialist, University of California at Berkeley, Berkeley, CA

Two small structures were built as an integral part of the program of the UC Forest Products Laboratory. The UWI building exhibits com-

mon building materials and construction details. Materials were selected because of their regular usage in California, or because their use demonstrated fire, thermal, or moisture performance characteristics. A number of the choices were related to fire test results on building sub-assemblies that were conducted with FEMA support from 1998-2002. Included are four different cladding materials, three types of windows and glass, two types of roofing material, an attic area and a cathedral ceiling, and five vent types. The setting for the structure is a "fire-safe garden" area that displays models of plant types and arrangements. Also the demonstration construction materials include plywood and OSB sheathing; 2x4, 3x4, and 4x4 studs; flashing; and seismic hold-downs. "Villa termiti" serves as a test bed for detection and treatment for termites, both subterranean and drywood. This building has easily-removable wall coverings and other areas to permit the insertion of special termite-containing blocks. With the blocks in place, testing was done over a number of years to assess the viability of a number of local or "whole house" treatment methods, and the information has been since published. Unlike normal residential structures, it has been possible to determine the effectiveness of location and extent of treatment. The building has also served as a test-bed for assessing a wide range of acoustic emission detectors for termites.

Seismic and Wind Experimental Research Buildings

J. Daniel Dolan, Ph.D., P.E., Professor, Department of Civil & Environmental Engineering, Washington State University, Pullman, WA

This presentation will cover the two building tests at San Diego and Berkeley as part of the CUREE-Caltech project, the building that Itani and McLean tested at Washington State University, the Northern Shores, NC building for hurricanes, the Texas Tech building for wind, and several instrumented buildings built by Central Florida in the last 3 years for hurricane monitoring. The presentation will cover a bit more than seismic, but it does cover some examples that are not usually covered in conferences serving the structural design community. The wind community tends to be more theoretical and deal with conferences that address fluid mechanics and computer modeling rather than structures.

SESSION II: Construction and Design Issues

Lessons from EIFS: Past, Present, and Future Challenges for Exterior Envelope Design and Construction

Jay H. Crandell, P.E., Owner/Consulting Engineer, Applied Residential Engineering Services, West River, MD; and *Jason V. Smart*, Project Engineer, Institute for Business & Home Safety, Tampa, FL

Water intrusion and accumulation problems with the installation and use of barrier EIFS claddings have received much attention in the past decade. This experience has served to heighten awareness of the importance of water management practices (i.e., flashing, secondary drainage planes, drying potential, details of integrating wall components to maintain continuity in weather protection, etc.) in all types of wall systems. The significance of this lesson cannot be overstated in terms of its importance to building durability, integrated building envelope design and installation, new product approval and testing methodologies, building codes and standards development, quality assurance protocols, and technological advancement. This paper provides an overview and update on the EIFS situation and again looks toward the future. The topics addressed include: 1) A chronology of events in the development and use of EIFS; 2) A brief overview of EIFS products (barrier vs. drainable EIFS); 3) An update on the market share of EIFS; 4) A summary of significant field studies revealing the nature and extent of moisture intrusion and accumulation problems with barrier EIFS; 5) Changes to building codes and standards regulating EIFS products; 6) Remediation strategies for problematic barrier EIFS installations; and 7) Installation Quality Assurance (QA) requirements and methods for EIFS. A number of conclusions and recommendations are given with a view toward an improved framework for specification and detailing of all cladding systems for consistent and predictable performance under varying conditions of use.

Monitoring of Environmental Loads on Light-Frame Timber Buildings

Ian Smith, Ph.D., P.Eng., FIWSc., Acting Dean, University Research Scholar, and Professor of Structural & Timber Engineering, Faculty of Forestry & Environmental Management, University of New Brunswick, Fredericton, NB, Canada

This paper discusses the strategy, method, and progress of an integrated series of studies aimed at rectifying some major deficiencies in the design and construction of low-rise, light-frame timber buildings. Three buildings are being monitored to determine environmental forces applied to them by wind and snow, and how those forces flow from surfaces over which they are applied to the foundation. The first building (Structure 1) is a preexisting industrial shed having an open plan. Structure 1 is located in Sainte-Foy, Quebec. Pilot monitoring activities for loads and structural response were undertaken during 2000, with detailed observation of wind loads having started in 2003. The other two buildings (Structures 2 and 3) are single story houses constructed especially for the project. Structure 2 is located in Fredericton, New Brunswick and represents 'typical' construction practices. It is very heavily instrumented with respect to determination of force flows and strains. All instrumentation is expected to be debugged and monitoring commenced in Spring 2004. Structure 3 will incorporate anti-hurricane design features and will be constructed in 2004. As yet, decisions regarding location of this building have not been finalized. Field experimentation (monitoring) is linked to full-scale laboratory studies and whole-building finite element modeling. Expected outcomes include improved wind load design code provisions, and development and validation of more accurate design level methods for sizing components of superstructures. As work is still in progress this paper constitutes a progress report.

Incentives for Progress for Woodframe Housing

Dean Youngkeit, Retired Aerospace Materials Engineer, Willard, UT

Incentives for progress for woodframe houses range from slum removal to green friendly in many arenas of interest. The types of incentive improvements will be discussed. The development of dimensional lumber was a great leap for mankind. An approach to search out and destroy unneeded thermal bridges is a basis for yielding more incentives. A novel diagonal corner stud can be made available where it is made as a diagonal wood I-beam composite. Shape optimization is discussed as a route for getting the most of anything per dollar. The U.S. Forest Service's FPL patent 4,005,556 has been proven valid with over 5,000 houses built with the 14 valid claims of improvement. I'm offering 53 added incentives. They are to be listed in the handout. Arenas of further improvements include mold and rot resistance and tornado resistance. Incentives to get the optimum in panelization is reached to improve erect ability and deconstruction ability all using fewer thermal bridges than platform type framing. Floor, wall, and roof panels can become a truss factory business expansion. The individual panels become optimized via truss plate field joints being the only frame assembly method. This is the way that the whole house becomes integrated trusses, not just roof trusses. The great reduction in thermal bridges in outer walls has been calculated to reduce BTU transfer at 11% for the lifetime of the building. The panel assembly method using truss plates has been calculated to be 22 times stronger than state-of-the-art hurricane straps now required by many codes. Thermal bridges using wood blocks as fire draft protection is sophistry. There are many alternatives to these and many other framing functions like starter studs for interior walls. Listed are serendipitous incentives, carpentry training incentives, profit incentives, implementation incentives, and avoiding knee-jerk reactions.

Damage Statistics and Design Methods

Vladimir G. Kochkin, Research Engineer, NAHB Research Center, Upper Marlboro, MD; and *Jay H. Crandell*, P.E., Owner/Consulting Engineer, Applied Residential Engineering Services, West River, MD

Damage statistics from high loading events remain an important part of our knowledge of the actual behavior of building materials and systems. Many new building code proposals pass or fail based on whether they can withstand the test of evidence of in-use problems including those during natural disasters such as the 1994 Northridge earthquake and the 1992 Hurricane Andrew. This connection between the building code requirements and accumulated experience is well understood by all building process participants. Yet, scientific approaches for using damage statistics for improving the understanding of analytical as well as prescriptive design methods have not found a wide acceptance. This paper will discuss benefits of using damage statistics for calibrating design methods and will also present a case study demonstrating a

practical application of such approaches in the New Madrid Seismic Zone. This case study uses a damage account from the historical 1811-12 New Madrid earthquake to improve the overall confidence in the seismic hazard characterization procedures in the building codes that regulate construction in the Central United States where little seismic experience exists.

Revised Procedures for Certifying Residential Construction on the Texas Gulf Coast

Dan L. Wheat, Ph.D., P.E., Professor, Department of Civil Engineering, University of Texas at Austin, Austin, TX; and *Darren Conrad*, Engineering Specialist, Texas Department of Insurance, Inspections Division, Austin, TX

In July of 2003, Hurricane Claudette, a Category I hurricane, struck the coast of Texas near Matagorda Bay. Damage was contained mostly to older structures built well before 1999, the year that the Texas Department of Insurance began a program requiring that a licensed professional engineer must certify design drawings for residential construction in certain coastal areas. This requirement only applies if the homeowner desires insurance from the Texas Windstorm Insurance Association, an agency with Legislative authority to provide property and casualty insurance policies on the Texas coast. The lack of damage sustained by post-1999 structures could be a product of quality engineering, or simply the result of Claudette's intensity, which was so small that it did not challenge the durability of those residences. Thus, the real durability is still in question. Our foci in this presentation are efforts to ensure the quality and durability of residential construction in coastal Texas and the required engineering of residential structures in order to gain reasonable windstorm and hail insurance rates. Despite state mandates that an engineer must certify the residential designs, it is no secret that, in fact, many residences receive inadequate attention in the design process. The reasons for the lack of attention are several, but they include the sometimes-dysfunctional interrelationships among the engineers, builders, and the Texas Department of Insurance. This presentation includes how new education programs, prescriptive design measures, and improved oversight strategies are anticipated to affect positively the quality and durability of residential construction.

An Insurance Perspective on Woodframe Construction

Rose Geier Grant, AIA, Program Director, and *Jim Cheng*, Ph.D., ARM, Senior Research Analyst, Building Technology Research Unit, State Farm Insurance Companies, Bloomington, IL

While the wood industry faces increasing challenges and changes of needs and requirements in the residential construction market, the property and casualty insurance industry has also made significantly strategic changes in its underwriting rules and business models. As results, the changing market and customer needs have made the insurers and building products manufacturers work more closely for their mutual interests. This paper will present the potential opportunities to the wood industry with regard to quality products and new technology from the residential insurance perspective. Topics include risk management, loss mitigation, new technology, and insurance losses due to failures of building systems and components. The wood construction industry needs to develop better or new products in order to prevent and to reduce the probability of woodframed construction failures in resistance to water, fire, wind, and deterioration. Analysis of causes of residential losses will help the wood products and construction industry make improvements in products, designs, and construction technology; and help the insurer identify areas for loss control. Risk management for organizations to reduce liability loss is discussed.

TUESDAY, OCTOBER 5, 2004

SESSION III: Disaster Mitigation

Mitigation of Fire Damage to Structures in the Urban-Wildland Interface

Frank C. Beall, Ph.D., Professor and Conference Chair, and *Stephen L. Quarles*, Ph.D., Cooperative Extension Advisor, University of California at Berkeley, Richmond, CA

Urban-wildland interface/intermix (UWI) fires in California have caused the loss of lives and destruction of nearly 1000 structures per year over the past decade. Although considerable information has been developed on measures to mitigate losses, the 2003 fire storm in southern California has been the most damaging in the state's history. A major part of the difficulty that the state faces is how to fully develop and enforce new building standards, as well as provide quality

information for homeowners to make existing buildings more fire safe. Over the past 5 years, research at the UC Forest Products Laboratory has led to better understanding of the contribution of nearby vegetation to fires and performance of major elements of the building envelope, as well as development of workshops for fire professionals and information for homeowners. The next major steps in the process include the following: 1) Develop workshops to provide training on a newly passed model fire performance code; 2) Develop a homeowner CD and training for fire authorities to survey parcels and provide priorities for mitigation efforts, both short- and long-term; 3) Conduct aging tests on walls and decks to determine the effect of weathering on changes in fire performance; 4) Develop performance tests on venting systems for structures to permit adequate ventilation, but minimize penetration of brands and flames; 5) Develop more robust tests for sids-ings, windows, and doors; and 6) Investigate defensive measures and materials.

Effect of Decay on Wall System Behavior

Robert J. Leichti, Ph.D., Associate Professor, *Jeffrey J. Morrell*, Ph.D., Professor, and *David V. Rosowsky*, Ph.D., Professor, Department of Wood Science & Engineering, Oregon State University, Corvallis, OR

Recent studies of single nail connection lateral strength in oriented strandboard and Douglas-fir framing members show that nail connections are quite robust with respect to ultimate load even at advanced stages of decay in the sheathing side member of the connections. Single connection tests also show that the cyclic performance of the nail connection remains quite good until a severe decay condition is reached in the side member of the connection. At a critical point in decay, the capacity and energy absorption characteristics deteriorate very quickly with further decay. In this presentation, the issues related to application of single nail tests are evaluated with an experiment that includes materials in various states of decay. An experiment was conducted that included monotonic and fully reversed cyclic tests of wall systems having brown rot decay fungi in various stages of advancement. The brown rot decay was initiated by inoculation of the model wall units, and the model wall units were then conditioned until the desired level of decay was observed. The fungal inoculum were placed so that the decay effects were sited, or centered, in locations that were critical to the wall performance. The study is in progress, but is expected to yield results that will provide guidance to remediation decisions and building performance expectations when decay is present.

Probabilistic Analysis of Damage to Woodframe Housing from Wind Hazards: Vulnerability and Loss Estimation of Woodframe Housing Due to Extreme Winds

Yue Li, Ph.D. Candidate, and *Bruce R. Ellingwood*, Professor, School of Civil & Environmental Engineering, Georgia Institute of Technology, Atlanta, GA

In North America the majority of residential buildings are woodframe construction. Extreme wind is one of the most costly natural hazards. In the past two decades, hurricanes have caused enormous losses to residences, impacting individuals, communities, and the insurance industry. The rapid increase in economic losses and societal disruption from natural hazards can be reversed by taking steps to improve the structural performance. A general methodology is developed for assessing the probabilistic response (fragilities) of woodframe housing exposed to hurricane winds. The reliability and risk analysis is demonstrated for selected common building configurations and construction. Limit state probabilities of structural systems for the performance levels identified above are developed as a function of 3-s gust wind speed leading to a relation between limit state probabilities and the wind hazard stipulated in ASCE Standard 7-02. Identification and quantification of various sources of uncertainty are essential for building risk assessment. Probabilistic models of structural response must include uncertainties in loading and resistance. Finite element models and structural reliability methods provide the basic computational tools for assessing the probabilistic response of woodframe housing subjected to wind load. Post-disaster surveys indicate that the roof and exterior windows are most vulnerable when subjected to extreme winds. The fragility models for wind hazards focus on performance of roof systems and windows. Quantitative risk assessment methodologies will lead to more predictable building performance, improve the utilization of wood and wood-based composites in woodframe housing, and provide technical support for recommendations to new building codes and standards. Such methodologies also can be used as a basis for setting insurance premiums, for rapid damage assessment after hurricanes and earthquakes, and for post-disaster planning and risk mitigation.

The Effects of Heat on Wood Trusses During a Fire

John "Rob" Melton, P.E., Project Engineer, Bracken Engineering, Inc., Tampa, FL

This presentation will cover the effects of heat on a wood truss during exposure to a fire. It will cover the reduction in bending and shear strength as a result of research and field testing to different levels of exposure. This presentation will address questions such as: 1) When a structure has experienced damage from a fire, which trusses need to be replaced and which ones may remain? 2) What does visible sap indicate? 3) If the truss is now black, does it automatically mean that it's no good? This presentation will also address the truss connections and other structural issues as related to fire damage.

Earthquake Performance of Timber Structures

Marjan Popovski, Ph.D., P.E., Research Scientist/Quality Assurance Manager, and *Erol Karacabeyli*, Manager, Wood Engineering Department, Forintek Canada Corporation, Vancouver, BC, Canada

This presentation provides an overview of the most important issues related to seismic performance of timber structures. In the beginning, factors that influence the seismic behavior of timber structures are discussed. Furthermore, the seismic performance of wood structures exhibited during a number of strong earthquakes throughout the world is included. In addition, the most important issues related to the seismic design of timber buildings are presented, including the performance of connections. This presentation shows that a majority of wood buildings of various ages survived severe earthquakes without serious structural damage or collapse. Many modern platform-frame buildings survived peak ground accelerations higher than 0.6 g without any visible damage. The few observed failures and collapses were traced primarily to specific instances of lack of lateral bracing, development of weak or soft first story mechanisms, or inadequate connection to the foundation.

Brace Yourself for Mother Nature

Thomas G. Williamson, P.E., Vice President, Quality Assurance & Technical Services, APA - The Engineered Wood Association, Tacoma, WA

In recent years, there has been an increased emphasis placed on designing structures for higher energy efficiencies. However, in some cases this has shifted the emphasis from the structural demands placed on the structure. In addition, designers are placing increased demands on structures by detailing narrow walls near windows and other openings. Yet these structures must still be able to withstand the forces generated during wind and seismic events. Confusion has developed among building officials, builders, and design professionals regarding how to properly design and construct narrow walls (walls with an aspect ratio of greater than 2:1). In order to develop a solution that provides adequate strength for use as bracing in traditional North American light-frame construction for narrower wall segments, a portal frame design was developed by APA. While the APA portal frame design was envisioned primarily for use as bracing in conventional light-frame construction, it can also be used in engineered applications. The portal frame is technically not a narrow shear wall because it transfers shear by means of a moment resisting frame. Monotonic and cyclic testing has been conducted on the APA portal frame design. Recommended design values for engineered use of the portal frames have been calculated and comparisons to existing prescriptive bracing segments have been made.

Reliability of Wood Shearwalls to Natural Hazard Loading

John W. van de Lindt, Ph.D., Associate Professor, Department of Civil Engineering, Colorado State University, Fort Collins, CO; *Jason N. Huart*, Graduate Student, Department of Civil & Environmental Engineering, Michigan Tech University, Houghton, MI; and *David V. Rosowsky*, Ph.D., Professor, Department of Wood Science & Engineering, Oregon State University, Corvallis, OR

Wood shearwalls provide the majority of lateral force resistance in light-frame wood structures. The importance of these critical light-frame sub-assemblies cannot be understated, making them a logical place to begin reliability assessment as a measure of structural performance. Performance criteria have historically been inter-story drift and/or moment-curvature relationships as they relate to life-safety and collapse of structures. The present study focuses on comparison of reliability indices for code-designed wood shearwalls subject to natural hazard-induced loads such as wind and earthquake loading. A portfolio of wood shearwalls representative of walls designed using the most commonly used load and resistance factor (LRFD) design specification for light-frame wood structures in the United States have been

analyzed using an ultimate strength-based limit state. In addition, the statistical distribution of the capacities at various drift limits are presented to demonstrate a potential source of error when using displacement-based reliability results to calibrate strength-based design procedures. The resistance of each wall is determined based on the results of a numerical model that uses existing load-slip fastener data to determine the monotonic and cyclic behavior of a wood shearwall. The mean wind load for each wall is determined directly from the design code through a bias factor and the coefficient of variation from previous studies. The shearwall reliability analysis subject to earthquake load uses a suite of representative, appropriately scaled, ground acceleration records in combination with the portfolio of wood shearwalls.

Comparison of Methodologies for Designing of Force Transfer Around Openings in Plywood Shear Walls

Alexander A. Robertson, P.E., Principal, Robertson & Associates, Huntington Beach, CA

This presentation will present a discussion of different methodologies available to the engineer for analyzing and designing force transfer around openings in plywood sheathed shear walls resulting from seismic lateral loads. Requirements contained in current building codes will also be discussed and examples of numerous physical shear wall opening configurations will be provided. Force transfer around each opening configuration will be analyzed using the following methods: 1) Perforated Wall Method; 2) Segmented Pier Methods; 3) Relative Stiffness Method; 4) Simplified Drag Strut Method; and 5) Cantilevered Beam Method. Fully documented numerical calculations will be provided for each method and wall configuration. Results of each wall configuration will be evaluated and summarized in both tabular and graphical format. A comparison of the results using the different methods will be provided and an enveloping graph of the results will be presented in assisting the engineer in selecting the appropriate method of analysis for a given wall configuration.

SESSION IV: Durability Treatment and Assessment

Treatment of Timber Framing and its Role in Leaky Buildings: A Perspective from New Zealand

Philip O'Sullivan, Building Consultant/Director, Prendos Ltd., Auckland, New Zealand; and *Robin Wakeling*, Ph.D., Research Scientist, Chairman of Biology Section of the International Research Group of Wood Preservation, Rotorua, New Zealand

In 1939, New Zealand started a research program to find a suitable treatment for the then recently planted and non-durable plantation forests of radiata pine. This program led to the widespread and successful use of wet boron treated radiata pine and the regulation of the timber preservation industry. Due to a series of circumstances, New Zealand moved away from framing treatment during the 1990s. However, after a sudden increase in the number and severity of weathertightness failures, this decision has recently been reversed. This presentation will familiarize the audience with New Zealand, our building methods and our natural environment. It will examine the factors and research that led to the adoption of treatment and then explain the circumstances for the move away. The role of timber treatment, with reference to weathertightness failures, will be examined, together with an explanation of how low levels of treatment can have a significant effect upon decay behavior. New Zealand's response to our leaky building issue will be examined and the reasons for our rapid return to treatment of timber framing will be explained. Finally, some underlying philosophies for treatment of framing timbers will be presented.

Wood-Based Panels Produced from Thermal Treated Materials: Properties and Perspectives

Martin Ohlmeyer, Ph.D., Research Scientist/Project Leader, Department of Wood Physics & Mechanical Technology of Wood, Federal Research Center for Forestry & Forest Products, Hamburg, Germany; and *Dirk Lukowsky*, Ph.D., Research Scientist, WKI, Fraunhofer-Institut für Holzforschung, Braunschweig, Germany

Wood-based panels for exterior use have to fulfill certain requirements (eg. resistance against moisture and decay). One promising option to meet these requirements is to use thermally treated wood to produce panels with optimized properties. This presentation will cover preliminary results on properties of panels produced of thermally modified wood as well as future perspectives for this kind of material. The panels were produced with two different types of modified wood, varying pressing times, and glue systems. The samples were tested according to European standards. The results show a very good potential for this panel material.

Silver-Based Antimicrobial Biocides as Wood Preservatives

Benjamin Dorau, Chemist, *Rachel Arango*, Biological Lab. Technician, and *Frederick Green III*, Ph.D., Research Microbiologist, USDA Forest Service, Forest Products Laboratory, Madison, WI

On December 31, 2003, the wood preservation industry, in conjunction with EPA, voluntarily phased-out the use of CCA treated lumber for residential applications. This ended over 25 years of CCA as the predominant wood preservative in the U.S. The first generation of replacement preservatives, alkaline copper quats (ACQ) and copper azole (CA), have begun replacing CCA during 2004. Other potential replacements for CCA are under investigation at FPL. One of these, recently mandated by the 108th Congress, are wood preservatives based upon silver (Ag) instead of copper. Silver has been shown to have potential as a viable, safe, and cost-effective preservative. FPL has initiated a feasibility study of ionic silver salts for inhibition of brown-rot fungi, termite damage, and mold contamination. To date, two silver formulations [~1% Ag] have been shown to be moderately resistant to brown-rot decay, to inhibit termite damage with 100% mortality of termites, and to resist colonization by three common mold species. Additional testing, to include ASTM leach testing and lower silver concentrations, will further explore the potential of silver-based biocides as wood preservatives.

A New Method to Determine Preservative Treatment Levels to Confer Decay Resistance to Framing Lumber Subjected to Temporary Wetting

Mick Hedley, Ph.D., Senior Scientist, Wood Processing & Products, and *Dave Page*, Senior Technical Officer, Wood Processing & Products, New Zealand Forest Research Institute Ltd., Rotorua, New Zealand

A technique was developed to determine effectiveness of preservative treatment systems to protect timber frames which may become wet following failure of the building envelope. Model house frame units (two studs, top and bottom plates, and a central "dwang") were constructed using 500-600 mm lengths of 90 x 45 mm untreated or preservative treated framing timber. Constructed frames were wetted to an initial moisture content of 35-40%. The back face of each unit was then covered with black polyethylene. Two locations at the stud/dwang and stud/bottom plate interfaces were swabbed with alcohol and a 35 x 70 x 7 mm "feeder strip," pre-decayed in the laboratory by brown rot fungi, was tacked in place on the swabbed area. Blocks of pre-wetted fiberglass insulation were then placed in the wall cavity and the remaining face covered with a layer of building paper and fiber cement board, attached to the timber frame by screws so that it and the building paper could be easily removed to assess extent of decay within units. Completed units were transferred to a controlled environment room maintained at 25°C and 95% RH. Extent of decay has been assessed at regular intervals. Results to date have been used to establish levels of preservative treatment predicted to prevent decay in framing should it become temporarily wet through leaks in the building envelope. This level of treatment has been incorporated into New Zealand timber treatment standards and timber construction standards and building codes as a subdivision of Hazard Class (Use Category) H1.

A Durability Rating System for Housing: Changing Behavior from First Cost Consumption to Life-Cycle Cost Acquisition

William Asdal, Managing Member, University for Contractors, LLC / Asdal Builders, LLC, Chester, NJ; and *David Hattis*, President, and *William I. Whiddon*, Manager, 'All Hazard' Condition Assessment Services, Building Technology Inc., Silver Spring, MD

No system is currently in place to evaluate existing or new buildings and their component systems to project some comparable durability to the balance of the housing stock. The benefits of such a system may include a shift from first cost consumption to life-cycle cost management. The objectives of this discussion are to explore the concept, to invigorate discussion, to advocate life-cycle cost management, and to pursue acceptance and implementation of a durability rating system. Included will be a discussion of attitudes and values and their effect on durability of housing. Beginning with manufacturers, the supply chain, builders, tradesmen, regulators, and the consumer, all can affect durability and their roles will be evaluated. Building practices are affected depending upon priorities of each participant in the housing process. Consumer and trade studies and current practice will be referenced. A durability rating system can benchmark building longevity and illuminate future costs or savings. This enlightenment can protect consumers from recurrent costs and foster incentives from interested parties. The

benefits of implementation of a durability rating system on the quality and durability of housing will be discussed.

Above Ground Durability of Spruce (*Picea abies*) Sapwood and Heartwood, and Durability of Coated Spruce Exposed Outdoors Above Ground for 9 Years

Mikael Bergström, Ph.D. Student, School of Technology & Design, *Åsa Rydell*, Ph.D. Student, Department of Forest & Wood Technology, and *Thomas Thörnqvist*, Professor of Forest Products, School of Technology & Design, Växjö University, Växjö, Sweden

Above Ground Durability of Spruce (Picea abies) Sapwood and Heartwood - Earlier studies have indicated differences in permeability between spruce heartwood and sapwood in the longitudinal direction. The aim of this study was to investigate whether this difference also exist in the radial direction and if the difference is significant in terms of microbial durability above ground. In this study, a new method for estimating the durability of wood above ground, recently developed by the company Mycoteam in Oslo, Norway, was used. The equipment, called Mycologg, was originally designed for testing paints, but can also be used for estimating the durability of wood panels. The Mycologg allows the test panels to be subjected to fungi and different RH (relative humidity) cycles simultaneously. The RH is controlled by time intervals to simulate wet and dry periods. Every half-hour temperature, RH, and the moisture content in each test panel are measured and saved in special software. This allows a constant update of the moisture patterns during the fungi attack. After 3 months in the Mycologg, there were significant differences in both moisture content and fungal growth between sapwood and heartwood of spruce. This indicates that, by removing sapwood, the above ground durability of spruce can be improved.

Durability of Coated Spruce Exposed Outdoors Above Ground for 9 Years - A durability test was conducted with coated spruce samples during a 9-year study of weather exposure above ground. Wood was sampled from three different origins: the North, Center, and South of Sweden. Half the wood was harvested in winter and half in summer. The samples were subjected to different treatments such as water storage and air- or kiln-drying. During the outdoor exposure, the moisture content was measured on 67 occasions. Biological activity, cracks, and flaking of the coating were controlled regularly. Weight loss was measured upon conclusion of the study in 1995. Data were evaluated using Principal Component Analysis (PCA) and traditional statistics. As expected, analysis showed that variables for the tendency to crack, moisture content, flaking, and weight loss were correlated. Density and annual ring width had no significant influence on the other measured variables. Neither was any significant relationship found between moisture content and water storage or time of felling. Although there was a tendency towards better durability for the kiln-dried coated samples, no significant difference was found. Wood from the central stand appeared to have the best durability regardless of treatment. Thus, origin can be of importance for durability even if the samples are coated.

SESSION V: Biological Degradation and Moisture Issues

TimberLife: Service Life Prediction and Design of Timber Construction

Greg C. Foliente, Ph.D., Principal Research Scientist/Team Leader, CSIRO Manufacturing & Infrastructure Technology, Highett, Victoria, Australia

This paper presents an overview of a large national project in Australia to develop service life prediction software, engineering design procedures, and guidelines for improved service life performance of timber construction. At the heart of this multi-disciplinary effort is the development of prediction models for the durability of exposed timbers, protected timbers, timber in ground contact, and fastener corrosion, among others. These models are now being integrated into a single software tool, called TimberLife, for industry and general public use. An early prototype of TimberLife is demonstrated and background information about the models and their applications and outputs is presented. In addition to service life prediction against various durability hazards, these models are also used to develop a timber durability compendium, an engineering design method that explicitly incorporates material degradation, and risk-based maintenance planning and asset management. Example formats and outputs for these applications are presented. Projected in-service performance of utility timber poles, with and without maintenance, is given as an asset management example.

A Probabilistic Model for Termite Attack on Housing in Australia

Robert H. Leicester, Ph.D., Research Fellow, and *C-H. Wang*, CSIRO Manufacturing & Infrastructure Technology, Highett, Victoria, Australia; and *L.J. Cookson*, CSIRO Forestry & Forest Products, Clayton South, Victoria, Australia

For engineering purposes, it is useful for termite attacks to be considered as probabilistic events. This presentation describes the development of a probabilistic model to predict the risk of termite attack on houses in Australia. First, a preliminary model was developed on the basis of opinions elicited from experts on termite behavior such as entomologists and pest controllers. These opinions were obtained through the use of a structured questionnaire. The model was then calibrated through the use of data gathered on 5,000 Australian houses. The model takes into consideration a great number of factors, such as the age of a house and its surrounding suburbs; the choice of inspection and maintenance programs; the use of physical and chemical termite barriers; the type of house construction; and the local climate. Application of the model indicates that the time to attack a particular house with a given probability in Australia can vary from a few months to hundreds of years, depending on the circumstances of that particular house. Thus, it is apparent that the application of a risk model can be very useful in selecting cost-effective protection strategies for houses and (by extension of this model) also for all other types of buildings. The model is also useful for the development of meaningful test protocols for assessing building constructions and termite barriers.

Mold Growth on Various Wall Materials

Dian-Qing Yang, Ph.D., Research Scientist, and *Marie-Claude Bisson*, Mycological Technician, Forintek Canada Corporation, Sainte-Foy, QC, Canada

Mold growth in buildings is becoming an increasing concern for building owners because of health and aesthetic problems. Mold usually appears as black or greenish-brown patches on surfaces in humid environments and is common in houses. In fact, mold growth is caused by moisture problems. To avoid moisture problems, the most important consideration in ensuring the durability of woodframe houses is to utilize design features, construction tools, and practices that keep wood as dry as possible and promote drying if the wood gets wet. One critical factor in these designs is the accurate estimate of the effects of various temperature and moisture conditions on the rates of fungal attack. The absence of definitive data forces engineers to make extremely conservative estimates of mold growth that may not accurately reflect the risk. This presentation will provide valuable information on mold growth on various wood and fiber products used for the construction of homes in different environmental conditions in North America.

A Comparison of U.S. Home Builder and New-Home Homeowner Perceptions and Concerns About Mold

Todd F. Shupe, Ph.D., FIWSc., Associate Professor, Wood Science, and *Richard P. Vlosky*, Ph.D., Professor of Forest Products Marketing and Director, Louisiana Forest Products Development Center, School of Renewable Natural Resources, LSU AgCenter, Baton Rouge, LA

In recent years, toxic mold (*Stachybotrys chartarum* or *Stachybotrys atra*) has been portrayed in the media as being a major health issue for homebuilders and homeowners in the United States. A number of lawsuits have been filed against wood products manufacturers and builders claiming that human health has been compromised by exposure to mold, with many claiming that mold is the "new asbestos." In this presentation, we share results from a study that examined differences and similarities in perceptions and concerns about mold from U.S. homebuilders and new-home homeowners. We used mail questionnaires to survey the top 500 homebuilders in the U.S. by 2001 sales and a national random sample of 1,500 new-home U.S. homeowners. Results are mixed. For example, builders are more concerned about building a home free from mold than homeowners are about having mold in the home they purchased. Similarly, 10% of homeowners believe that mold is an issue in their neighborhoods, while 35% of homebuilders believe that this is an issue in the homes they build/sell. Homeowners also more strongly believe that treated wood offers protection against mold. Finally, neither group has a high degree of trust in treated wood claims made by wood product suppliers concerning mold.

Comparative Measured Moisture Performance of Woodframe Walls

Daniel W. Cautley, P.E., Owner, Cautley Engineering, Washington, DC

Moisture is the cause of significant damage in woodframe buildings, and is a topic of ongoing interest among researchers. Analytic techniques are limited in their ability to handle the complexity of real assemblies. Field measurement of the moisture content of building materials can be valuable in characterizing building performance. In a project developed to gather field data, a test home was constructed in Madison, Wisconsin, with 12 stud bays constructed using various combinations of interior vapor barrier and exterior sheathing. Nine of the 12 test bays were made as airtight as possible, minimizing the effects of air leakage on moisture flow. Moisture content was measured in at least six locations in the test bays, and in a number of other locations in the home. The electrical conductivity of wood was used as an indirect measurement of moisture content. Observed moisture content was higher in most measurement locations during the winter than during summer, and was generally within expected ranges. Presence of a vapor barrier had a clear effect in limiting winter moisture levels in wall framing and sheathing, but the data do not show conclusive results concerning the effect of sheathing type or air leakage. The data provide evidence of condensation on sheathing near the bottom of walls. Episodes of suddenly increasing moisture content during warm weather were attributed to rainwater leakage.

Educating Builders on Moisture Management

Steven C. Zylkowski, Director, Quality Services Division, APA - The Engineered Wood Association, Tacoma, WA

The wood industry's image in residential construction is damaged when costly retrofits are required to fix moisture problems. The fact that the root cause of the moisture failure is generally due to some ancillary part of the envelope system is lost on the unhappy homeowner. Therefore the wood industry is undertaking various outreach efforts among the construction industry to assure proper installation of systems that involve wood products. Forensic studies of major moisture failures indicates that moisture intrusion is often due to lack of basic moisture management techniques, some of which are already well documented in building codes and industry recommendations. Other more complex failure modes require better understanding of heat and moisture movement through the building envelope. This presentation will review examples of common installation mistakes, forensic findings, research projects in progress, and intra-industry efforts at collaborative education of the building industry.

Laboratory Water Penetration Tests of Shiplap (Dropside) Hardboard Siding

George A. Tsongas, Ph.D., P.E., Consulting Engineer and Professor Emeritus, Department of Mechanical Engineering, Portland State University, Portland, OR; *Howard Spalt* (deceased), Former Head of Research, Masonite Corporation, St. Charles, IL; and *George Hummel*, Private Construction Defects Consultant, Conifer, CO

The durability and suitability of many composite siding materials from a moisture point of view has been a contentious issue in the courts for a number of years. In a subdivision of about 400 single-family detached homes in West Palm Beach, Florida, decay of the hardboard siding and the adjacent wood trim, along with woodframing members, was observed in many situations. In many of the homes, water entered the wall cavities and living spaces and caused damage to the walls and floors. It was alleged by plaintiffs' experts in a legal case brought by the developer against the siding manufacturer that the hardboard siding was the cause of the water entry and resultant damage. Specifically, they felt that rain water was wicked up in between the siding laps by capillary action and wetted the siding and other wall components. That wetting then led to deterioration of the siding and other wall components. However, it was believed by the defense as well as HUD investigators that the real cause of much of the damage was bulk rain water leakage through improperly flashed windows and shed roofs over box windows. Thus, a series of laboratory tests were undertaken: 1) to evaluate the water shedding performance of hardboard sided walls with windows and shed roofs properly installed according to the siding manufacturer's installation instructions and good construction practices, and 2) to determine the mechanisms that caused water entry into the siding and wall cavities of the homes as actually improperly constructed. The tests involved slightly modified ASTM E331 type water penetration tests of a variety of mock-up walls as well as new aquarium tests of capillary wicking in between the laps of the hardboard siding. The ASTM E331 tests are aimed at examining the water leakage characteristics of windows installed in

walls under heavy, wind-driven rain conditions. In one of the water penetration tests, water was sprayed on a plane wall to see if any water wicked up in between the siding laps. Additional spray tests were undertaken on walls with properly and improperly installed (poorly flashed and sealed) windows as well as shed roofs with box windows to determine if leakage into the wall cavities occurred as a result of improper construction. In the aquarium tests, two pieces of siding were immersed in dyed water such that the water just contacted the bottom drip edge of the top course of siding to check for capillary wicking between the laps. The set up of the tests will be described in detail along with the test results and conclusions. The tests showed that water does not wick up in between siding laps, in agreement with other test findings, that improperly flashed and sealed windows or shed roofs can allow surprisingly large amounts of water to enter into and even through walls, and that properly installing windows and shed roofs essentially eliminates water entry around them into wall cavities.

Attic and Crawl Space Ventilation: Implications for Homes Located in the Urban-Wildland Interface

Stephen L. Quarles, Ph.D., Cooperative Extension Advisor, University of California at Berkeley, Richmond, CA; and *Anton TenWolde*, Research Physicist, USDA Forest Service, Forest Products Laboratory, Madison, WI

Roof (attic and cathedral ceiling) and crawl space ventilation has commonly been used as a moisture management tool to minimize performance problems associated with excessive moisture accumulation in these spaces. For homes located in the urban wildland interface, roof vents, in particular, have provided an entry point in the attic or crawl space for flame and burning embers. Research conducted at the University of California Fire Research Laboratory have shown that all forms of vents on the underside of the eaves (strip vents, frieze block, etc.), in both boxed and open-eave construction, are almost immediately penetrated under flame impingement, confirming the vulnerability of vents to at least one kind of wildfire exposure. As a result of the observed vulnerability of vents to wildfire, they are sometimes eliminated, or relocated in order during reconstruction, often without consideration for the potential impact on moisture-related damage (predominately fungal growth). Fortunately, alternative moisture control strategies have been suggested for moisture control, and other performance related issues related to roofing. These strategies include alternative venting strategies, and minimizing heat and moisture flow into attic and cathedral ceiling spaces by relying on construction details incorporated on the interior of the building. The objective of this presentation will be to review the function and vulnerability of vents, and examine the options for traditional venting scenarios.

A Novel Chemical Tracer for Determining Moisture and Movement in Building Systems

Elmer L. Schmidt, Ph.D., Professor, *Brian A. Jordan*, Research Associate, *Patrick H. Huelman*, Associate Professor, Department of Wood & Paper Science, and *Sagar V. Krupa*, Professor, Department of Plant Pathology, University of Minnesota, St. Paul, MN

Many moisture related problems now are of increasing concern in the building envelope. In particular, siding, millwork, sheathing, and framing as well as interior wall surfaces (above and below ground) are examples of potential biodeterioration sites (mold and decay) where sufficient moisture exists. The monetary and potential health implications are severely impacting the housing industry. In certain individual cases of wood wetting, the source of liquid water is readily determined (e.g. lack of flashing or external sealings about wall installations). However, there is still debate and general lack of specific knowledge on the role of moisture redistribution after external ingress and the impact of condensation in wall and roofing systems. We have found that water spiked with a safe, non-radioactive isotope (deuterium) can be introduced into wood by direct wetting, condensation, or vapor phase and recovered via simple solvent distillation or mechanical expression. The use of deuterium as a moisture tracer can assist in determining the origin of moisture (particularly through the vapor phase transition) to help provide insight into current recommended practices for moisture control in buildings, and assess the application of current moisture modeling on existing moisture failures.

POSTER PRESENTATIONS

POSTER 1

Using System-Based Design Principles for Affordable, Durable, and Disaster-Resistant Housing

Jay H. Crandell, P.E., Owner/Consulting Engineer, Applied Residential Engineering Services, West River, MD

Research into system-based design of light-frame homes and similar structures has resulted in an improved understanding of failure mechanisms, actual structural resistance, and observed performance in recent natural disasters. However, this research is merely academic and informational unless it is implemented in a practical way. This poster explores "beyond code" applications of innovative structural and building envelope design methodologies using data and findings from various research studies and accepted design resources. Many of the concepts are featured in available design guidance and research publications, such as *Durability by Design* and the *Residential Structural Design Guide*, which are available through the U.S. Department of Housing and Urban Development (<http://www.huduser.org>). System-based design concepts explored include whole-building shear wall analysis, wind uplift load path, and integrated rain water management practices for the exterior envelope.

POSTER 2

Wind-Borne Debris Protection Using Wood Structural Panels and Innovative Attachment Methods

Jay H. Crandell, P.E., Owner/Consulting Engineer, Applied Residential Engineering Services, West River, MD; *Robert Hill*, P.E., Director of Laboratory Sciences & Certification Programs, NAHB Research Center, Upper Marlboro, MD; and *Robert Fee*, President, Plylox, Inc., Friendswood, TX

In the past several years, new ASTM standards have been developed and model U.S. building codes have adopted these standards to regulate the provision of wind-borne debris protection devices in hurricane prone regions. At the same time, building codes have retained provisions allowing the traditional use of wood structural panels as wind-borne debris protection in hurricane prone regions with design wind speeds not exceeding 130 mph (gust). One of the problems observed in the past with this practice has been the proper installation of panels such that they do not themselves become sources of flying debris in a hurricane. To address that concern, newer model building codes have specified connection requirements using screws or nails to meet calculated design wind pressures. While the use of plywood remains a viable means of protecting windows and doors against hurricane winds and flying debris, new test data has demonstrated the need to improve panel connection requirements and bracing of sheathing to avoid secondary shear forces on panel end connections due to deflection of panels under transverse pressure loading. In addition, an innovative panel attachment technique has been recently tested and shows promise for simple and reliable panel installation into recessed window and door openings. The technique does not require the use of tools or a high skill level. This poster presentation also brings attention to the need to develop wind pressure testing methods that account for the air-permeability of panel coverings (and similarly air-permeable claddings) which have been shown to experience much reduced wind pressure. Such innovation in performance criteria is needed to maximize practical and efficient component design while promoting innovation in disaster protection.

POSTER 3

Structural Durability of Exposed Timber

Robert H. Leicester, Ph.D., Research Fellow, *C-H. Wang*, *N. Minh*, *Greg C. Foliente*, Ph.D., Principal Research Scientist/Team Leader, and *X. Wang*, CSIRO Manufacturing & Infrastructure Technology, Hightett, Victoria, Australia; and *C. McKenzie*, TRADAC, Brisbane, Queensland, Australia

The major attack on houses constructed with timber is usually by decay to timber that is exposed to rain. Such exposed timbers are features that are popular with many architects. To assess the loss of structural strength with time, it is necessary to predict the loss of cross-section due to decay. A preliminary model to predict the decay of exposed timber members has been developed. The model refers to members that decay on external surfaces. The model was initially developed on the basis of test data from standard exposure panels and L-joints locat-

ed around Australia. Roughly 30 species, including both hardwoods and softwoods, were used for this purpose. When this had been done, the model was calibrated with data from full-scale in-service structures. The two dominating influences are the climate and the member geometry. The climate is defined in terms of temperature, time-of-wetness, and drying parameters (such as vapor pressure deficit and local wind speed). An important consideration is to take into account the effects of local sheltering on these parameters. The geometry parameters are primarily concerned with grain direction, and surface contacts. However in practice, geometry, and shelter effects are often quite difficult to separate; for example the effect of location and orientation of a member within a structure may be described in terms of either geometry or shelter effects. The model is generic in format, and so it is hoped that when fully developed it will be applicable to any type of structure, constructed with any type of timber, and located anywhere in the world.

POSTER 4

VOC-Emissions of Building Products - European Standards and Regulations

Martin Ohlmeyer, Ph.D., Research Scientist/Project Leader, Department of Wood Physics & Mechanical Technology of Wood, Federal Research Center for Forestry & Forest Products, Hamburg, Germany

Due to better insulation and lower air exchange rates of buildings the energy consumption for housing in Germany and Europe was reduced (e.g. low energy houses, EnEV). Usually the air exchange rates are below the recommended values of 0.5 to 0.8 per hour (DIN 1946-6). As a consequence volatile organic compounds (VOC) emitted from building products can accumulate in the indoor air and lead into increased concentration of VOC. Higher concentration of VOC is related to e.g. the Sick-Building Syndrome (SBS). To protect the health of occupants in housing a number of concepts were developed to determine and assess the air quality and emissions of building products. This poster presentation describes the different concepts and gives an idea about the consequences for wood products (wood-based panels and also solid timber).

POSTER 5

Actual Service Lives for North American Buildings

Jennifer O'Connor, Research Scientist, Forintek Canada Corporation, Vancouver, British Columbia, Canada

This poster presents results of a demolition survey in a major North American city that captured building age, building type, structural material, and reason for demolition for 227 buildings. The findings challenge many common assumptions about building longevity, and, in particular, the relationship between structural material and service life. Although it is often believed that "durable" structural materials such as steel and concrete will provide the longest service lives for their buildings, our results suggest there is no significant relationship between the structural system and the actual useful life of the building. Reasons for demolition were instead related to changing land values, lack of suitability of the building for current needs, and lack of maintenance of various non-structural components. Only eight buildings identified a specific structural failure. Indeed, the service lives of most buildings are probably far shorter than their theoretical maximum lives; the majority of demolished steel and concrete buildings in the study were less than 50-years-old. In the context of sustainable construction, this raises some interesting questions and shifts the spotlight away from durability of materials and on to: 1) flexibility of design to allow future changes; 2) deconstructability; and 3) the use of more accurate life-span predictions in life-cycle assessment calculations on whole buildings.

POSTER 6

Seismic Performance of Code-Prescribed Wood Shear Walls

Rakesh Gupta, Ph.D., Associate Professor, Department of Wood Science & Engineering, *Thomas H. Miller*, Ph.D., P.E., Associate Professor, Department of Civil, Construction & Environmental Engineering, *Peter Seaders* and *Kevin White*, Graduate Research Assistants, Department of Wood Science & Engineering and Department of Civil, Construction & Environmental Engineering, and *Milo Clauson*, Senior Faculty Research Assistant, Department of Wood Science & Engineering, Oregon State University, Corvallis, OR

All woodframe shear wall design values in the U.S. are currently based on monotonic tests following the ASTM E72 or E564 testing protocols. These tests are not representative of the short duration, random, reversing loads experienced during earthquakes and windstorms. The goal of this project is: 1) To understand the behavior (load-deflection response, strength, failure mode, ductility, energy dissipation characteristics, etc.) of shear walls under various actual earthquake records: a) subduction zone, long duration earthquakes from Oregon/Washington, and b) earthquakes from specific sites in California; and 2) To compare the behavior of shear walls under the standard static test (ASTM E564) and cyclic test protocol (CUREE) to the shear walls subjected to actual earthquake loading records. An assessment of variability in performance will also be made using the monotonic and CUREE testing results. Previous research has consisted of test groups of two to three walls. We will test eight walls under the monotonic testing protocol and eight walls under the CUREE testing protocol. This will provide a statistical sample that can be used to measure variability. A comparison of partially anchored (PA) (no hold downs) walls with fully anchored (FA) (with hold downs) walls will also be made. So far, 54 walls (34 - PA and 20 FA) have been tested under three loading conditions: monotonic (16 walls), cyclic (10 walls), and four different earthquakes (28 walls). Standard 8 ft by 8 ft walls consisting of 2x4 studs on 16" o.c., OSB sheathing and gypsum wallboard, 8d nail on 6" o.c. on edges, 8d nails on 12" o.c. in field, two 1/2" anchor bolts and with (FA walls) or without (PA walls) hold downs were tested. Results of these walls will be discussed.

POSTER 7

Durable, Energy-Efficient Houses for the Southern Climatic Region

Terry L. Amburgey, Ph.D., Professor, and *Shane C. Kitchens*, Ph.D. Student, Department of Forest Products, Mississippi State University, Mississippi State, MS

The Southern Climatic Housing Research Team at Mississippi State University will construct a research/demonstration house on the MSU campus. The unique approach of the interdepartmental team couples designs to affect energy efficiency with biological and structural durability issues. The objective is to address the challenges of decay fungi, subterranean termites, and high wind events while improving both indoor air quality and energy efficiency for houses built in the southern climatic region. Convinced that housing research must be regionalized rather than trying to develop a "one size fits all" structure, the research team, which includes a forest products biologist, architect, civil engineer, mechanical engineer, and landscape architect, is combining disciplines in every phase of the process including building design, construction, and maintenance. Currently, two graduate students are working with the team. Hopefully, this effort will lead to the creation of a multi-departmental curriculum dealing with building sciences.

POSTER 8

MSU Formosan Termite Field Research Facility

Michael G. Sanders, Research Associate II, and *Terry L. Amburgey*, Ph.D., Professor, Department of Forest Products, Mississippi State University, Mississippi State, MS

Coptotermes formosanus more commonly known as the Formosan subterranean termite has become a major problem in many areas of the southern U.S. It is our intent to establish a world-class testing facility for the study of this organism at the Mississippi Agricultural and Forestry Experiment Station at McNeill, Mississippi, a site known to be adjacent to established colonies of *C. formosanus*. Areas within the site will be established for studying the organism itself and preservative efficacy in both laboratory and multiple variations of field studies. These tests will include, but not be limited to, field stakes, framing, siding, and panel product testing in small-scale houses, and near-

ground exposure, all over established and active Formosan colonies. This site is being established as part of the research program of the Coalition for Advanced Housing and Forest Products Research.

POSTER 9

Curbing Indoor Mold Growth with Mildewcides

Carol A. Clausen and *Vina W. Yang*, Research Microbiologists, USDA Forest Service, Forest Products Laboratory, Madison, WI

Environmentally acceptable mildewcides are needed to curb the growth of mold fungi in woodframe housing when moisture management measures fail. Excess indoor moisture can lead to rapid mold establishment which, in turn, can have deleterious effects on indoor air quality. Compounds with known mildewcidal activity and low mammalian toxicity, such as food preservatives, pharmaceuticals, wood preservatives, or plant extractives were evaluated individually and in combination for their efficacy toward four common mold fungi on wood-based building materials. Dip-treatment of southern pine wood or oriented strandboard with azole-derivatives and plant extractives combined with borate-based compounds effectively prevented mold growth.

POSTER 10

Antifungal Metabolites of Two *Lactobacillus* Bacteria

Vina W. Yang and *Carol A. Clausen*, Research Microbiologists, USDA Forest Service, Forest Products Laboratory, Madison, WI

An increasingly important issue in housing durability is the growth of mold and its affect on indoor air quality (IAQ). Airborne mold spores can pose a genuine health threat to the dwelling's occupants. Developing environmentally acceptable methods for preventing mold establishment and growth on wood-based building materials is one focus of our bio-preservation program. Because several genera of bacteria are known to produce antimicrobial peptides called bacteriocins, we evaluated the inhibitory effect of various bacterial cell-free supernatants to mold growth. Of seven strains of bacteria tested, two *Lactobacilli* were identified that inhibited four common mold fungi. Lactic acid bacteria are known to produce different antimicrobial compounds and are important in the biopreservation of food and feed. Bacteriocins from *Lactobacilli* would be particularly beneficial as mold inhibitors in housing since they can be safely ingested and are part of the normal flora of healthy human beings. Cell-free supernatants were fractionated into smaller molecular weight fractions (10K, 3K and 1K). All of the fractions inhibited mold fungi in culture dishes. Thin layer chromatography analysis of filtrates differentiated lactic acid, a major component, from at least three unknown bands. Isolation and identification of antifungal metabolites from *Lactobacilli* will enable us to determine their effectiveness as mold inhibitors on wood. Developing natural mold inhibitors for use in dwellings is one strategy for protecting wood-based building materials from mold growth.

POSTER 11

Correlation of Adhesive Strength with Service Life of Paint Applied to Weathered Wood

R. Sam Williams, Ph.D., Senior Scientist, USDA Forest Service, Forest Products Laboratory, Madison, WI

Western redcedar siding was "preweathered" by placing panels outdoors for 1, 2, 4, 8, or 16 weeks prior to being painted. The amount of time these panels were exposed (preweathered) directly affected the paint adhesion and service life of the paint subsequently applied to these preweathered panels. The paint on those panels preweathered for 16 weeks began to flake and peel after 4-5 years. Paint on panels preweathered for 8 weeks began to flake and peel after 7-8 years, on panels preweathered for 4 weeks after 9-10 years, and panels preweathered for 2 weeks after 10-11 years. Siding exposed for as little as 1 week started to flake and peel after 13 years, whereas the unexposed controls are still in almost perfect condition after 17 years. Pretreatment of similarly preweathered siding with a water-repellent preservative prior to painting slightly improved paint performance.

POSTER 12

Innovative Robust Residential Wall and Roof System to Enhance Durability

Marilou Cheple, Extension Educator/Instructor, Cold Climate Housing Program, and *Patrick H. Huelman*, Associate Professor, Department of Wood & Paper Science, University of Minnesota, St. Paul, MN

An innovative structurally engineered panel (SEP) with an exterior drainage plane and insulation was designed and built as part of an affordable housing project (Project 20/20) in Minnesota. Partners for the project are the University of Minnesota (Cold Climate Housing, Department of Architecture, Center for Sustainable Building Research) and the Wilder Foundation. A total of 20 single-family demonstration housing and 20 rental housing units are planned. The following is a brief description of the first house constructed in the project. Construction began early in 2003 and was completed in September 2003. The structural wall is composed of solid 1-1/8" and 1-1/2" oriented strandboard (OSB) panels. The roof system for the project is TJIs with a ridge beam. Roof sheathing is OSB. A layer of 60 mil bituminous peel and stick material is carefully applied to the entire exterior of the wall and roof framing. Its purpose is to provide a drainage and moisture barrier, an air barrier, and a vapor retarder. Two inches of extruded polystyrene insulation boards completely cover the exterior of the building envelope both below and above grade. Furring strips fastened to the face of the exterior insulation provide the nailing base for the vinyl siding. An additional 3/4" rigid board insulation spans the area between the strips, providing a solid back for the siding. The wall system connects with the foundation system in a manner to support the wall and provide shear strength. This wall and roof system provide several advantages over traditionally framed buildings. They assure a very tight building envelope. This system allows for the possibility that factory precut panels can be erected in hours. The OSB serves as the interior wall surface, providing a more durable interior finish than drywall and eliminating the cost of drywall and the time needed for drywall installation and drying. The disadvantages of the system include unfamiliarity of trades and new concepts of plumbing, electrical and duct systems due to lack of wall cavities. In addition, VOC off-gassing may occur for a time. The decision to build the first house of the 20/20 Wilder Project, the SEP wall system was made by a design/research team in consultation with Wilder Foundation team members. This decision was based in part on the perception that the opportunities to save materials and labor time were greater using this system than other alternatives reviewed. Although the team recognized that new designs and methods for construction would be necessary, it was determined that this method presented the best opportunity for lowering the costs of construction.

POSTER 13

Flood Damage Resistant Residential Envelopes - Results of Field Testing

Robert L. Wendt, Research Architect, Oak Ridge National Laboratory, Oak Ridge, TN; and *Heshmat Aglan*, Ph.D., Principal Investigator, Tuskegee University, Tuskegee, AL

The objective of this presentation is to provide the findings from our flood damage resistance testing project. The first seven field tests investigated the performance of residential envelope materials and systems that have been subjected to flood conditions. Two tests included conventional envelope materials and systems found in homes. The remainder of the tests investigated materials and systems that were thought to have enhanced flood damage resistance properties. Two tests attempted "dry-floodproofing" where water was to be excluded from entering the structure. The data collected included: ambient conditions, moisture contents of materials before, during, and after flooding, mold observations and identification, physical properties, and the restoration potential of flooded materials. Our conclusions and recommendations as to which specific materials and systems perform better will also be presented.

POSTER 14

Oriented Strandboard Enhancements

John A. VavRosky, Structural Panels Marketing Manager, Potlatch Corporation, Spokane, WA; and *World Neih*, Ph.D., Research Director, Potlatch Corporation, Grand Rapids, MN

Technology improvements are allowing OSB manufacturers to add extras to standard construction rated sheathing and flooring structural OSB panels. Manufacturers now have the ability to add treatments for fire prevention, foil for solar reflectance and energy savings, and wood treatment chemicals for mold, insect, and rot protection. This poster will cover coating and technologies that are available for fire resistance; radiant barrier OSB and how it provides energy savings; and internal chemical treatments for OSB that provide termite, mold, and rot protection. All these topics will be backed up by independent research and test results.

POSTER 15

New Process for the Protection of Timber Framing and Other Wood-Based Building Products

Alan S. Ross, Ph.D., Vice President and Technical Director, Kop-Coat, Inc., Pittsburgh, PA

Due to instances of decay in structures in New Zealand, timber framing for many uses is now required to have fungicidal protection in the event of exposure to dampness. The preservative treatment requirements for framing are defined in New Zealand Specification 3640 Chemical Preservation of Round and Sawn Timber. Hazard Class H1.2 applies to timber in uses protected from the weather, but where there is a risk of moisture conducive to decay. Traditional methods for meeting the requirements of H1.2 include dip/diffusion treatment using borates and double vacuum treatment with a LOSP-borne preservative. However, each of these methods has several shortcomings. A new technology which is having commercial success in New Zealand is the Tru-Core™ Process. The preservative system in Tru-Core consists of a unique mixture of borates, organic preservatives, water repellents, and surfactants. The Tru-Core preservative system is applied as an in-line spray to kiln-dried framing timber machined to final shape and form dimensions. After spraying, the timber is stacked into normal pack sizes and stickering configuration. Packs of sprayed timber are then exposed to an activation schedule in a conditioning room or kiln. The activation conditions require a hot (>60°C) and highly humid (>95% RH) environment. After activation, Tru-Core treated timber meets the H1.2 retention and penetration requirements, which include full sapwood penetration. The process does not impair dimensional stability or result in grain raising of the treated timber. Broader applications of the Tru-Core process include treatment of siding and OSB.

POSTER 16

The BEG (Building Engineering Group) HUT: Durability Research in Canada

John F. Straube, Ph.D., Assistant Professor and Director, Building Engineering Group, University of Waterloo, Waterloo, ON, Canada

The durability and energy-efficiency of woodframe buildings is a topic of great interest to many stakeholders in the building industry and society. The inter-connected flows of heat, air and moisture, the dynamically varying and poorly understood exterior conditions, the poorly quantified and highly variable material properties, and the complexity of the three-dimensional woodframe structures combine to create a problem that is very difficult for analysis to solve. Measuring the performance of full-scale building enclosures exposed to realistic exterior conditions is one experimental technique that can be very useful. This presentation will describe the role of full-scale field test huts in the experimental investigation of building enclosures. The spectrum of material lab and climate chamber testing, analysis, and field studies will be introduced. Specific case studies including the University of Waterloo BEGHUT test facility and other commercial test huts and buildings around the world will be presented. Experimental techniques and methods for field monitoring of hygrothermal performance of woodframe structures will also be discussed. Finally, lessons learned about woodframe durability will be briefly summarized.



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