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Acquisition of Advanced Engineered Wood Composites Manufacturing and Science Laboratory

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Principal Investigator: Dagher, Habib J. **Award ID:** 9871411
Organization: University of Maine
Title:
Acquisition of Advanced Engineered Wood Composites Manufacturing and Science Laboratory

Project Participants

Senior Personnel

Name: Dagher, Habib
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Shaler, Stephen
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Goodell, Barry
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Landis, Eric
Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Lopez-Anido, Roberto
Worked for more than 160 Hours: Yes
Contribution to Project:
Helped write grants that leveraged the MRI grant. Also, helped specify and purchase the equiment.

Name: Douglas, Gardner
Worked for more than 160 Hours: Yes
Contribution to Project:
Helped write grants that leveraged the MRI grant. Also, helped specify and purchase the equiment.

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Name: Strong, Donald
Worked for more than 160 Hours: Yes
Contribution to Project:
Helped identify vendors, specify, and install equipment

Other Participant

Research Experience for Undergraduates

Organizational Partners

APA the Engineered Wood Association

MDA

USDA Forest Products Laboratory

Maine Technology Institute
Funded a number of joint industrial projects using the equipment purchased through MRI

BP Amoco
Funded a number of joint research projects utilizing MRI Equipment

Dow Chemical Company
Funded a number of research projects that utilized MRI equipment

Other Collaborators or Contacts

Over 100 industrial partners have utilized the MRI equipment through joint development efforts

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Findings:
The purchased of the MRI Equipment has contributed to findings outlined in 240 publications and presentations and 4 awarded patents between 1999 and 2002. These publications and patents contributed to significant advances in the field of engineered wood composites, including:

1. Methods to bond wood to fiber-reinforced polymers (FRP) were developed, using conventional PRF adhesives.
2. Methods to produce layered FRP that are compatible with wood hygrothermal properties were developed (patent awarded).
3. Methods to produce structural wood-plastic composites were advanced. These include extruded wood-fiber/thermoplastic composites reinfored with synthetic fibers.
4. Methods to model the creep of wood/FRP composites were developed.
5. Wood-FRP-concrete composites were developed, and demonstrated in the field. These composites have signficant more strength and stiffness than traditional wood composites.
6. New methods and models for randomizing defects in glulam beams were developed, which allow the use of low-grade laminations, and the production of high-performance composites. These methods led to the development and commercialization of Advanced Engineered Lumber (AEL). This beam and column product has allowable bending stress values in the 2,800 psi-3,400 psi range with 1.9 Msi-2.1 Msi Modulus. A new private manufacturing facility, which will employ 70 people.
licensed the University Technlogy,and constructed a plant in Bangor Maine.
7. Methods to produce disater-resistant advanced wood composite sheathing panels were developed. Two patents were awarded. The technology introduces synthetic fibers into the panel to strengthen the panel-framing connections, resulting in 100% increase in energy-absorbing capacity in seismic events.
8. Work is on-going with Federall Highway Administration funding to develop AASHTO Specifications for FRP-Glulam bridge girders. These girders have up to twice the capacity of conventional glulams. The girders were developed and patented using equipment funded through the MRI grant.

Training and Development:
The AEWC Center grew from 4 faculty to 25 full-time researchers and faculty associates, and sponsors 100 students every year from 12 different academic departments. This inter-displinary research environment allowed all faculty and students to learn skills from the other

contributing disciplines:
- Civil /structural engineering
- Wood science
- Chemical engineering
- Mechanical engineering
- Composite materials engineering
- Mechanics

Over 240 inter-disciplinary presentations & publications over the 1999-2002 period typifies the crossdisplinary learning environment.(Please refer to our web site www.aewc.umaine.edu for list of publications)

Outreach Activities:

1. We have obtained a $575,000 NSF Partnership for Innovation grant which has allowed us to take our technology to practice.
2. Worked with 100 companies to help develop new products. These companies and their employees participate first-hand in the science and technology needed to develop new products.
3. Have run and National Science Foundation Research Experience for Undergraduate Site for each of the past three years. This brings 10 students every year to our lab tha participate in various projects. The students project are advertizsed to the medida.
4. The AEWC Center has hired a full-time communication specialist who continues to tell the science and engineering stories to both industry groups, trade magazines, TV shows, etc. We have been featured in dozens of such publications, newspaper articles and TV spots.
5. The Center hosts hundreds of high-school students every year to tour the Center and see onging research.
6. Developed an Internet web site www.aewc.umaine.edu

Journal Publications

Dagher, H.D; Bragdon, M.M, "Advanced Fiber-Reinforced-Polymer-Wood Composites in Transportation Applications", Transportation Research Record, p. 237, vol. 1814, (2002). Published

Battles, Eoin, Dagher, H.J., and Abdel-Magod, B., "Durability of Composite Reinforcement for Timber Bridges", Transportation Research Record, p. 131, vol. 1696(2), (2000). Published

Davids, W.G.; Dagher, H.J.; Breton, J.M., "Modeling Creep Deformations of FRP-Reinforced Glulam Beams", Wood and Fiber Science, p. 426, vol. 32(4), (2000). Published

Books or Other One-time Publications

Web/Internet Site

URL(s):

www.aewc.umaine.edu

Description:

This web site describes, among others, the equipment purchased under this MRI Grant. It features the worl-leading 33,000 ft2 laboratory that was constructed to house this equipment, as well as the research personnel who work in the new laboratory.

Other Specific Products

Contributions

Contributions within Discipline:

This MRI equipment grant has allowed us to leverage and develop a 33,00 ft2 laboratory considered currently as a world leader in wood composites research.

Contributions to Other Disciplines:

The 33,000 ft2 laboratory that was constructed and equipped under this MRI grant currently brings together faculty and students from 12 different academic departments. Contributions of the lab are inherently inter-displinary, as shown by the staff and publications at www.aewc.umaine.edu.

Contributions to Human Resource Development:

1. In part because of the MRI equipment grant, the AEWC Center has grown from 4 faculty to 25 full-time researchers, associated faculty and staff.
2. The Center has sponsored 223 students (B.S., MS, and Ph.D.) over the period of three years. These students worked in an interdisciplinary environment on research projects, and received their degrees in their respective academic departments.

Contributions to Resources for Research and Education:

The largest resource was the development of a 33,000 ft2 laboratory, and the Advanced Engineered Wood Composites Center.

Contributions Beyond Science and Engineering:

1. The Advanced Engineered Wood Composites Center has worked with over 100 companies to develop new products.
2. One product (patent pending) developed by the Center led to a new commercial manufacturing business startup (70 employees expected within 2 years). The startup company in Bangor, ME produces a composite beam product developed at the Center and called Advanced Engineered Lumber. Please view article on the new business at: http://www.umaine.edu/umainetoday/Magazine/UMaineToday_v3_no1.pdf

Categories for which nothing is reported:

Any Book

Any Product

Research and Education Activities

In this Major Research Instrumentation (MRI) project, The NSF provided $700,000 in to outfit a new Composite-Reinforced-Wood (CRW) Manufacturing Science Laboratory at the University of Maine. The laboratory is part of a new 33,000 ft2 facility designed to develop the next generation of wood composites for construction. The University of Maine provided $413,816 in cash to match the NSF-MRI grant. The accomplishments of the project significantly exceeded the goals of the original grant:

1. The 33,000 ft^2 laboratory used to house the NSF MRI Equipment was constructed one year ahead of schedule through $4.3 million provided by the US Department of Commerce, the University of Maine and industry.
2. The focus of this proposal was to acquire equipment for the CRW Manufacturing Science Laboratory. The integrated semi-works/testing facility has been constructed and now allows the manufacture of FRP, fabrication of CRW structural elements, and structural and material testing all under one roof. With this unique capability, it is is possible to experiment with different FRP materials reinforcements, FRP and wood processing parameters, and CRW structural shapes. The web site www.aewc.umaine.edu for the new lab shows and describes all the equipment acquired through the NSF-MRI grant.
3. A detailed plan has been carried out to sustain this program through additional federal grants, establishment of industrial partners, active cooperation with other institutions including universities and national labs, and continued university support. Success was achieved through a careful management plan and specific benchmarks to monitor progress.
4. A University Research Center, the Advanced Engineered Wood Composites Center (AEWC) was established by the University of Maine Board of Trustees in 1999.
5. The AEWC Center has grown from 4 faculty at the time the NSF MRI grant was submitted to 25 full-time staff and faculty associates, and 100 students funded every year.
6. Since the NSF-MRI equipment was put in place, the external research funding for the AEWC Center grew to $4 million/year.
7. Two AEWC Center associated Faculty Dr. Roberto Lopez-Anido and Dr. Eric Landis have received NSF-CAREER Awards
8. Received NSF Partnership for Innovation (PFI) grant $575,000 to commercialize the research developed by the Center.
9. Supported over 100 companies who use the NSF-MRI equipment. Recently spunoff a new private manufacturing company, Engineered Materials of Maine, which is to employee 70. The product that they will manufacture, "Advanced Engineered Lumber" was developed, patented, and building-code-approved using the NSF-MRI Equipment.
10. NSF-MRI equipment allowed the AEWC Center to attract and additional $11,676,889 in the three years 1999-2002.
11. Publications & Presentations: 240 by AEWC Center's staff from 1999-2002
12. Patents: 4 awarded from 1999-2002.