COVER SHEET FOR GRANT PROPOSALS

State Board of Education

SBOE PROPOSAL NUMBER: (to be assigned by SBOE)	AMOUNT REQUESTED: **$50,000**

TITLE OF PROPOSED PROJECT:
Development of an Energy Efficient Integrated FRP-confined Precast Concrete Sandwich Roof Panel for Green Buildings

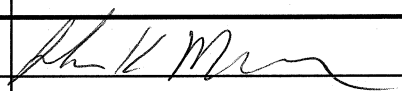
SPECIFIC PROJECT FOCUS:
Based on a preliminary study, this project aims to develop a Fiber-reinforced polymer (FRP)-confined precast concrete sandwich (FPCS) roof panel, which innovatively combines the roofing, insulation, and supporting structure into one integral part, to achieve high performance in strength, cost, and energy efficiency. It can be widely used as building roofs and green roofs, and has a great potential to replace existing roof constructions, an approximate $4 billion annual market in the USA.

PROJECT START DATE: 7/1/2012	PROJECT END DATE: 6/31/2013
NAME OF INSTITUTION: **University of Idaho**	DEPARTMENT: **Department of Civil Engineering**

ADDRESS: **University of Idaho, PO Box 441022, Moscow, ID 83844-1022**

	E-MAIL ADDRESS: **achen@uidaho.edu**	PI PHONE NUMBER: **(208) 885-7158**

	NAME:	TITLE:	SIGNATURE:
PROJECT DIRECTOR	**An Chen, Ph.D., P.E., LEED AP**	**Assistant Professor**	
CO-PRINCIPAL INVESTIGATOR	**Richard Nielsen, Ph.D., P.E.**	**Associate Professor**	
CO-PRINCIPAL INVESTIGATOR			
CO-PRINCIPAL INVESTIGATOR			

	NAME:	SIGNATURE:
Authorized Organizational Representative	**Jack McIver, VP of Research and Economic Development**	
	John K. McIver ~~Vice President for Research~~ University of Idaho	

SUMMARY PROPOSAL BUDGET

Name of Institution: University of Idaho

Name of Project Director: An Chen

A. FACULTY AND STAFF

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
An Chen				**1.0**	**$ 9,000**
% OF TOTAL BUDGET: **18.0%**				**SUBTOTAL:**	**$ 9,000**

B. VISITING PROFESSORS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
% OF TOTAL BUDGET:				**SUBTOTAL:**	

C. POST DOCTORAL ASSOCIATES / OTHER PROFESSIONALS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
% OF TOTAL BUDGET:				**SUBTOTAL:**	

D. GRADUATE / UNDERGRADUATE STUDENTS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
Graduate Research Assistant			**4.5**	**1.5**	**$ 20,800**
Undergraduate Student Research Assistant			**3.0**	**1.5**	**$ 7,300**
% OF TOTAL BUDGET: **56.2%**				**SUBTOTAL:**	**$ 28,100**

E. FRINGE BENEFITS

Rate of Pay (%)	Salary Base	Dollar Amount Requested
Project Director		**$ 2,100**
Graduate/Undergraduate Research Assistants		**$ 900**
	SUBTOTAL:	**$ 3,000**

F. EQUIPMENT: (List each item with a cost in excess of $1000.00.)

Item/Description	Dollar Amount Requested
SUBTOTAL:	

G. TRAVEL:

Dates of Travel (from/to)	No. of Persons	Total Days	Transportation	Lodging	Per Diem	Dollar Amount Requested
RT MoscowDixon, MO	**2**	**5**	**$1,600**	**$ 800**	**$400**	**$ 2,800**
					SUBTOTAL:	**$ 2,800**

H. Participant Support Costs:

	Dollar Amount Requested
1. Stipends	
2. Travel (other than listed in section G)	
3. Subsistence	
4. Other	
SUBTOTAL:	

I. Other Direct Costs:	Dollar Amount Requested
1. Materials and Supplies	$ 5,600
2. Publication Costs/Page Charges	
3. Consultant Services (Include Travel Expenses)	
4. Computer Services	
5. Subcontracts	
6. Other (specify nature & breakdown if over $1000) – **Computation Software License**	$ 1,500
SUBTOTAL:	$7,100
J. Total Costs: (Add subtotals, sections A through I) **TOTAL:**	$ 50,000
K. Amount Requested: **TOTAL:**	$ 50,000

Project Director's Signature: [signature] Date: 5/9/12

INSTITUTIONAL AND OTHER SECTOR SUPPORT

(add additional pages as necessary)

A. INSTITUTIONAL / OTHER SECTOR DOLLARS

Source / Description	Amount

B. FACULTY / STAFF POSITIONS

Description

C. CAPITAL EQUIPMENT

Description

D. FACILITIES & INSTRUMENTATION

Description

SBOE Idaho Incubation Fund Program Proposal

DEVELOPMENT OF AN ENERGY EFFICIENT INTEGRATED FRP-CONFINED PRECAST CONCRETE SANDWICH ROOF PANEL FOR GREEN BUILDINGS

1. INSTITUTION: University of Idaho (UI)

2. FACULTY MEMBER DIRECTING PROJECT: Project Director: An Chen, PhD, PE, LEED AP; Co-PI: Richard Nielsen, PhD, PE, Department of Civil Engineering, University of Idaho, Moscow, ID 83844-1022

3. HAS THIS TECHNOLOGY BEEN PROPOSED AND/OR BEEN AWARDED AN INCUBATION FUND AWARD IN THE PAST: No.

4. EXECUTIVE SUMMARY: A traditional roof consists of roofing material and insulation layer on top of a supporting structure. These parts are constructed separately, which is time consuming and labor intensive. The proposed Fiber-reinforced polymer (FRP)-confined precast concrete sandwich (FPCS) roof panel innovatively combines the roofing, insulation, and supporting structure into one integral part, to achieve high performance in strength, cost, and energy efficiency. Based on favorable results from a preliminary study on insulated precast concrete sandwich panels, this proposal requests incubation funds to support further development and testing of the FPCS panel to advance the technology to a level for prototype production. With strong support from public and private sectors, a comprehensive technical development plan, including configuration optimization and testing of scaled and full-scale FPCS panels will be conducted. A complete business development plan will be developed to commercialize the technology.

This project is aligned with the priorities of the University of Idaho (UI) to promote research on energy efficiency and sustainability. The project will also enhance the curricula of

two courses the PI will be teaching over the course of the project. Graduate and undergraduate students will work on this project to gain more research experience. The proposed innovation has a great potential to replace existing roof constructions, an approximate $4 billion annual market in the USA. The UI holds all intellectual properties of the proposed technology.

5. "GAP" PROJECT OBJECTIVE AND TOTAL AMOUNT REQUESTED: We are requesting $50,000 of incubation funds to develop and test an innovative FPCS roof panel using an advanced technology of FRP-concrete hybrid sandwich structures. The technology has been proven applicable to roof construction based on a preliminary study on insulated precast concrete sandwich panels. The study included a detailed Finite Element (FE) analysis by the UI (inventor), and a bending test by Central Pre-Mix Prestress Co. (CPPC) and Hopkins Structural Design Solutions, LLC (HSDS), co-inventor of the technology.

The objective of the "GAP" funds is to further incorporate FRP components and advance the technology to a level for prototype production of the FPCS panels at the manufacturing plant. Specifically, technical objectives include: (1) configuration optimization of the FPCS panel using FE analysis; (2) evaluation of scaled FPCS specimens subjected to bending and creep tests; and (3) evaluation of full-scale FPCS specimens subjected to bending test. The business objective is to develop a complete business plan to commercialize the technology.

6. PROJECT RELATIONSHIP TO HOME INSTITUTION PRIORITIES: Research on sustainability is an important priority of the UI. In particular, the UI has established a Center of Sustainability to provide "a strong framework, leadership and empowerment for the continued development of sustainable practices," and to "develop and maintain healthful educational living environments while fully integrating sustainable practices at the University of Idaho." Energy efficient structure as proposed herein is an important aspect of sustainable and green design. The

project also aligns with the priorities of the Office Technology Transfer and UI as a land-grant university to develop products and transfer technology to public and private sectors.

7. POTENTIAL IMPACT TO THE ECONOMY OF IDAHO: There are a number of potential impacts to Idaho's economy. In the USA, buildings are responsible for 39% of energy use, 71% of electricity consumption, and 38% of carbon dioxide emissions. The reduction in construction cost and energy consumption from the FPCS roof can be translated into a direct economic benefit for Idaho companies, in particular the construction industry, and building occupants. In addition, this green product could be widely used by public sector. The U.S. General Services Administration's (GSA) has required a minimum LEED Gold certification for all new federal building construction and substantial renovation projects. Similarly, the UI requires all new construction to achieve LEED Silver. LEED Rating System™ is the most systematic and widely adopted green building rating system all around the world. The FPCS roof can be eligible for Optimize Energy Performance under Energy and Atmosphere, the category with the highest point in the rating system. There is also a great potential that an FRP manufacturing plant could be built in Idaho by the commercialization partner, Missouri Structural Composites, LLC (MSC), which will directly create employment opportunities.

8. PARTNERSHIPS WITH THE PUBLIC OR PRIVATE SECTOR OR NEW COMPANY CREATION: The PIs have strong support from MSC, a leading manufacturer of FRP products in the USA; and CPPC and Knife River Prestress, two major manufacturers of precast/prestress concrete products. They have expressed interests in helping to penetrate the market of this product and assisting with the development and testing. The PIs will also work with public sectors, such as the City of Moscow and UI to promote wider application of this green product.

9. THE MARKET OPPORTUNITY: Need the project would address: Green technology and energy efficient constructions have been at the forefront in recent years for building innovation and popularity. This project will address the increasing need for energy efficient, cost-effective, and durable structures.

Applications and markets for the technology: The targeted market for the proposed innovation is building roofs and green roofs. The roof construction represents an approximate $4 billion annual market in the USA.

Product description, potential market audience, competition, and barriers to market entry: The product will be an energy efficient integrated roof panel with high water resistance, fast construction, light weight, reduced cost, reduced overall depth, and increased durability. The competition is from traditional roofs. The proposed innovation is expected to be superior to and replace the existing roof construction and create a huge market. In particular, the proposed innovation is suitable for applications in cold regions such as Idaho, where concrete pouring becomes extremely difficult during winter time and insulation is an important factor for building design. It is also suitable for construction community which is less skilled in forming and shoring concrete construction on site. Potential customers will be building owners and contractors.

Similar to any new structural type, the barrier for market entry is the acceptance from the building authorities since FPCS panels are not addressed specifically in the model building code. Engineering designs (usually with sealed sets of plans) based on the results from this project, either by in-house engineers or other consulting engineers who are familiar with the design of the FPCS panel, can be used to obtain building permits.

10. TECHNOLOGY: Technology description: As shown in Fig. 1, the FPCS panel consists of four layers: pre-manufactured top FRP shell including an FRP plate and connectors (Fig. 2),

steel-free top precast concrete wythe, foam core, and bottom precast, prestressed concrete wythe. The thickness of the concrete wythes varies depending on the loading.

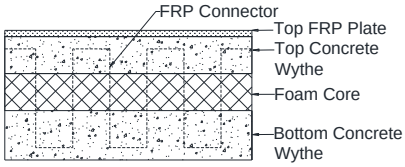


Fig. 1. FPCS Panel

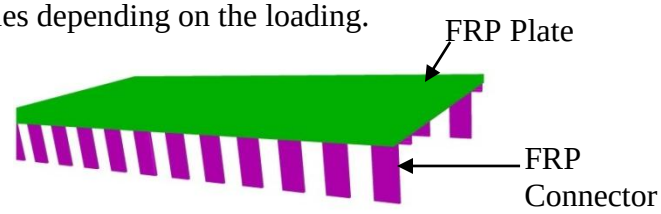


Fig. 2. Pre-manufactured FRP Shell

FRP composite is made of a polymer matrix (polyester) reinforced with fibers (glass), with high tensile strength, lightweight, and high resistance to corrosion. In particular, it has high water resistance and has been used for water tanks, fish tanks, underwater rehabilitation and other applications subjected to high moisture. Therefore, the top FRP plate can provide a water barrier and also protect the concrete below. Due to special treatment of the interior FRP surface during manufacturing of the FRP plate to achieve interface bond, the top FRP shell can work compositely with and act as reinforcement for the top concrete wythe. Therefore, no reinforcement for the top concrete wythe is required. The bottom concrete wythe will be precast, prestressed concrete. FRP connectors will transfer the shear between top and bottom concrete wythes to achieve a full-composite action. The fabrication of the panel will follow a reverse order as shown in Fig. 1. First, the FRP shell with specially treated interior surface will be laid on the bed, which also acts as formwork for concrete. Second, concrete will be cast for the "top" wythe. Third, foam core will be installed. Fourth, prestressing strands will be installed and tensioned. Fifth, concrete will be cast for the "bottom" wythe. And finally, after the concrete reached the required strength, the strands will be distressed.

Fig. 3. Bending Test of Insulated Precast Concrete Sandwich Panel

Current state of the technology: A preliminary study, including a detailed 3-D FE analysis by the PIs at UI and a

bending test by the collaborators, CPPC and HSDS, has been conducted on a similar full-scale insulated precast concrete sandwich panel, as shown in Fig. 3. The panel was 23 ft long and 10 ft wide, which included two 3 inch thick outer wythes of precast, prestressed concrete and a 4 inch thick foam core. The panel can sustain an equivalent uniform distributed load of about 90 psf. Composite action was achieved based on correlations between the testing and FE results. This study not only proves the applicability of the sandwich panel for roof construction, but also paves the way for the development of FPCS roof panel, since the incorporation of the FRP is expected to significantly increase the strength of the sandwich panel.

How the technology contributes to the product and market need and its intellectual property status: Traditional roof systems treat roofing, insulation, and supporting structure separately. The proposed technology will address this limitation and provide an energy efficient, cost-effective, and durable structure with ease of construction. During fabrication, no concrete stripping is required, and the construction speed can be increased. During roof installation, the FPCS panel can be installed in one-step and no additional insulation layer and roofing materials are required, which can significantly reduce the construction time and cost, in particular labor cost. For conventional asphalt roofing, labor represents approximately 75% of the total cost and materials are only 25%. The insulation layer in the FPCS panel can not only significantly increase the structure's strength but also remarkably improve thermal resistance of the panel for greater thermal comfort and less energy waste. The R-value of a 10" thick FPCS panel with a 6" insulation layer is approximately 30 times greater than the value of a concrete panel with the same thickness and the same strength. Additionally, the non-steel reinforced top concrete wythe not only eliminates the potential corrosion problem associated with the steel rebars, but also provides a shield for the concrete inside the shell, expecting to significantly increase the service

life of the structure. The FPCS panel is particularly suitable for green roofs, since green roofs usually have more stringent requirements for strength and water resistance.

The UI holds all intellectual properties to the proposed technology and a provisional patent has been filed through the Office of Technology Transfer.

Who developed the technology and with what funding: The technology was developed by the PI from the UI and Paul Hopkins from HSDS. The preliminary bending test was funded by CPPC and other financial support was provided by the UI through a startup package for the PI.

11. COMMERCIALIZATION PARTNERS: Our commercialization partner will be MSC. The PI has over 10 years working relation with MSC and has successfully helped MSC to develop and commercialize FRP sandwich panels for highway bridge decks and fish tank applications. We will continue this relation for the proposed technology. Dr. Jerry Plunkett, the president of MSC, has for over 40 years worked in the field of developing products and is a pioneer in FRP applications. MSC has expressed strong interest in commercializing this technology and intends to build an FRP manufacturing plant in Idaho once this technology can be developed. CPPC and Knife River will provide business advice on commercialization. Knife River also expressed interest in commercialization the system if test results are favorable.

12. SPECIFIC PROJECT PLAN AND DETAILED USE OF FUNDS:

Tasks to be Taken: Four major tasks will be executed:

Task 1: Configuration Optimization: An FE model has been developed at the UI to simulate insulated precast concrete sandwich panels and calibrated against existing test results. The FE model will be used to incorporate FRP components to predict and optimize the configuration of the FPCS panel, considering parameters including thickness of FRP plate, top and bottom concrete wythes, foam core; spacing of the FRP connector, and material properties of the foam.

Task 2. Evaluation of Scaled Specimens: *Sub-task 2.1: Structural Evaluation:* Four-point bending tests on scaled specimens will be conducted to study the behavior of the FPCS panels under roof loads. The specimens will be 12 ft long and 4 ft wide. Bottom concrete wythe will be 3 inch thick. Two thicknesses of 1 inch and 3 inch will be considered for top concrete wythe to be potentially used for regular roof and green roof. The two concrete wythes will be separated by a 4 inch thick foam core. Four specimens will be tested, with two for each group. Strain gages will be bonded to the FRP plate and the concrete wythes through the thickness of the panel to study the composite behavior. Load-displacement relations will be recorded to study the stiffness. All panels will be tested until failure to study the strength and failure modes.

Sub-task 2.2: Creep tests: Creep test will be conducted to study long-term deflection of the panels under sustained loads. The same specimens as described in Sub-task 2.1 will be subjected to a four-month creep in bending at 40% of the static capacity, as determined from Sub-task 2.1. Two specimens will be tested, with one specimen for each group.

Task 3. Evaluation of Full-Scale Specimens: Based on findings from Tasks 1 and 2, full-scale specimens, 24 ft long and 8 ft wide, will be constructed considering both 1 inch and 3 inch top concrete wythes. Bending tests will be conducted. The performance will be evaluated and the failure modes will be characterized.

Task 4. Development of a Business Plan: A complete business plan will be developed with the commercialization partners to commercialize the proposed technology.

The project will be completed in 12 months, as shown in the Table below.

Research Timeline 2012-2013	J	A	S	O	N	D	J	F	M	A	M	J
Task 1: Configuration Optimization												
Task 2.1: Bending Test of Scaled Specimens												
Task 2.2: Creep Test of Scaled Specimens												
Task 3: Evaluation of Full-scale Specimens												
Task 4: Business Plan Development												
Final Report												

Personnel and Qualifications: *Dr. An Chen (PI)* has more than ten years of research and design experience on FRP sandwich panels, high-rise buildings, and energy efficient structures. His research has been funded by NCHRP, State DOTs, State Challenge Grant, Universities, and others. As a project manager, he has completed design of over twenty new high-rise buildings, most of which are multi-million projects. He will oversee the whole project. *Dr. Richard Nielsen (Co-PI)* is an expert on structural modeling, structural dynamics, and random vibration and has extensive administrative experience as a department Chair. He will assist with FE modeling and business plan development.

Proposed budget: Funds requested will support the PI for one month. A graduate student ($20/hour with 20 hours/week) and an undergraduate student ($10/hour with 12 hours/week during academic year and 20 hours/week during summer) will be supported for 12 months to conduct FE analysis and laboratory testing. Funds will also cover computational software license for the FE analysis and material and supply costs associated with the laboratory testing. Travel support from Moscow, ID to Dixon, Missouri is requested for the students to visit MSC and get hands-on experience on FRP manufacturing.

Salary/Wages	
Project Director (one month)	$ 9,000
Fringe@23%	$ 2,100
Graduate/Undergraduate Students (12 months)	$ 28,100
Fringe@1% for academic year and 9% for summer	$ 900
Travel	$ 2,800
Computational Software License	$ 1,500
Materials and Supplies	$ 5,600
Total	**$ 50,000**

13. EDUCATION AND OUTREACH: The proposed research will be used to enhance the existing curricula and contribute to new course development. Over the course of this project, two courses will be offered by the PI: an undergraduate course CE 441-Reinforced Concrete Design (enrollment: 45) in Fall 2012 and a graduate course CE 547-Advanced Reinforced Design

(expected enrollment: 20) in Spring 2013. An interactive environment will be created for students to explore concepts of reinforced concrete design through design, manufacturing, and physical experiments of the FPCS panels. Students will actively participate in creating their own knowledge (constructivism) by an inductive experiential active learning approach, from concrete experience of experimental study (grasping experience) to abstract conceptualization of new and key theoretical aspects of reinforced concrete design (transforming experience), developing innovative and critical thinking and research ability and acquiring life-long learning qualities. The research will also contribute to a new course, Sustainable Structures, to be scheduled in Spring 2013. In addition, one graduate student and one undergraduate student will participate in this research under the supervision of the PIs. The students will also have the opportunities to work with industrial professionals and visit their laboratories and manufacturing plants. Therefore, the students' educational and research experience will be greatly enhanced. The experimental tools and results from this project will be used in support of the college's undergraduate programs for underrepresented groups and middle/high schools, which include middle school and high school outreach activities, HOIST (Helping Orient Indian Students and Teachers into STEM), and freshmen engineering courses. The results of the project will be disseminated broadly through technical conferences and journal publications.

14. INSTITUTIONAL AND OTHER SECTOR SUPPORT: The Office the Technology Transfer of UI will provide support to protect the intellectual properties. Support will also be provided by MSC in terms of technical contribution and manufacturing technology for FRP components and commercialization plan development; CPPC in terms of technical and business consulting and student mentoring through site visits; and Knife River in terms of technical and business consulting (see attached letters of support).

APPENDICES:

1. FACILITIES AND EQUIPMENT:

University of Idaho (UI) researchers have outstanding structural, materials, mechanics/mechatronics, and computational facilities to accomplish the proposed work, which includes:

Structural Testing:

- Spacious structural lab with strong concrete floor
- MTS servo-hydraulic actuators with 110,000 pound and some manual hydraulic jacks with 50,000 pound capacity
- Two strong testing frames for scaled or full-scale structural static, dynamic, and fatigue testing
- Data acquisition system to measure displacements with LVDTs, loads with load cells, and strain with strain gages

Material Testing:

- Universal Hydraulic Testing Machines permitting static and dynamic testing of structural elements and materials over a wide continuous load range:
- 25,000 pound MTS 810, which is computer-controlled with on-line graphic displays

Concrete Testing:

- 400,000 pound compression testing machine
- Concrete Mixer
- Humidity Room Controls
- Slump Test Kits
- Air Content Meters
- Sulfur Capping Unit

Computers and Software:

- About 16 Dell Precision T1600 computers
- Software includes the latest version of ABAQUS, Risa 2D/3D, SAP 2000, MATHCAD, AutoCAD, etc. for computational calculations and modeling.

2. BIOGRAPHICAL SKETCHING AND INDIVIDUAL SUPPORT:

An Chen, Ph.D., P.E., LEED® AP

Assistant Professor, Department of Civil Engineering, University of Idaho
E-mail: achen@uidaho.edu

EDUCATION:

- Ph.D. in Civil Engineering (Structural Engineering), West Virginia University, Morgantown, WV, 2004
- M.S. in Civil Engineering (Structural Engineering), Dalian University of Technology, China , 1998
- B.E. in Civil Engineering (Structural Engineering), Dalian University of Technology, China, 1995

AREAS OF EXPERTISE:

Sustainable civil infrastructure and buildings, waste material utilization, energy efficient buildings, fiber wrap technology for concrete bridge rehabilitation, FRP sandwich panels for buildings, bridge deck and fish tank applications, FRP-concrete interface mechanics, and seismic resistance of high-rise buildings.

FIVE RELEVANT PUBLICATIONS:

- **Chen, A.,** and Davalos, J.F. (in press). "Development of Facesheet for Honeycomb FRP Sandwich Panels," accepted by *Journal of Composite Materials.*
- Davalos, J.F., **Chen A.**, and Zou, B. (2011), "Stiffness and Strength Evaluations of a New Shear Connection System for FRP Bridge Decks to Steel Girders," *Journal of Composites for Construction, ASCE,* 15(3), pp. 441-450.
- **Chen, A.** and Davalos, J.F. (2010). "Strength Evaluations of Sinusoidal Core for FRP Sandwich Bridge Deck Panels," *Composite Structures*, 92(7), pp. 1561-1573.
- **Chen, A.** and Davalos, J.F. (2007). "Transverse Shear with Skin Effect for Composite Sandwich with Honeycomb Sinusoidal Core", *Journal of Engineering Mechanics, ASCE,* 133(3), pp. 247-256.
- **Chen, A.** and Davalos, J.F. (2005). "A Solution including Skin Effect for Stiffness and Stress Field of Sandwich Honeycomb Core", *International Journal of Solids and Structures*, 42(9-10), pp. 2711-2739.

CURRENT AND PENDING FINDINGS

Research Title or Area	Granting or Sponsoring Agency	Date of Award and Duration of Grant	Contract Amount
Development of Bridge Foundation Movement Criteria (contract under negotiation)	NCHRP	Duration: 30 months, Expected Start Date: June 2012	$350,000 (PI for UI subcontract: $65,000)
Center for Transportation Security and Infrastructure Innovations	WV Higher Education Policy Commission	Duration: 07/01/07 to 06/30/12	$1,500,000 (Co-PI)

Richard J. Nielsen, Ph.D., P.E.
Chairman and Associate Professor
Department of Civil Engineering, University of Idaho
E-mail: rnielsen@uidaho.edu; Phone: (208) 885-8961; Fax: (208) 885-6608

EDUCATION

Brigham Young University, Provo, UT	Civil Engineering	B.S., 1980
Stanford University, Palo Alto, CA	Civil Engineering	M.S., 1981
	Earthquake Engineering	Engr, 1982
	Civil Engineering	Ph.D., 1986

APPOINTMENTS

- Associate Professor, Department of Civil Engineering, University of Idaho, Moscow, ID, 1993-present
- Assistant Professor, Department of Civil Engineering, University of Idaho, Moscow, ID, 1986-93
- Structural Analyst, URS/J.A. Blume & Assoc. San Francisco, CA, June-Sept. 1983.
- Engineer-in-Training, Reaveley Engineers & Assoc. Salt Lake City, UT, June-Sept. 1981.
- Site Engineer, L.D.S. Church Engineering Dept. Salt Lake City, UT, 1979 & 1980.

PROFESSIONAL REGISTRATIONS

- Registered Professional Engineer (PE) in Civil Engineering, Idaho

AREA OF EXPERTISE

Structural modeling. Structural dynamics. Bridge design, bridge rating and bridge management. Fatigue and fracture reliability. Earthquake engineering. Pavement reliability.

FIVE RELEVANT PUBLICATIONS

- Abdo, A. A., Bayomy, F. M., Nielsen, R. J., Weaver, T. J., Jung, S. J., Santi, M. J. Development and Evaluation of Hot Mix Asphalt Stability Index. International Journal of Pavement Engineering. Vol. 11, No. 6, Dec. 2010, pp 529-539.
- Milligan, J.H., R.J. Nielsen and E.R. Schmeckpeper. "Short and Long-Terms Effects of Element Costs and Failure Costs in Pontis," Journal of Bridge Engineering, Vol. 11, No. 5, 2006, pp. 626-632.
- Sielaff, B.J., R.J. Nielsen, and E.R. Schmeckpeper, "Evolution of Design Code Requirements for Exterior Elements and Connections," Earthquake Spectra, Vol. 21, No. 1, 2005, pp. 213-224.
- Nielsen, R.J. and E.R. Schmeckpeper. "Single-span Prestressed Girder Bridge: LRFD Design and Comparison," Journal of Bridge Engineering, Vol. 7, No. 1, 2002, pp. 22-30.
- Schmeckpeper, E.R., R.J. Nielsen, and G. Gentry, "The Effects of Over-Compressing ASTM F595 Direct Tension Indicators on A325 Bolts Used in Shear Connections." Engineering Journal, AISC, Vol. 36, No. 1, 1999, pp. 39-50.

Full CV of Project Director

NAME: An Chen **DATE:** 5/7/2012
RANK OR TITLE: Assistant Professor
DEPARTMENT: Civil Engineering
OFFICE LOCATION AND CAMPUS ZIP: BEL 128, 441022
OFFICE PHONE: 208-885-7158
FAX: 208-885-6608
EMAIL: achen@uidaho.edu
DATE OF FIRST EMPLOYMENT AT UI: August 14, 2011

EDUCATION BEYOND HIGH SCHOOL:

Degrees:

- Ph.D. in Civil Engineering (Structural Engineering), West Virginia University, Morgantown, WV, 2004
- M.S. in Civil Engineering (Structural Engineering), Dalian University of Technology, China, 1998
- B.E. in Civil Engineering (Structural Engineering), Dalian University of Technology, China, 1995

Certificates and Licenses:

- Professional Engineer (PE) in Civil Engineering, Registered State: CT, License No: PEN.0025517
- Leadership in Energy and Environmental Design Accredited Professional (LEED® AP) - accredited by the US Green Building Council (USGBC)

EXPERIENCE:

Teaching, Extension and Research Appointments:

- August 2011-present Assistant Professor, Department of Civil Engineering, University of Idaho, Moscow, ID
- July 2008-Aug 2011 Research Assistant Professor, Department of Civil and Environmental Engineering, West Virginia University, Morgantown, WV
- Aug 2001-Aug 2004 Research Assistant, Department of Civil and Environmental Engineering, West Virginia University, Morgantown, WV
- Aug 1999- Aug 2001 Research Assistant, Department of Civil and Structural Engineering, The Hong Kong Polytechnic University, Hong Kong, China;

Consulting:

- Sept 2004-July 2008 Junior Associate (promoted in 2007), the Office of James Ruderman LLP, New York, NY
  Project manager for building and green building design using steel, concrete, masonry and timber materials. Duties included project management, 3-D finite element analysis using state-of-art programs such as RAM and LARSA, super- and sub-structural design of new structures, rehabilitation and renovation of existing structures, shop drawing review, and overseeing construction. Familiar with building codes, specifications and

LEED Rating System™. Completed over twenty new projects encompassing residential buildings, retail centers, office and commercial buildings, and industrial projects.

TEACHING ACCOMPLISHMENTS:

Areas of Specialization: Structural Engineering, Sustainability

Courses Taught:

Courses at University of Idaho

Role	Semester	Course Title	Enrollment
Instructor	Spring 2012	CE542-Advanced Design Steel Structures	16
Instructor	Fall 2011	CE342-Theory of Structure	43

Courses at West Virginia University

Role	Semester	Course Title	Enrollment
Co-Instructor	Fall 2010	CE493O-Sustainable Construction Materials	33
Instructor	Spring 2010	CE591F-Analysis of Plates and Shells	6
Instructor	Fall 2009	CE552-Finite Element Method	16
Guest Instructor	Spring 2010	MAE593R-Structural Composite Design	7
Guest Instructor	Fall 2010	CE591Y-Energy/Env./Sustainable Infrastructure	8
Teaching Assistant	Spring 2003	CE552-Finite Element Method	44

Students Advised:

Graduate Students:

Major Professor at University of Idaho:

Name of Student	Degree Areas	Degree Received Date
Paul Hopkins	Ph.D. in Civil Engineering	In Progress

Co-advisor and committee co-chair at West Virginia University:

Name of Student	Degree Areas	Degree Received Date
John Wattick	M.S. in Civil Engineering	In Progress
Pengcheng Jiao	M.S. in Civil Engineering	May 2012
Bradley McGraw	M.S. in Civil Engineering	May 2012
Fatemeh Sedigh Imani	M.S. in Civil Engineering	August 2010
Adam Justice	M.S. in Civil Engineering	August 2010

Served on graduate committee

Name of Student	Degree Areas	Degree Received Date
Soumya Chowdhury	M.S. in Civil Engineering	December 2011
Manish Roy	M.S. in Civil Engineering	December 2011
Arkamitra Kar	M.S. in Civil Engineering	December 2010
Matthew Anderson	M.S. in Civil Engineering	August 2010
Sathish Konduru	M.S. in Civil Engineering	December 2009
Bin Zou	Ph.D. in Civil Engineering	December 2008

Materials Developed:

Developing *Istructures*-an Active Learning Cyber-Teaching Lab for Structural Analysis

SCHOLARSHIP ACCOMPLISHMENTS:

Publications:

Invited Paper

1) Davalos, J.F., **Chen, A.,** and Ray, I. (2011). "A Sustainable Rehabilitation System of Reinforced Concrete T-beam Structures using Externally Bonded FRP Composites," The HKIE/IStructE Structural Division Annual Seminar 2011, Hong Kong.

Refereed Journal Publications (published or accepted)

1) **Chen, A.,** and Davalos, J.F., Jiao, P., and McGraw, B. (accepted). "Buckling Behavior of Sinusoidal Web for Composite Wood I-Joist with Elastically Restrained Loaded Edges under Compression," *Journal of Engineering Mechanics, ASCE.*
2) Davalos, J.F., **Chen, A.**, and Zou, B. (accepted). "Experimental Investigation of a Scaled FRP Deck-on-Steel Girder Bridge Model with Partial Degree of Composite Action," accepted by *Engineering Structures.*
3) **Chen, A.,** and Davalos, J.F. (in press). "Development of Facesheet for Honeycomb FRP Sandwich Panels," accepted by *Journal of Composite Materials.*
4) **Chen, A.**, Davalos, J.F., Justice, A.L., Michaelson, G.K., and Perisetty, N (in press). "Effective Flange Width for Orthotropic FRP Bridge Decks with Degrees of Composite Action," accepted by *Journal of Bridge Engineering, ASCE.*
5) Davalos, J.F., **Chen, A.**, Ray, I., and Levan, J. (in press). "Externally Bonded FRP Composites for the Rehabilitation of Reinforced Concrete T-beam Bridges," accepted by *Journal of Infrastructure Systems, ASCE*.
6) Davalos, J.F., Parish, G., **Chen, A.** and Ray, I. (in press). "Effect of Anchoring Schemes for Beams Aged by Accelerated Corrosion and Strengthened with Carbon Fibre-Reinforced Polymer," accepted by *Structure and Infrastructure Engineering*
7) Davalos, J.F., **Chen A.**, and Zou, B. (2011), "Stiffness and Strength Evaluations of a New Shear Connection System for FRP Bridge Decks to Steel Girders," *Journal of Composites for Construction, ASCE,* 15(3), pp. 441-450.
8) Zou, B., **Chen A.**, Davalos, J.F., and Hani A. Salim (2011), "Evaluation of Effective Flange Width by Shear Lag Model for Orthotropic FRP Bridge Decks," *Composite Structures,* 93, pp. 474-482.
9) Zou, B., Davalos, J.F., **Chen, A.**, and Ray, I. (2011). "Evaluation of Load Distribution Factor by Series Solution for Orthotropic Bridge Decks," *Journal of Aerospace Engineering, ASCE,* 24(2), pp. 227-239.
10) Ray, I., Parish, G., Davalos, J.F., and **Chen, A.** (2011). "Effect of Concrete Substrate Repair Methods for Beams Aged by Accelerated Corrosion and Strengthened with CFRP," *Journal of Aerospace Engineering, ASCE,* 24(2), pp. 240-248.
11) **Chen, A.** and Davalos, J.F. (2010). "Strength Evaluations of Sinusoidal Core for FRP Sandwich Bridge Deck Panels," *Composite Structures,* 92(7), pp. 1561-1573.
12) Mahmoud, A.M., Ammar, H., Mukdadi, O.M., Ray, I., Imani, F.S., **Chen, A.**, and Davalos,J.F. (2010). "Non-Destructive Ultrasonic Evaluation of CFRP-Concrete

Specimens Subjected to Accelerated Aging Conditions," *NDE & T International*, 43(7), pp. 635-641.

13) Li, C.S., Lam, S.S.E., **Chen, A.**, and Wong, Y.L. (2008). "Seismic performance of a transfer plate structure", *Journal of Structural Engineering, ASCE*, 134(11), pp. 1705-1716.
14) **Chen, A.** and Davalos, J.F. (2007). "Transverse Shear with Skin Effect for Composite Sandwich with Honeycomb Sinusoidal Core", *Journal of Engineering Mechanics, ASCE*, 133(3), pp. 247-256.
15) **Chen, A.** and Davalos, J.F. (2005). "A Solution including Skin Effect for Stiffness and Stress Field of Sandwich Honeycomb Core", *International Journal of Solids and Structures*, 42(9-10), pp. 2711-2739.
16) Davalos, J.F. and **Chen, A.** (2005). "Buckling Behavior of Honeycomb FRP Core with Partially Restrained Loaded Edges under Out-of-plane Compression", *Journal of Composite Materials*, 39(16), pp. 1465-1485.
17) Aravinthan, T., Mutsuyoshi, H., Niitsu, T., and **Chen, A.** (1998). "Flexure Behavior of Externally Prestressed Beams with Large Eccentricity", *Transaction of the Japan Concrete Institute*, Japan Concrete Institute, 20, 1998, pp. 165-170.

Conference Proceedings

1) McGraw, B., **Chen, A.,** Davalos, J.F., and Ray, I. (2012). "Evaluation of Wood Composite I-Joist with Sinusoidal Web," *ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments (Earth and Space 2012),* Pasadena, CA, April 15-18, 2012. (Presenter)
2) Jiao, P., McGraw, B., **Chen, A.,** Davalos, J.F., and Ray, I. (2012). "Flexural-Torsional Buckling of Cantilever Composite Wood I-Beams with Sinusoidal Web Geometry," *ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments (Earth and Space 2012),* Pasadena, CA, April 15-18, 2012. (Presenter)
3) Davalos, J.F., **Chen, A.,** Zahabi, M., and Ray, I. (2012). "Prediction of Degradation of Interface Fracture Energy from Accelerated Aging Tests and Mode-II Loading," *ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments (Earth and Space 2012),* Pasadena, CA, April 15-18, 2012. (Presenter)
4) Kar, A., Ray, I., Unnikrishnan, A., Davalos, J.F., and **Chen, A.** (2012). "Prediction of Shrinkage of Concrete Containing Fly Ash and/or Silica Fume Using Composite Modeling," *ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments (Earth and Space 2012),* Pasadena, CA, April 15-18, 2012. (Presenter)
5) Jiao, P., **Chen, A.,** and Davalos, J.F. (2011). "Cohesive Zone Model of FRP-Concrete Interface under Thermal and Mechanical Stresses," *16th International Conference on Composite Structures (ICCS16),* Porto, Portugal. June 28-30, 2011.
6) Zahabi, M, **Chen, A.,** and Davalos, J.F. (2011). "Long-term Prediction Model for Interfacial Energy Release Rate of Crack Propagation between FRP and Concrete Under Mode II Loading Condition," *16th International Conference on Composite Structures (ICCS16),* Porto, Portugal. June 28-30, 2011.

7) Jiao, P., McGraw, B., **Chen, A.,** and Davalos, J.F. (2011). "Buckling Behavior of Sinusoidal Web for Composite Wood I-Joist with Partially Restrained Loaded Edges under Compression," *ASCE EMI 2011 Conference*, Boston, MA. June 2-4, 2011.
8) McGraw, B., Roy, M., Jiao, P., **Chen, A.,** and Davalos, J.F. (2011). "Evaluation of Lateral and Distortional Buckling of Wood I-joist with Sinusoidal Web Geometry," *ASCE EMI 2011 Conference*, Boston, MA. June 2-4, 2011.
9) Bradley, M., **Chen, A.**, and Davalos, J.F. (2010). "Buckling Behavior of Sinusoidal Panel with Partially Restrained Loaded Edges under in-plane Compression," *ASCE EMI 2010 Conference*, Los Angeles, CA. August 8-12, 2010 (Abstract)
10) Bradley, M., Roy, M., Jiao, P., Davalos, J.F. and **Chen, A.** (2010). "Flexural-Torsional and Lateral-Distortional Buckling of Wood I-Joist With Sinusoidal Web Geometry", *ASCE EMI 2010 Conference*, Los Angeles, CA. August 8-12, 2010 (Abstract)
11) Davalos, J.F., **Chen, A.**, Ray, I., and Levan, J. (2010). "A Systematic Study of Rehabilitation of Reinforced Concrete T-beam Structures using Externally Bonded FRP Composites," *Proceedings of the 5th International Conference on FRP Composites in Civil Engineering*, Beijing, China, September 27-29, 2010. (Presenter)
12) Mahmoud, A.M., Ammar, H., Mukdadi, O.M., Ray, I., Imani, F.S., **Chen, A.**, and Davalos,J.F. (2010). "Ultrasonic Evaluation of CFRP-Concrete Interface for Specimens under Temperature and Water-Immersion Aging Effects," *Proceedings of the 5th International Conference on FRP Composites in Civil Engineering*, Beijing, China, September 27-29, 2010.
13) Imani, F.S., **Chen, A.**, Davalos, J.F., and Ray, I. (2010). "Temperature and Moisture Effects on Mode II Fracture Behavior of CFRP-Concrete Interface," *Proceedings of the 5th International Conference on FRP Composites in Civil Engineering*, Beijing, China, September 27-29, 2010.
14) Anderson, M., Ray, I., Davalos, J.F., **Chen, A.** (2010). "A Study on the Applicability of ECE Technique on Chloride Contaminated Concrete Beams Retrofitted with FRP Strips," *Proceedings of the 5th International Conference on FRP Composites in Civil Engineering*, Beijing, China, September 27-29, 2010. (Presenter)
15) **Chen, A.** and Davalos, J.F. (2010). "Strength Evaluation of Honeycomb FRP Sandwich Panels with Sinusoidal Core Geometry," *Proceedings of the 5th International Conference on FRP Composites in Civil Engineering*, Beijing, China, September 27-29, 2010. (Presenter)
16) Davalos, J.F., Vantaram, A., and **Chen, A.** (2010). "Honeycomb Fiber-Reinforced Polymer Sandwich Panels for Fish Culture Tanks," *Proceedings of the 5th International Conference on FRP Composites in Civil Engineering*, Beijing, China, September 27-29, 2010. (Presenter)
17) McGraw, B., Davalos, J.F., **Chen A.**, Denes, L. and Lang, E.M. (2010). "Corrugated Wood Composite Web Panel for I-joist using Discarded Veneer-Mill Residues," *Proceeding of 16th US National Congress of Theoretical and Applied Mechanics (USNCTAM 2010)*, June 27 - July 2, 2010, State College, PA.
18) Peng, J., **Chen A.**, and Davalos, J.F. (2010). "Interfacial Stresses for Plated Reinforced Concrete Beams using Simplectic Method," *Proceeding of 16th US National Congress of Theoretical and Applied Mechanics (USNCTAM 2010)*, June 27 - July 2, 2010, State College, PA.

19) Bhattacharya, A., Ray, I., Davalos, J.F., and **Chen A.** (2010). "Restrained Shrinkage Cracking of Self-Consolidating Concrete," *Proceeding of 16th US National Congress of Theoretical and Applied Mechanics (USNCTAM 2010)*, June 27 - July 2, 2010, State College, PA.
20) Mahmoud, A.M., Ammar, H., Mukdadi, O.M., Ray, I., Imani, F.S., **Chen, A.**, and Davalos,J.F. (2010). "Ultrasonic Evaluation of CFRP-Concrete Interface for Specimens under Temperature and Water-Immersion Aging Effects," *Proceeding of 16th US National Congress of Theoretical and Applied Mechanics (USNCTAM 2010)*, June 27 - July 2, 2010, State College, PA. (Presenter)
21) Imani, F.S., **Chen, A.**, Davalos, J.F., and Ray, I. (2010). "Characterization of Mode II Fracture Behavior of CFRP-Concrete Interface Using J-integral method, " *Proceeding of 16th US National Congress of Theoretical and Applied Mechanics (USNCTAM 2010)*, June 27 - July 2, 2010, State College, PA.
22) Davalos, J.F., **Chen, A.**, Ray, I., and Levan, J. (2010) "Rehabilitation of Reinforced Concrete T-beam Structures using Externally Bonded FRP Composites," the *12th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments*, Honolulu, Hawaii, March 14-17, 2010. (Presenter)
23) Imani, A.S., **Chen, A.**, Davalos, J.F., and Ray, I. (2010) "Temperature and Moisture Effects on Mode II Fracture Behavior of CFRP-Concrete Interface," *Proceedings of 12th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments*, Honolulu, Hawaii, March 14-17, 2010.
24) Konduru, S., Ray, I., Davalos, J.F., **Chen, A.** (2010) "Evaluations of Latex Modified Concrete Overlay Bonded to Normal Concrete Deck," *Proceedings of 12th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments*, Honolulu, Hawaii, March 14-17, 2010.
25) McGraw, B., Denes, L., Lang, E.M., Davalos, J.F., and **Chen, A.** (2010) "Development of a Corrugated Wood Composite Web Panel for I-joist from Discarded Veneer-mill Residues," *Proceedings of 12th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments*, Honolulu, Hawaii, March 14-17, 2010. (Presenter)
26) Anderson, M., Ray, I., Davalos, J.F., **Chen, A.** (2010) "Exploratory Study on ECE Technique for Chloride Removal from Concrete Beams Retrofitted with FRP Strips," *Proceedings of 12th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments*, Honolulu, Hawaii, March 14-17, 2010. (Presenter)
27) **Chen, A.**, Davalos J.F., and Imani, A.S. (2009). "Interfacial Stresses for Plated Beams Composed of Different Materials," *2009 Joint ASCE-ASME-SES Conference on Mechanics and Materials*, Blacksburg, VA June 24-27, 2009 (Abstract)
28) Davalos, J.F., Zou, B., and **Chen, A.** (2009). "Evaluation of Load Distribution Factor by Approximate Series Solution," *2009 Joint ASCE-ASME-SES Conference on Mechanics and Materials*, Blacksburg, VA June 24-27, 2009 (Abstract)
29) Davalos, J.F., Parish, G.C., **Chen, A.**, and Ray, I. (2009). "Repair of Concrete Beams Aged by Accelerated Corrosion using Externally Bonded CFRP Fabrics," *2009 Joint ASCE-ASME-SES Conference on Mechanics and Materials*, Blacksburg, VA June 24-27, 2009 (Abstract, Presenter).

30) Davalos, J.F., Levan, J.R., **Chen, A.**, Ray, I., Justice, A., Anderson, M., Parish, G., and Sasher, W. (2009). "Externally Bonded FRP Composites for the Rehabilitation of Reinforced Concrete T-beam Bridges," *Proceedings of the 26th Annual International Bridge Conference (IBC 2009)*, Pittsburgh, PA, June 14-17, 2009 (Presenter).
31) **Chen, A.** and Davalos, J.F. (2007). "Shear and Bending Warping Effects for Composite Sandwich with Honeycomb Sinusoidal Core," *Proceedings of the 18th ASCE Engineering Mechanics Division Conference, (EMD 2007),* Blacksburg, VA, June 3-6, 2007 (Presenter).
32) **Chen, A.** and Davalos, J.F. (2005). "Development of Design Guidelines for Honeycomb FRP Sandwich Deck Panels," *Proceedings of the American Society for Composites 20th Technical Conference,* Philadelphia, PA, September 7-9, 2005 (Presenter).
33) Shan, L., Qiao, P., Davalos, J.F., and **Chen, A.** (2005). "Explicit Local Buckling Analysis of Honeycomb Cores in Sandwich Structures," *Proceedings of McMat2005: 2005 Joint ASME/ASCE/SEC Conference on Mechanics and Materials,* Baton Rouge, LA, June 1-3, 2005.
34) **Chen, A.** and Davalos, J.F. (2004). "Development of Facesheet for Honeycomb FRP Sandwich Bridge Deck Panels," *Proceedings of 4th International Conference on Advanced Composite Materials in Bridges and Structures, ACMBS IV,* Calgary, Canada, July 20-23, 2004.
35) **Chen, A.** and Davalos, J.F. (2004). "Behavior of Honeycomb FRP Sandwich Sinusoidal Core Panels with Skin Effect," *Proceedings of 9th ASCE Aerospace Division International Conference on Engineering, Construction and Operations in Challenging Environments,* Houston, TX, March 7-10, 2004, pp. 625-632 (Presenter).
36) **Chen, A.** and Davalos, J.F. (2004). "Bonding and Aspect Ratio Effect on the Behavior of Honeycomb FRP Sandwich Cores," *Proceedings of 8th Pan American Congress of Applied Mechanics, PANCAM VIII,* Havana, Cuba, January 5-9, 2004.
37) **Chen, A.** and Davalos, J.F. (2003). "Buckling of Honeycomb FRP Core with Partially Restrained Loaded Edges," *Proceedings of Composites in Construction International Conference,* Cosenza, Italia, September 16-19, 2003.
38) **Chen, A.** and Davalos, J.F. (2003). "Bending Strength of Honeycomb FRP Sandwich Beams with Sinusoidal Core Geometry," *Proceedings of the Fourth Canadian-International Composites Conference, CANCOM 2003,* Ottawa, Canada, August 19-22, 2003 (Presenter).
39) **Chen, A.**, Davalos, J.F., and Plunkett, J.D. (2002). "Compression Strength of Honeycomb FRP Core with Sinusoidal Geometry," *Proceedings of the American Society for Composites 17th Technical Conference,* West Lafayette, IN, October 21-23, 2002 (Presenter).
40) **Chen, A.**, Li, C.S., Lam, S.S.E. and Wong, Y.L. (2002). "Testing of a transfer plate by pseudo-dynamic test method with substructure technique," *Proceedings of International Conference on Advances in Building Technology,* Hong Kong, December 4-6, 2002.
41) **Chen, A.**, Lam, S.S.E., and Wong, Y.L. (2000). "Verification of a Pseudodynamic Testing System," *Proceedings of International Conference on Advances in Structural Dynamics,* Hong Kong, December 2000 (Presenter).

Reports:

1) Davalos, J.F., **Chen, A.**, Ray, I., Justice, A., and Anderson, M. (2010). *"District 3-0*

Investigation of Fiber-wrap Technology for Bridge Repair and Rehabilitation (Phase III)," submitted to Pennsylvania Department of Transportation.

2) **Chen, A.**, Ray, I., Wattick, J., and Pertl, E. (2011) "Concrete-Filled FRP Sandwich Wall Panels for Energy Efficient and Seismic/Blast Resistant Buildings," submitted to WVU Research Corporation

Patents:

1) **Chen, A.,** Hopkins, P., and Brown, K. "Energy Efficient and Water Resistant Insulated FRP-Confined Precast Concrete Sandwich Roof Panel," patent pending, disclosed in November 2011.
2) **Chen, A.**, and Davalos, J.F. "Concrete-Filled FRP Sandwich Wall Panels," patent pending, disclosed in March 2010.
3) **Chen, A**., Davalos, J.F., and Plunkett, J.D. "Heavy Duty Steel-less Hybrid Honeycomb FRP-Concrete Panels for Bridge Decks," patent pending, disclosed in November 2010

Grants and Contracts Awarded:

Research Title or Area	Granting or Sponsoring Agency	Date of Award and Duration of Grant	Contract Amount
Research in progress/pending:			
Development of Bridge Foundation Movement Criteria (contract under negotiation)	NCHRP	Duration: 30 months, Expected Start Date: June 2012	$350,000 (PI for UI subcontract: $65,000)
Center for Transportation Security and Infrastructure Innovations	WV Higher Education Policy Commission/WV EPSCoR	Duration: 07/01/07 to 06/30/12	$1,500,000 (Co-PI)
Research completed:			
Concrete-Filled FRP Sandwich Wall Panels for Energy Efficient and Seismic/Blast Resistant Buildings	West Virginia University Research Corporation	Duration: 7/1/2010 to 12/31/2011	$25,000 (PI)
District 3-0 Investigation of Fiber Wrap Technology for Bridge Repair and Rehabilitation, Phase III	Pennsylvania Department of Transportation	Duration: 1/15/2008 to 1/14/2010	$204,216 (Co-PI)
Advanced Materials Program-Phase II: High Performance Concrete, Deck Overlays, and Short-Span Steel Bridges	West Virginia Division of Highways	Duration: 5/15/2006 to 4/30/2011	$1,257,887 (Co-PI)

SERVICE:

Major Committee Assignments:

Member, Department Graduate Committee, University of Idaho, 2011-2012
Member, Department Facility Committee, University of Idaho, 2011-2012
Departmental high school visitation, West Virginia University, Spring 2010, Spring 2011
Departmental freshmen visitation, West Virginia University, Fall 2010, Spring 2011

Professional and Scholarly Organizations:

Secretary, Committee on Advanced Materials and Structures, American Society of Civil Engineers (ASCE) Aerospace Division
Member of American Society of Civil Engineers (ASCE)
Member of American Society for Composites (ASC)
Member of American Institute of Steel Construction (AISC)
Member of International Institute for FRP in Construction (IIFC)
Member of U.S. Association for Computational Mechanics (USACM)
Member of International Association for Computational Mechanics (IACM)

Scientific Committee	*the 4th Asia-Pacific Young Researchers and Graduates Symposium (YRGS2012),* 4-5 December 2012, Hong Kong
Session Co-Chair	Engineering for Extreme Environments, *the International Conference on Engineering, Science, Construction and Operations in Challenging Environments (Earth and Space 2012),* Pasadena, CA, April 15-18, 2012
Session Chair	*the 5th International Conference on FRP Composites in Civil Engineering*, Beijing, China, September 27-29, 2010
Program Committee and Co-Organizer for two Symposia	*the 16th US National Congress of Theoretical and Applied Mechanics* (USNCTAM 2010), State College, PA, June 27-July 2, 2010
Session Co-Chair	Advanced Materials for Sustainable Development, *the 12th International Conference on Engineering, Science, Construction and Operations in Challenging Environments*, Honolulu, HI, March 14-17, 2010
Session Co-Chair	*Mechanics of Advanced Materials and Structures, 2009 Joint ASCE-ASME-SES Conference on Mechanics and Materials*, Blacksburg, VA, June 24-27, 2009
Session Co-Chair	*Mechanics of Advanced Materials and Structures, the 18th ASCE Engineering Mechanics Division Conference (EMD 2007)*, Blacksburg, VA, June 3-6, 2007
Journal Referee	Journal of Composite for Construction, ASCE; Journal of Bridge Engineering, ASCE; Journal of Aerospace Engineering, ASCE; Journal of Composite Materials; International Journal of Solids and Structures; Composite Structures; Composites Part B: Engineering

3. OTHER SECTOR RESOURCE COMMITMENTS

Missouri Structural Composites, LLC

400 South Elm Street • Dixon MO 65459
Phone: 573-759-6096 • Fax: 573-759-2169
jdpame@gmail.com

May 2, 2012

Program Director
Idaho Incubation Fund Program
Higher Education Research Council
Idaho State Board of Education

Dear Sir/Madam,

I am writing this letter in support of Dr. Chen's proposal for development and commercialization of energy efficient integrated FRP-confined precast concrete sandwich roof panels.

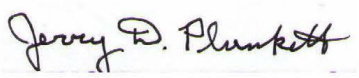
Missouri Structural Composites, LLC (formerly Kansans Structural Composite, Inc.) is the leading innovator in the field of heavy duty structures fabricated from FRP technology in the USA. We developed and installed the first all composite bridge on a public road in the US in 1996. It remains in perfect condition after 16 years. We also developed the first successful FRP bridge deck attachment system; the first connector system to attach steel bridge rails and concrete barrier to FRP deck; and the strongest FRP panel-to-panel connection. Our FRP deck has been used in about 20 bridges all over the USA.

We have been collaborating with Dr. Chen for more than ten years. With his help, we have successfully developed and commercialized FRP sandwich panels for bridge deck and fish tank applications. We will continue this productive relationship with this proposed technology, even though he is now in Idaho.

We are interested in expanding our market into the largest market in which we plan to enter, the building products market. Therefore, this proposal is of great interest to our company and we enthusiastically support this proposal. We believe the synergy of the academic and industrial collaboration with the support from GAP funds will accelerate the development of this innovation. As the commercialization partner of this proposal, we will provide technical contributions and manufacturing knowledge for economical production of FRP components and treatment of the FRP surface and actively explore the commercialization opportunity of the proposed innovations in buildings once this project succeeds. We also intend to open a new manufacturing plant in Idaho once the technology is ready.

We believe the results from this proposal will contribute novel solutions to green and sustainable technology developments for a wide range of structural applications in the US and abroad. If you may have any questions or require further information, please contact us.

Sincerely,



Jerry Plunkett, Ph.D.
President

CENTRAL PRE-MIX PRESTRESS CO.
922 NORTH CARNAHAN • SPOKANE, WASHINGTON 99212
P.O. BOX 3366 • SPOKANE, WASHINGTON 99220-3366
OFFICE: (509) 533-0267 • FAX: (509) 534-3013

May 8, 2012

Idaho Incubation Fund Program
Higher Education Research Council
Idaho State Board of Education

RE: Energy Efficient FRP-Confined Precast Concrete Sandwich Roof Panels

This letter is to express my support for Dr. Chen's proposal for the development and commercialization of Energy Efficient Integrated FRP-Confined Precast Concrete Sandwich Roof Panels.

Last year, Central Premix Prestress Co. (CPPC) teamed with Hopkins Structural Design Solutions, LLC to analyze and test a 10'x23' insulated precast/prestressed concrete sandwich panel for out-of-plane flexural strength. From the results it was concluded that the panel could provide the strength necessary for roof and floor applications. Further testing is warranted.

I, on behalf of CPPC, a producer of structural and architectural precast/prestressed concrete, support the continued research and development of precast concrete sandwich panels reinforced with FRP materials. These panels, when properly developed and tested, will be marketable for use in energy efficient floor and roof applications for buildings and similar structures.

CPPC will be available for technical and business advice for this research. We will also provide opportunities for University of Idaho students to tour our plant and jobsites.

Please feel free to contact us if you need any further information.

Sincerely,

Kris Brown

Kris Brown, PhD, PE
Chief Engineer
Central Premix Prestress Co.
(509) 536-3339
Kris.brown@oldcastle.com

KNIFE RIVER
AN MDU RESOURCES COMPANY

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(541) 995-9447 FAX

To: Program Director
Idaho Incubation Fund Program
Higher Education Research Council
Idaho State Board of Education

May 7, 2012

From: Pat Hynes PE (Knife River Prestress)

I have reviewed the research proposal "Development of an Energy Efficient Integrated FRP-confined Precast Concrete sandwich Roof Panel for Green Buildings" proposed by An Chen and Richard Nielsen. As a producer of insulated wall panels, I do find that there are potential gains in terms of energy, faster construction, and lower costs with a precast insulated roof system. This proposal, as I see it, is a first step to gaining knowledge and understanding the merits of this type of construction. I believe that it may lead to additional studies to validate its use and to eventually commercialize and codify it with the model building codes. The study will evaluate the use of leading edge materials in conjunction with concrete to determine possible benefits in building envelope design. I have been asked to be an industry project consultant. If test results are favorable I am interested in the commercialization of this system. I encourage that this project be awarded. Feel free to call if you have any questions.

Sincerely,

Pat Hynes