**Accomplishments**

* What are the major goals of the project?

This project is a collaborative to advance the efficiencies of cold-formed steel structures (also known as light steel framing) and utilize those efficiencies such that Egypt can leapfrog technologies and develop next generation residential mid-rise buildings to meet societal needs. The U.S. based portion of the project is largely focused on the optimization of light steel framed building systems from members, to structural systems, and incorporating non-structural aspects - specifically energy/sustainability. In addition a large component of the U.S. portion of the project is to steward the technology transfer to the Egyptian team.

* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

**Major Activities:** Two major activities related to the project are the U.S. Meetings and Tours (April 2012) and the Egyptian Workshop (December 2012).

The entire project team met in the U.S. in April of 2012. The meeting was planned in conjunction with the North American Steel Construction Conference held in Grapevine.
Texas. The team toured the cold-formed steel testing facilities at the University of North Texas lead by Associate Professor Cheng Yu. After attending the conference the entire group then went to Baltimore for additional tours and visit. A half-day workshop covering all of the research in the JHU Thin-walled Structures group was provided along with a tour of the Thin-walled Structures laboratory and visits with administration and other faculty. The team toured a ClarkDietrich manufacturing facility and toured a load bearing cold-formed steel framed building using TSN studs in Wilmington. The team visited a cold-formed steel panelizer: Panel Systems in Woodbridge VA and toured a building using Panel Systems walls in downtown Washington, D.C. The team finished its multi-day tour with a visit to the National Association of Home Builders Research Center in Upper Marlboro, MD. The tour, organized by the PI, provided a hands-on look at the application of cold-formed steel building technology in the United States.

Egypt is in political turmoil. Making a difference in these times is probably asking too much from a small joint USAID/NSF research project, but for two days in the second week of December 2012 approximately 200 Egyptian engineers, architects, builders, and manufacturers and even a few ministers from the Egyptian government met at the University of Cairo to imagine a future for Egypt that takes advantage of the latest technology: light (cold-formed) steel framing. The workshop was organized by Professor Metwally Abu-Hamd of the University of Cairo and Professor Benjamin Schafer of Johns Hopkins University as part of an ongoing grant that the two professors are leading: "US Egypt Cooperative Research: Use of Cold-Formed Steel in Residential Housing".

The workshop was led by the United States and Egyptian project teams and included key participation from the United States Industrial Advisory Board. Four members of that board: George Richards (BORM), Don Allen (DSi), Nader ElHajj (Framecad), and Nabil Rahman (TSN), came to Cairo to share their experiences with making light steel framing a reality not only in the United States, but around the world. Their talks were augmented by research talks from the project team (Egypt: Metwally Abu-Hamd, Maged Twafick Hanna, Mohammed Badr; United States: Benjamin Schafer, Zhanjie Li). An industrial exhibition also complemented the workshop and demonstrated to the Egyptian engineers that the manufacturing base was already in place to make light steel framing happen in Egypt.

Being in Egypt, at the same time as protestors marched in Tahrir square, only made the Egyptian participants even more gracious with their United States participants. Benjamin Schafer summarizes: "It was a once in a lifetime chance to demonstrate that we care about an Egyptian future, without being political, instead we simply set down to the business of becoming better engineers and learning new skills so we can provide society with more from less."

Specific Objectives: We have achieved our objectives reagarding member-level optimization and energy analysis of light steel framing buildings. Work remains on the U.S. side with regard to system-level optimization.

Significant Results: The recent two-level optimization work on cold-formed steel members represents a significant step forward in the application of optimization to cold-formed steel structures. Instead of looking at producing one shape that is better, the optimization provides an entire family of shapes that are optimal across expected engineering demands. This provides for the first time direct input to the manufacturers on an entire efficient family of cross-sections that light steel framing could use. It is shown that as little as 12
different section could be more efficient than the 100+ section currently in use in the United States.

Our comprehensive energy analysis of a typical light steel framed structure has provided the groundwork for building level optimization in light steel framing. Though work remains it is significant that we have tied the details of the selected structural system to the energy analysis in a way amenable to later optimization.

Key outcomes or Other achievements:
The two day workshop held in Cairo in December 2012 with both of the U.S. project participants, and participation from four of the U.S. industry advisory board members was a real achievement for the team. Over 200 Egyptian engineers were educated in light steel framing and cold-formed steel design. For two days everyone focused on a future made brighter through better engineering and this project was a key part of that.

* What opportunities for training and professional development has the project provided?

On the U.S. side the project has provided training for a post-doctoral student (Dr. Li).

* How have the results been disseminated to communities of interest?

In addition to the project website, conference papers, and journal articles the project has developed and kept an industrial advisory board up to speed on the research. The team held a two day workshop for approximately 200 structural engineers in Cairo in December 2012.

* What do you plan to do during the next reporting period to accomplish the goals?

We are in the no cost extension. We are working on the optimization work and doing additional work to move from conference papers to journal articles, also we are finalizing the last work marry the energy analysis and optimization work. In addition we continue to support activities in Egypt through providing materials, contacts, and once a month meetings.

Products

Books

Book Chapters

Conference Papers and Presentations


Inventions
Nothing to report.

Journals
Peer Reviewed = Yes

**Licenses**
Nothing to report.

**Other Products**
Nothing to report.

**Other Publications**


**Patents**
Nothing to report.

**Technologies or Techniques**
Nothing to report.

**Thesis/Dissertations**

**Websites**
*Egyptian Society of Steel Structures*
http://www.esss-eg.org

The Egyptian Society of Steel Structures was created as an outgrowth of this research project. The Society hosted the Egypt-USA Workshop in December 2012. All Egyptian participants became members of the Society. The Society is being used as a vehicle for education and training of cold-formed steel structures in Egypt. The U.S. team participates in and aids the Society as appropriate. The Egyptian Pi of theos project is the founding chairman of the Society.

*Research Project Website*
http://www.ce.jhu.edu/bschafer/us-egypt-cfs/index.htm

This is the website for the project. It is part of the PI’s larger website.

**Participants/Organizations**

**What individuals have worked on the project?**

<table>
<thead>
<tr>
<th>Name</th>
<th>Most Senior Project Role</th>
<th>Nearest Person Month Worked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schafer, Benjamin</td>
<td>PD/PI</td>
<td>1</td>
</tr>
<tr>
<td>Li, Zhanjie</td>
<td>Postdoctoral (scholar, fellow or other postdoctoral position)</td>
<td>12</td>
</tr>
</tbody>
</table>

**Full details of individuals who have worked on the project:**

Benjamin W Schafer  
Email: schafer@jhu.edu

https://reporting.research.gov/rppr-web/rppr?execution=e1s5
Most Senior Project Role: PD/PI  
Nearest Person Month Worked: 1

**Contribution to the Project:** Professor Schafer is the lead for the U.S. side of this U.S. Egypt collaborative effort. He directs the research on cold-formed steel optimization and energy analysis. He also manages the collaboration hosting goto meetings approximately every 3 weeks between the U.S. and Egyptian team. He provides feedback on all of the Egyptian research and actively participates in their research, education, and training efforts.

**Funding Support:** This grant provides partial support (less than 1 mo./year) for the PI. The PI's institution and other grants and contracts provide the balance of support.

**International Collaboration:** Yes, Egypt  
**International Travel:** Yes, Egypt - 0 years, 0 months, 5 days

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Zhanjie Li  
**Email:** lizhanjie@jhu.edu  
**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Nearest Person Month Worked:** 12

**Contribution to the Project:** Dr. Li is working on cold-formed steel member and structural optimization and on energy analysis of cold-formed steel structures.

**Funding Support:** This grant

**International Collaboration:** Yes, Egypt  
**International Travel:** Yes, Egypt - 0 years, 0 months, 4 days

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**What other organizations have been involved as partners?**

<table>
<thead>
<tr>
<th>Name</th>
<th>Type of Partner Organization</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Iron and Steel Institute</td>
<td>Other Nonprofits</td>
<td>Washington, D.C.</td>
</tr>
<tr>
<td>BORM</td>
<td>Industrial or Commercial Firms</td>
<td>Newport Beach, CA</td>
</tr>
<tr>
<td>DSI Engineering</td>
<td>Industrial or Commercial Firms</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td>Devco Engineering</td>
<td>Industrial or Commercial Firms</td>
<td>Corvalis, OR</td>
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<tr>
<td>Framecad</td>
<td>Industrial or Commercial Firms</td>
<td>Mclean, VA</td>
</tr>
<tr>
<td>Nucor</td>
<td>Industrial or Commercial Firms</td>
<td>Denton, TX</td>
</tr>
<tr>
<td>The Steel Network</td>
<td>Industrial or Commercial Firms</td>
<td>Raleigh, NC</td>
</tr>
</tbody>
</table>

**Full details of organizations that have been involved as partners:**

American Iron and Steel Institute
**Organization Type:** Other Nonprofits  
**Organization Location:** Washington, D.C.

**Partner's Contribution to the Project:**  
Other: Advisory Board

**More Detail on Partner and Contribution:** Jay Larson at AISI actively participates on the advisory board for the project.

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**BORM**

**Organization Type:** Industrial or Commercial Firms  
**Organization Location:** Newport Beach, CA

**Partner's Contribution to the Project:**  
Other: Advisory Board and Egyptian Workshop

**More Detail on Partner and Contribution:** George Richards at Framecad actively participates on the advisory board for the project and also participated in the two day workshop in Egypt in November 2012.

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**DSi Engineering**

**Organization Type:** Industrial or Commercial Firms  
**Organization Location:** Atlanta, GA

**Partner's Contribution to the Project:**  
Other: Advisory Board and Egyptian Workshop

**More Detail on Partner and Contribution:** Don Allen at DSi Engineering actively participates on the advisory board for the project and also participated in the two day workshop in Egypt in November 2012.

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**Devco Engineering**

**Organization Type:** Industrial or Commercial Firms  
**Organization Location:** Corvalis, OR

**Partner's Contribution to the Project:**  
Other: Advisory Board

**More Detail on Partner and Contribution:** Rob Madsen at Devco Engineering actively participates on the advisory board for the project.

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**Framecad**

**Organization Type:** Industrial or Commercial Firms  
**Organization Location:** Mclean, VA

**Partner's Contribution to the Project:**  
Other: Advisory Board and Egyptian Workshop
More Detail on Partner and Contribution: Nader El Hajj at Framecad actively participates on the advisory board for the project and also participated in the two day workshop in Egypt in November 2012.

Nucor

Organization Type: Industrial or Commercial Firms
Organization Location: Denton, TX

Partner's Contribution to the Project:
Other: Advisory Board

More Detail on Partner and Contribution: Rick Haws at Nucor actively participates on the advisory board for the project.

The Steel Network

Organization Type: Industrial or Commercial Firms
Organization Location: Raleigh, NC

Partner's Contribution to the Project:
Other: Advisory Board Participation

More Detail on Partner and Contribution: Nabil Rahman at The Steel Network actively participates on the advisory board for the project and also participated in the two day workshop in Egypt in November 2012.

Have other collaborators or contacts been involved? Yes

Impacts

What is the impact on the development of the principal discipline(s) of the project?

Structural optimization in the face of significant nonlinearity is addressed in the research in this work. Our methods have already been adopted in other groups and stand to improve the methods to perform optimization of the manufacturing of cold-formed steel structural members.

What is the impact on other disciplines?

We are linking manufacturing and final design in civil construction for cold-formed steel structures - this has long-term potential for efficiencies. With respect to more social disciplines we are demonstrating that technical exchanges even in difficult times can still be beneficial for all parties.

What is the impact on the development of human resources?

Human resources impacts have been twofold (1) training for an advanced postdoc has been provided (2) the project has provided significant training in citizen diplomacy for the PI and the PI's postdoc in our interactions with our Egyptian colleagues. I believe that just the opportunity to work with my Egyptian colleagues has changed my world outlook significantly for the better.
What is the impact on physical resources that form infrastructure?

I believe the U.S. contributions to the Egyptians in this regard have been significant; however, on the U.S. side the project has not included a physical component so essentially nothing to report.

What is the impact on institutional resources that form infrastructure?

The project provides a future linkage to Egyptian researchers and their efforts and potential future collaborations including sharing of resources, otherwise nothing specific to report.

What is the impact on information resources that form infrastructure?

To meet goals of the Egyptian side of the project the team has assembled a large body of information related to light steel framing performance and technologies, these internal reports cover the following topics: acoustic performance, fire performance, concrete floors, ferrocement floors, GRC floors, optimization of families of cold-formed steel shapes, energy analysis of CFS buildings, and sustainability. These reports form a unique resource for determining the advantages and disadvantages of this type of framing.

What is the impact on technology transfer?

The project has engaged a number of U.S. industry partners on an advisory board. The advisor board includes companies covering engineering design, software, and manufacturing - their participation has provided them with insights on Egyptian engineering and in turn we have been able to share our optimization work with them at the same time. I believe the experience has improved U.S. competitiveness and abilities.

What is the impact on society beyond science and technology?

This project is a fine example of science-based citizen diplomacy in addition to good science and engineering.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them

Collaboration with Egypt has been particularly interesting in these times. Our December 2012 workshop was planned originally for February 2012, we delayed once and then ultimately decided that conditions were stable enough. The workshop went well and included the U.S. project team and several U.S. advisory board participants.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.