Newsletter for the
July 2005
Light Gauge Steel Engineers Association
A Council of the Steel Framing Alliance

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Upcoming Events

AISI Committee on Framing Standards Lateral Task Group — Aug. 3
San Francisco, CA

Hawaii Chapter Meeting — Aug. 25
Honolulu, HI
www.lgsea.com/hawaii.htm

Atlanta/Southeast Chapter Meeting: Details for design — Sept. 8
Atlanta, GA
http://www.lgsea.com/atlanta_southeast.htm

AISI Committee on Framing Standards Meeting — Sept. 13-14
Baltimore, MD
jlarson@steel.org

SEAOAL Presentation on Cold-Formed Steel — Sept. 15
www.seaoal.com

Wall Stud Design Seminar: Los Angeles — Sept. 20
Los Angeles, CA
www.steelframing.org

Wall Stud Design Seminar: Rosemont — Oct. 3
Rosemont, IL
www.steelframing.org

METALCON international Trade Show and Seminars — Oct. 4-6
Rosemont, IL
www.metalcon.com

LGSEA Becomes Professional Membership of SFA

In a landmark decision, members of the Light Gauge Steel Engineers Association provided overwhelming approval in June to a proposal by the Steel Framing Alliance for LGSEA to become an operating council of SFA. The ballot, which received a "yes" by 75 percent of LGSEA voting members, adopts a set of operating procedures that provide autonomy over technical issues, including technical notes, design guides, and other products and activities intended for design professionals.

Prior to this, the LGSEA had operated as a separate entity, receiving substantial financial and administrative support from SFA, which also provides direct support for codes and standards development, research, education, and other programs intended to grow the steel framing industry. In several areas, both the SFA and LGSEA had duplicate programs and committees, and dozens of members were paying membership dues to both organizations.

The alignment of the LGSEA with SFA effectively eliminates these redundancies. Under the new arrangement, LGSEA will have responsibility for making technical decisions on a broader range of industry publications, seminar content and other engineering and design issues. Members will oversee SFA's Technical Review Committee, the group through which all SFA and LGSEA technical documents are passed. And a new LGSEA Research Development Committee will take over the SFA Technol-

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Constructing Blast-Resistant Structures Utilizing Cold-Formed Steel Studs

By Russ Norris, P.E.
U.S. Department of State


Russ Norris

The US Department of State (DOS) began designing and constructing blast resistant structures in the aftermath of the bombings of our embassies in Beirut and Kuwait in 1983 and 1984. For two decades the DOS has been engaged in improving blast resistant designs for diplomatic facilities that may be the target of large, vehicle borne, explosive devices. The blast load pressures, and attendant durations, anticipated by the DOS are significantly greater than those typical of domestic blast resistant construction. An aftermath of the 1998 east Africa attacks on our embassies in Nairobi and Dar es Salaam saw a redoubling of the effort to protect U.S. Government employees overseas. The current R&D effort carried out by the DOS', Bureau of Diplomatic Security was initiated in 1999 and is focused on blast effects mitigation and innovative methods of constructing blast resistant structures. This effort has included numerous blast tests that have validated and refined this body of work. The DOS does much of the research for this program, including engineering and testing, through the US Army Corps of Engineers, Engineer Research and Development Center (ERDC).

An important phase of this effort is to bring this body of knowledge into the commercial design and construction marketplace for the benefit of

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LGSEA Aligns with SFA

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ogy Team's responsibilities in identifying research needs and prioritizing industry research funding.

"As a council of the Steel Framing Alliance, LGSEA becomes an effective means for a professional membership in the cold-formed steel-framing industry," says Larry Williams, SFA president, who also helped found the LGSEA and served as its Managing Director for nearly a decade. "LGSEA is now clearly identified as the steel-framing industry's technical resource and the home for design professionals."

The alignment promises a number of benefits to LGSEA members and the group as a whole over the previous relationship. Members and leaders will gain time to concentrate on technical issues that affect steel-framing design. LGSEA programs and activities will receive significant additional financial support, enabling program implementations and product development efforts to accelerate. And LGSEA members will have increased access to a broader range of industry technical products and programs, including discounts on educational programs, design standards, cold-formed steel specifications and design guides.

Implementation of the operating procedures approved by LGSEA members includes the dissolution of the LGSEA's corporate state and transfer of administrative burdens to SFA staff. A seven-member Transitional Board of Directors is overseeing the changeover. These volunteers were assigned to the task following approval by the SFA Operating Team at its June 23 meeting in Kansas City. In accordance with the new Operating Procedures, a nominating committee will convene for officer selection, and LGSEA members will have the opportunity to vote on a new president and vice president before the LGSEA general membership meeting at METALCON on Oct. 5.

Don Allen, secretary of LGSEA, appointed according to operating procedures, says LGSEA has already done excellent work on technical documents and seminars.

"Task groups have been established to review LGSEA Tech Notes and publications, with about half of those reviews already completed," says Allen. "After the entire list is completed, several documents will be slated for upgrade or revision, and several new publications in the pipeline for LGSEA will continue as scheduled."

"This alignment of the activities of both organizations will prevent duplication of efforts and membership. With these changes, I see a better, stronger, more integrated engineering group that still maintains its autonomy."

"I am optimistic that this transition will be completed rapidly and seamlessly, and that all members will see immediate benefits from this integration," says Larry Williams, president of the SFA. "I know that we all extend a warm welcome to the LGSEA members as they join the Steel Framing Alliance."

Newsletter for the Light Gauge Steel Engineers Association

LGSEA

A Council of the Steel Framing Alliance

Membership Information

To receive the LGSEA Newsletter, Technical Notes, and other benefits of the LGSEA, call toll-free: 866-GO-LGSEA (866-465-4732). www.LGSEA.com

The LGSEA Newsletter is published by LGSEA

LGSEA/SFA Alignment: What is the Cost? What are the Benefits?

By Don Allen
LGSEA Secretary

With news of the successful passage of the Board-recommended LGSEA ballot, and the alignment of the LGSEA within the Steel Framing Alliance, many are asking if there will be any additional costs, and what benefits members can expect from this alignment. Although much of this will be decided in the coming weeks by the transition team, the short answer on the cost side is this: for the remainder of the 2005 membership year, there will be no additional membership charges, and current, paid LGSEA members will be given a complimentary SFA membership for the remainder of 2005.

What are the benefits of SFA membership?

- Access to members-only section of the SFA Web site.
- Free, unlimited downloads of selected SFA technical and non-technical publications.
- A free subscription to the Steel Framing Alliance electronic newsletter, The Gateway.
- Additional discounts on SFA and American Iron and Steel Institute publications.
- Discounts at SFA seminars and local Alliance events and training sessions

LGSEA members will continue to receive the high-quality technical documents they have come to expect. This includes the new LGSEA newsletter, in both print version and a printable, electronic PDF format. This also includes LGSEA Technical Notes, Research Notes, back copies of newsletters, and discounts on LGSEA-sponsored seminars and chapter events. Look for an updated "Engineers Section" of the Steel Framing Alliance website soon. For now, members can access high-quality technical content at both www.lgsea.com and www.steelframing.org.

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others that may face comparable security challenges in the "post 9/11" security environment. This article is an introduction to one of the concepts pursued by this program that fabricates blast-resistant structures from 54 mil (16 gauge), cold-formed, steel studs. This technique can be adapted as a retrofit system inboard of non-blast design, traditional building façades or as a curtain wall cladding for a new or existing concrete or steel moment resisting frames. This technique is an alternative to the staple for this type of hardened construction that employs cast-in-place, reinforced concrete frame and wall components. The DOS philosophy tends to place greater emphasis on protecting human life than maintaining a high degree of operational capability in our facilities in the aftermath of an attack. As such, the DOS can accept limited damage to its structures provided it protects its occupants during an attack.

The essence of the steel stud construction approach lies in the reaction of the studs to the blast loads applied. Conventionally designed blast-resistant structure designs have tended to perform within the elastic range of materials and exhibit relatively small plastic deformations. This results in traditional bending stress on wall diaphragms and results in members that exhibit compression on the side closest to the blast and tension on the side further away (inboard) of the blast.

The steel stud design concept takes a different approach. Instead of limiting the construction materials to elastic or minimal deformation, this system allows substantial plastic deformation of its members to capitalize on their inherent capacity to elongate and absorb energy. This reaction mechanism requires components exhibiting high degrees of ductility and this criteria lends itself to utilizing cold rolled steel studs that are attached web-to-web (back-to-back) to limit rotation during the blast event. The reaction mechanism sought by this system in a blast loading condition is tension membrane. In tension membrane the entire member is stressed so greatly that both faces of the member are placed in tension. This results in much greater elongation and deformation while still maintaining the element within its acceptable ultimate design strength limit. What this means in lay terms is that the ultimate strength of the steel stud is being developed and exploited to its fullest while the wall's deformation is actually absorbing part of the blast load. The challenge with this approach is to design and construct the attachment of stud pairs to structure and building frame to accommodate the transferred blast loads and compensate for stud deformations.

Initially developed as a retrofit solution, a stud wall partition was installed between successive floors of a structure. This required attaching the ends of the studs sufficiently for it to achieve tension membrane in the face of the design basis loads without failure at the end connections. Much like the "glass fails first" criteria employed in blast resistant glazing design, good design practice for this system also calls for the stud to fail before its connection to structure. The DOS has developed a connection that is optimized for the six inch, 54 mil stud pairs that are the basis of its application and involves a robust connection utilizing 1/2" steel angle, six through bolts attaching the studs to angle clips and two high-strength undercut concrete anchors connecting the angle clips to structure (see **figure 1**).

Initial refinement of this construction system tailored it for new construction applications. Multistory adaptation of this technique involves a different dynamic reaction and design approach. Here the tension forces in the wall between floors induced by the load tend to cancel themselves out and the stud pairs are effectively "pinned" at successive floors in a blast event. The DOS testing program has found that if the steel studs that comprise the exterior framework are run from the first-floor level continuously beyond the roof **(figure 2)**, they only need to be rigidly attached at the first level floor slab to function in the blast loading environment. Attachments at successive floors are driven by dead load, wind load and normal design parameters. As in any curtain wall application it is important to design all these connections so that they provide a finite amount of horizontal, vertical and in plane adjustment to account for variance in the concrete diaphragms to which the steel studs will be anchored.

The US Department of State levies various security requirements on its overseas facilities. In addition to

DOS blast test at Eglin AFB, Fla.; Sept. 2002

Figure 1. "First generation" and infill condition connection

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News Briefs

LGSEA Committee Meetings in Santa Clara provide Feedback on Tech Note Progress

On June 1, the LGSEA held their spring committee and Board meetings on the campus of Santa Clara University in Santa Clara, California. The meetings, held concurrently with the Pacific Coast Builders Conference, provided attendees with updates on development of tech notes and other upcoming publications and programs from the LGSEA. Notes on slip track, truss bracing, steel to wood connections, shearwalls, and X-bracing were discussed and reviewed. Truss, Fastener, Structural Assembly, and Research Development committees all held informative meetings.

With the adoption of the updated Operating Procedures by the members, the current committee structure is in the process of being overhauled. New committees will include a Technical Review Committee and a Technology Development Committee (the combined group from the old SFA Technology Team and the LGSEA Research Development Committee.) The current Corrosion and Durability Task Group, which is a joint group with the AISI Committee on Framing Standards, will remain active within the new framework of the LGSEA. Watch the LGSEA website for committee meeting minutes and news of upcoming committee activities.

Sacramento Seminar a Smashing Success

On May 26, the LGSEA held a series of presentations in conjunction with the Structural Engineers Association of Central California (SEAOCC.) Over 100 LGSEA and SEAOCC members attended. Topics and presenters included the following: Load Bearing Mid-Rise Construction by Patrick Ford; Lateral Design using AISI Standard for Cold-Formed Steel Framing by Reynaud Serrette; Seismic Design of Light-Gauge Steel Framing for Interior Partitions and Exterior Cladding in Hospital Buildings by Chris Tokas; ISSI Systems by Marc Press; Cold-Formed Steel Trusses by Gary Heal; and Light Gauge Insulated Panel Systems by Tony Wu. Several sponsors set up tables outside the presentation room, and attendees were able to learn firsthand from manufacturers about steel framing products and accessories. LGSEA plans to host several future seminars in conjunction with local Structural Engineering Associations. The next scheduled state events are with the Structural Engineers Association of Alabama (September 15,) and the Structural Engineers Association of Texas (October 21.) If you are a member of a Structural Engineers Association, and would like to set up a presentation on cold-formed steel framing, please contact either Maribeth Rizzuto (mrizzuto@steeelframing.org) or Don Allen (dallen@steelframing.org); or call 866-GO LGSEA for additional information.

Wall Stud Design Seminar Dates Changed

The Los Angeles engagement of the Design of Wall Systems Using Cold-Formed Steel seminars has been set for Sept. 20. Originally slated for May, the dates for both the Los Angeles and Seattle seminars were changed to give the many people interested in the seminars more time to plan. The new Seattle date has not yet been announced, but will appear on the LGSEA web page as soon as it is available.

2005 seminar dates:

Los Angeles, CA: September 20
Seattle, WA (TBA)
Chicago, Oct. 3: METALCON International 2005
Tampa, FL: Dec. 12
Orlando, FL: Dec. 13
Atlanta, GA: Dec. 14

The full-day programs will be conducted by Don Allen P.E., secretary of the Light Gauge Steel Engineers Association, and Roger LaBoube, Ph.D., P.E., director at the Wei-Wen Yu Center for Cold-Formed Steel Structures at the University of Missouri-Rolla.

They will begin with the basics of cold-formed steel wall framing and take attendees through multiple systems and installations, including design examples and real-world scenarios along the way.

New software tools and options will be introduced and analyzed, and design using the "North American Specification for the Design of Cold-Formed Steel Structural Members" and the "AISI Standard for Cold-Formed Steel Framing - Wall Stud Design" will be discussed. A limited number of tabletop displays are available at each venue.

To learn more or to register, visit www.steelframing.org, or call 866-GO LGSEA. To register for the October 3 presentation, as well as other METALCON seminars, go to www.metalcon.com.

Seats Still Available for the 2005 Short Course on Cold-Formed Steel Design

On October 18-20 in St. Louis, Missouri, the Wei-Wen Yu Center for Cold-Formed Steel Structures (CCFSS) will present its 19th biannual 3-day course on the "North American Specification for the Design of Cold-Formed Steel Structures." This course gives a focused overview of the specification, with detailed design examples and indexed and referenced course notes. Lecturers will include Dr. Roger LaBoube, Director of the CCFSS, and Dr. Wei-Wen Yu, Curators' Professor Emeritus of Civil Engineering at the University of Missouri-Rolla. The short course will discuss the behavior of cold-formed steel members and connections, and is structured to provide and introduction to design for the engineer unfamiliar with cold-formed steel. For en-

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Constructing Blast Resistant Structures

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Figure 2: Ledge at first level replaces heav heavy anchors shown in Figure 1.

blast resistance for the entire building envelope there is also a mandate to incorporate forced entry and ballistic resistance (FE/BR) protection to the lower floor areas of the building. These competing performance requirements have been met in this construction system by including specific elements that work in conjunction to provide the required levels of protection in the different zones of the structure.

Typical of DOS building designs is exterior cladding comprised of stone, masonry, stucco or other finish systems. This cladding affords a measure of physical protection that varies in relation to its density and thickness. The Bureau of Diplomatic Security (DS) has performed ballistic testing of various building cladding materials. The result of this testing is that, generally speaking, if the cladding material features a nominal four inch thickness of stone, brick, masonry or concrete the material will meet the DOS requirement for ballistic resistance on the lower floor areas of the building. Thinner sections of these materials, or stucco/EFIS systems of any thickness, will not provide the mandated ballistic resistance and require additional measures to compensate.

The next element of the security envelope incorporated into the bottom of our buildings is a layer of A36 steel plate that is behind the building's veneer and attached on the outboard side of the steel stud framing. To meet the Department's requirements for forced entry protection the steel plate required behind 4" thick stone only needs to be 1/4" thick. Thinner sections of these materials, or stucco/EFIS systems, require an interstitial sheathing of 1/2" steel plate. In either case the steel plate is attached to the steel stud framework by welding or by utilizing ELCO DrilFlex drill screws to attach the 54 mil stud pairs to 1/4" or 1/2" steel plate. In locations on upper floors of the building, where FE/BR protection is not required, the 54 mil studs are sheathed on the outboard side with 54 mil sheet steel to distribute load and block debris generated by the blast from entering occupied space.

The current design for DOS applications is prescriptive and is based on utilizing "back-to-back" (web-to-web) six inch deep, 54 mil, 33 ksi studs. Outboard of these are the various materials that provide the different levels of security mandated for DOS facilities as described above. Recent testing has confirmed that DOS rated FE/BR and blast rated curtain wall systems do not require special attachment at the ground floor depicted in **figure 1**. These curtain wall systems, with their attendant mass and rigidity, respond primarily in simple bending stress and can be supported by having the curtain wall bear on a nominal 6-inch vertical surface provided by a brick ledge in the ground floor slab. The cold-formed steel stud wall's deformation under the DOS design basis loading will not deflect sufficiently for it to disengage the brick ledge and fail by blowing into the occupied building. (See **Figure 2**)

The steel stud exterior wall construction system is amenable to many different construction and erection scenarios. The basic framework of steel studs, 1/4" or 1/2" steel plate and 54 mil sheet metal can be prefabricated horizontally. This assembly can then be manipulated into position and attached on the building floor/ceiling/roof slabs. Once in position, additional exterior cladding can be installed as required by the construction documents. Alternatively, the system can be "stick built", in place, if required by the general contractor. The sequence begins with attachment of the steel studs to the building diaphragms and cycles through installation of 1/4" or 1/2" sheet steel, 54 mil sheet metal and finally the cladding material(s). There are numerous combinations and permutations for constructing this system and it is flexible enough to be adapted to a wide range of field conditions and sub-contractor preferences.

Rough openings are addressed differently depending on whether they occur on portions of the building sheathed in 1/4" or 1/2" steel plate or 54 mil sheet metal. In each case the blast load is transmitted to the adjacent structure and eventually to a building diaphragm. For ground floor/first level construction, the steel plate condition is a bit more forgiving. Here blast loads can be transmitted from the window frame through a steel angle sub-frame to the steel plate sheathing and finally to the surrounding steel stud frame work and adjacent diaphragms. **Figure 3** is a photo of a typical test configuration of window and sub-frame installed in a test wall system. It makes the transition and allows for mechanical or welded attachment, between the window and surrounding steel wall sheathing. A significant advantage of this approach is that it takes these transitional sub-frames out of the construction critical path of the building's exterior walls. They can be installed anytime between initial wall construction through actual window installation. Another benefit of this approach is that it allows removal, replacement or repair of the window without disturbing adjacent interior finishes if they are designed as drilled and tapped sub-frames. Large expanses of rigid

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LGSEA/SFA Alignment

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There will be no additional costs to members who have paid their dues for 2005; all paid LGSEA members will be given access to the SFA site, using their current LGSEA username and password. (If you have misplaced your username or password, please contact Rose Kuria, either at 866-GO LGSEA, or rkuria@steelframing.org.) For members who have not yet paid their 2005 dues, the SFA Operating Team has authorized a one-time renewal for professional members, good for the remainder of 2005. For $50, or half of the regular fee, professional members can renew their lapsed memberships, and regain access to both LGSEA and SFA documents and discounts. For $150, current LGSEA members (either with or without lapsed dues payments) can extend their membership through the end of 2006.

At the end of 2005, members will be contacted on an individual basis concerning their dues renewal for 2006. The typical professional member with an engineering degree will be able to renew membership in LGSEA for $150. Note that this includes membership in one local chapter or alliance. Before, members of the Atlanta/Southeast chapter and California Chapter had been paying $140 and $150 respectively, so there is very little change for these individuals. For others in this category, the difference is larger, but the benefits of the added technical products and support should outweigh the cost.

For members who fall into one of the other SFA membership categories, the cost may be different. Panelizers, rollformers, steel suppliers and others involved in the manufacturing and supply side of the market may have higher membership fees after 2006, but will be contacted individually by SFA and LGSEA staff to discuss options. However, for engineers, the basic membership rate will remain at $150 for the near future. For further information on fees, see the FAQ section of the LGSEA or SFA Web sites, at www.lgsea.com or www.steelframing.org.

A Victory for Cold-formed Steel

Alignment Opinion from Hawaii Chapter Member

By Les Nagata, P.E.
President, Structural Analysis Group, Inc.

As a long-standing member of the Light Gauge Steel Engineers Association, I am very pleased with the planned merger of LGSEA with the Steel Framing Alliance. This union will bring two great organizations into alignment.

Both organizations have done a great deal for the cold-formed steel industry. By combining resources, efforts and manpower, even greater possibilities exist for both organizations. Indeed, LGSEA, the technical entity of the cold-formed steel industry, is essential for the attainment of SFA's goal to establish prominence for cold-formed steel in the construction marketplace. Conversely, LGSEA needs SFA's support to conduct the technical programs that the industry demands and to disseminate this information. This logical marriage creates a synergy that is not only desirable but essential.

Here in Hawaii, our local LGSEA chapter is very strong and active. Likewise, the local SFA has many programs throughout the year and is very visible throughout the state. Both organizations have worked closely together for many years. Our local LGSEA and SFA organizations have participated in joint functions, co-sponsored joint seminars and collaborated on many projects for the benefit of the cold-formed steel industry.

As an example, Hawaii's SFA and LGSEA have created a joint scholarship program in conjunction with the University of Hawaii, with SFA funding the scholarship and LGSEA overseeing the award of this scholarship to a student interested in pursuing an engineering career preferably focusing on cold-formed steel. It is this kind of cooperation and joint effort that has ensured a thriving steel industry in Hawaii.

The progress made in cold-formed steel design and construction in Hawaii would not have been possible without both the SFA and the LGSEA. Many individuals in Hawaii belong to both organizations and have served on both Boards. Thus it makes sense, especially here in Hawaii, that SFA and LGSEA unite and streamline their operations.

By uniting both organizations, significant efficiencies can be realized. Duplication of effort and programs will be virtually eliminated and each group can focus on what is germane to its existence. The engineers will be able to focus on technical issues (without administrative distractions) and SFA will have a strong technical arm which is necessary for its mission to spread the use of cold-formed steel in the construction industry.

By uniting under one umbrella, the finite resources of SFA and LGSEA can be put to more efficient use. The volun-

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Welcome to the Steel Framing Alliance Family!

The team at SFA welcomes LGSEA members and staff.
Thank you for supporting the steel framing effort and community!

As members of the steel framing community, you understand the need for good, experienced designers, and having the resources you need to get the job done. The SFA is committed to supporting the engineers that make up the LGSEA, as well as providing products and services that support the goals and mission of the LGSEA. Welcome aboard!

LGSEA

Steel Framing Alliance™
Steel. The Better Builder.

LGSEA Mission: To enable and encourage the efficient design of safe and cost effective cold-formed steel (CFS) framed structures.

The Light Gauge Steel Engineers Association needs you and your experience. Please email or fax your opinions, questions, and design details that are relevant to the cold-formed steel industry. Upon editorial review, your submission may be printed in the Technical Exchange Section of this Newsletter.

Cold-Formed Steel Framed Shearwalls & Design Example

By Jeff Ellis P.E., S.E.

AISI has recently released a new standard entitled "Standard for Cold-Formed Steel Framing – Lateral Design." LGSEA will publish a document in the near future regarding design of cold-formed steel framed, wood and steel sheathed shear wall assemblies using this new AISI standard. The following article will include an excerpt of text and an example from the LGSEA document.

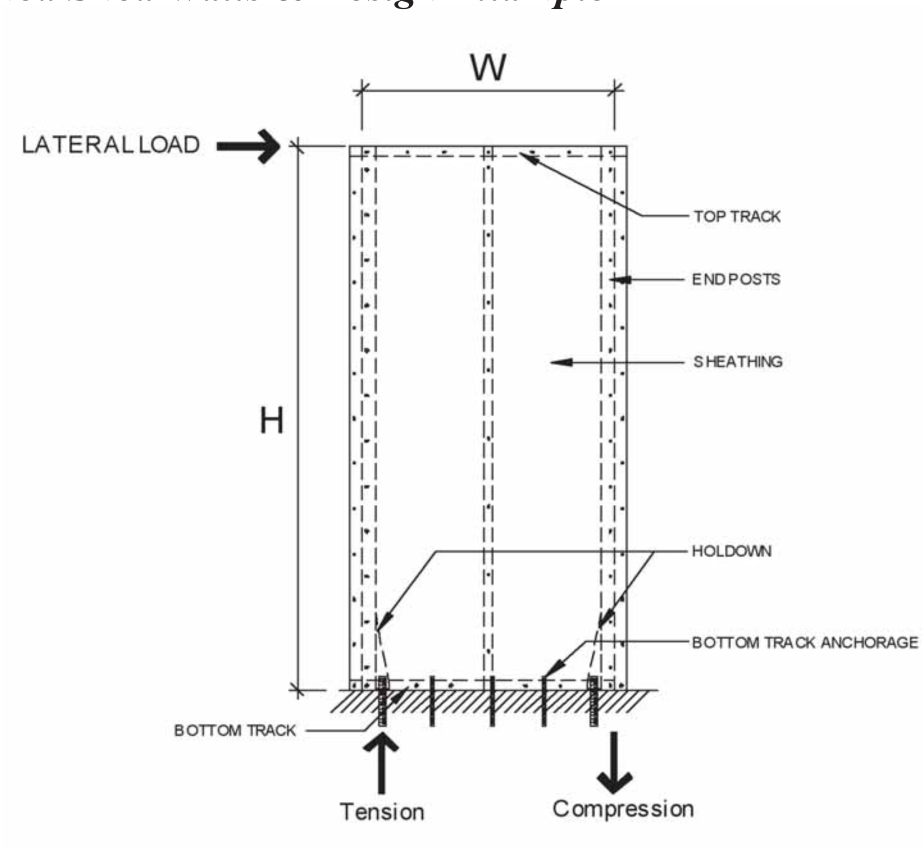

Figure 1

General

Light-framed shear walls have been successfully used as lateral force resisting elements for many years. A typical shear wall assembly is shown in **Figure 1**. There has been a large amount of recent testing and analysis performed on these systems including monotonic, cyclic, and shake table testing. Typically, shear wall assembly strengths are determined through monotonic tests per ASTM E72 for wind load resistance and cyclic tests per the Sequential Phase Displacement or the CUREE protocol for seismic resistance.

Typical lateral loads on shear walls result from either wind or seismic demand. Design wind loads are the actual expected wind forces, whereas design seismic loads are reduced from the actual expected seismic forces based on the type of lateral system used, how many lateral elements are used in the structure, and the level of seismic detailing performed. Designing for a reduced seismic load reduces the cost of construction significantly, but the tradeoff is damage in the structure during a major earthquake.

Design Procedure

A general procedure for design of shear wall assemblies is outlined as follows:

1. Determine design loads (gravity, wind, seismic, etc.).
2. Determine shear wall sheathing/fastener/spacing/framing type based on published strengths in code or standard.
3. Design connection of member delivering the shear load to the shear wall (collector).
4. Design boundary members and supporting elements of the structure.
5. Design wall stud bracing (Ref. AISI Wall Stud Design Standard).
6. Determine the overturning restraint (holdown) and anchorage required.
7. Analyze top of shear wall horizontal displacement (story drift) to determine compliance with code requirements and adjust as necessary. Note that one may have to verify the initial load distribution based on the final shear wall stiffness if a rigid diaphragm is used.
8. Design the foundation for all induced forces, including anchorage embedment and transfer of overturning compression.

Design Example

(Calculations on p. 10)

The example is a steel sheathed cold-formed steel framed type 1 shear wall, with less than a 2:1 aspect ratio, per load and resistance factor design (LRFD) for high seismic performance or design categories. The shear wall is the lower middle transverse shear wall of the two-story cold-formed steel framed office building and is noted as shear wall 4 in **Figure 2**. The strength level seismic force and strength level wind force are denoted as w_{equ} and w_{wu}, respectively, also in **Figure 2**. **Figure 3** is the elevation of shear wall 4.

Deflection

Consideration of top of shear wall horizontal deflection is important, whether the wall is governed by wind or seismic forces, as excessive deflection can lead to building envelope leaks or unsightly cracks or failures in finish materials (stucco, gypsum board, glass windows, etc.). In addition, excessive deflection can lead to mem-

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Cold-Formed Steel Framed Shearwalls & Design Example

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ber or assembly failure and collapse.

Currently, there is no code drift limit for walls loaded in-plane for wind. However, ASCE7-02 commentary section CB.1.2 states "An absolute limit on interstory drift may also need to be imposed in light of evidence that damage to nonstructural partitions, cladding and glazing may occur if the interstory drift exceeds about 3/8" unless special detailing practices are made to tolerate movement." For seismic loading, while drifts must be computed by amplifying the calculated LRFD deflections, at the ASD level this does translate to a limit of roughly 1/2" for an 8 foot tall wall.

The Lateral Standard provides a deflection equation for blocked cold-formed steel framed wood or steel sheathed shear wall assemblies. This equation is a function of four basic parts: linear elastic cantilever bending, linear elastic sheathing shear, non-linear effects, and holdown deformation. The vertical deflection due to holdown deformation is to be multiplied by the shear wall height to width ratio (h/w) to obtain the holdown contribution to

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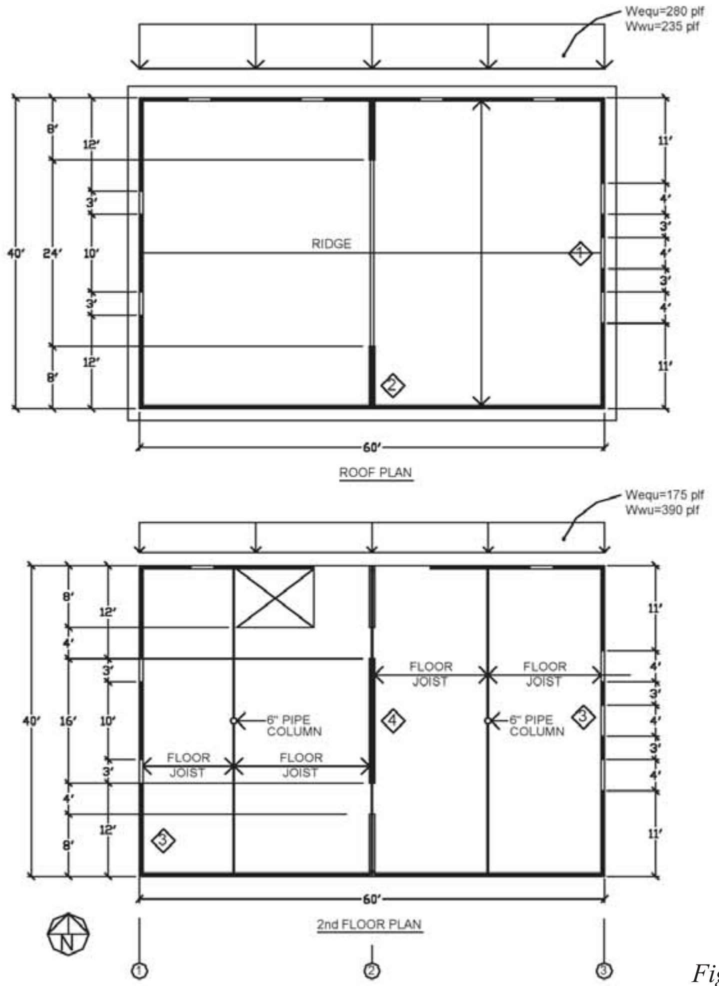

Figure 2

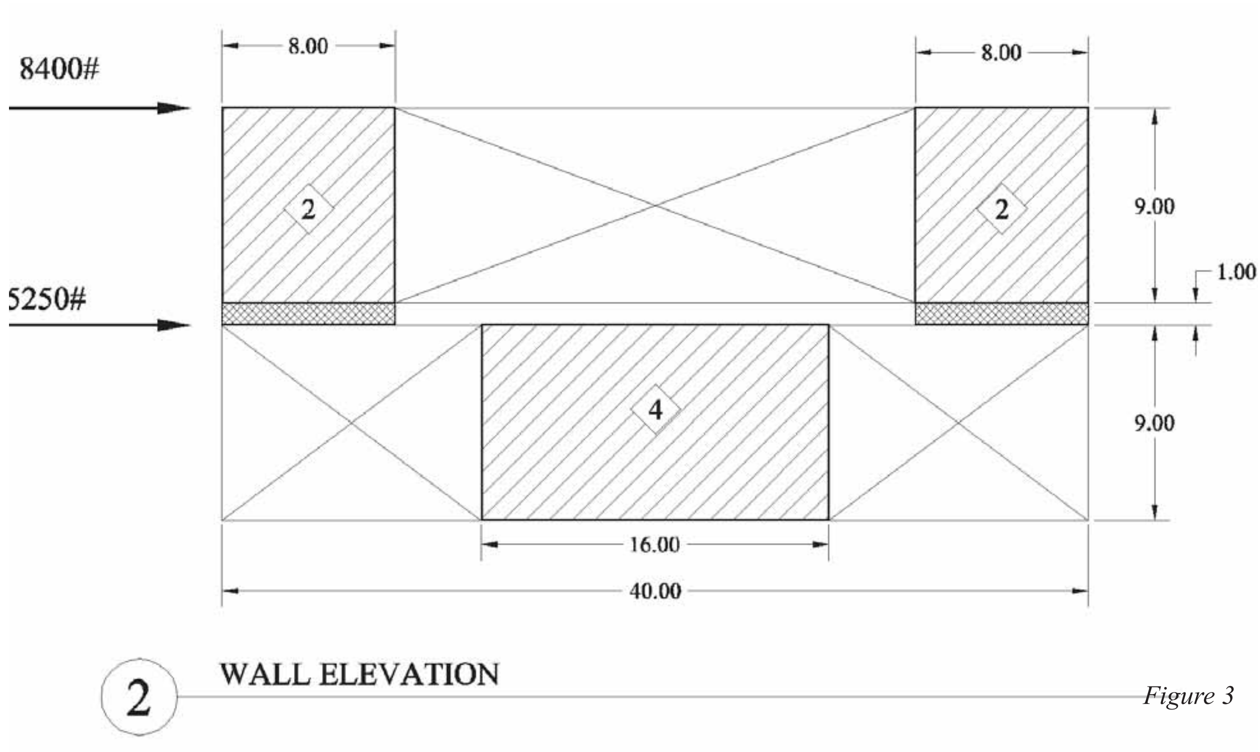

Figure 3

Continued from page 8

top of wall horizontal drift as shown in **Figure 4**.

The deflection equation is for a Type I shear wall. However, 2003 IBC states that one may compute deflection of wood framed shear walls with openings (Type II) by taking the maximum individual deflection of shear wall segments and dividing it by the shear resistance adjustment factor used in the design of the Type II shearwall. This same methodology appears appropriate as well for cold-formed steel framed shear wall assemblies.

Special seismic requirements

The 2003 IBC assigns an R-value of 6.5 for light-framed wood or steel-sheathed shear wall assemblies with no building height limit for Seismic Design Category (SDC) A through C and a 65-foot building height limit for SDC D through F. As the R-value is high and, therefore, the seismic design load is low, the codes and standards require special design and detailing considerations to better ensure ductile behavior of the lateral system. The Lateral Standard specifies special requirements when one determines the design seismic forces for a cold-formed steel shear wall using an R-value greater than 3.0.

Both the code and standard requirements include that the strength of connections (top chord splices, boundary members, and collectors), the boundary members, and the anchorage be designed for the amplified seismic loads (overstrength factor, Ωo) or the maximum force that the system can deliver. As mentioned previously, this is to prevent sudden failure, such as end post buckling or a connection failure, and better ensure ductile behavior of the assembly.

Summary

Design provisions for cold-formed steel shear wall assemblies and understanding of their performance have certainly grown since the early 1990's. Significant advances and additions in the provisions for these systems have occurred since the inclusion of the first code provisions in the 1997 UBC, such as addition of values for steel and gypsum sheathing, allowance for thicker framing members, shear walls with openings, and deflection equations. The current codes and AISI standards and commentary developed over the last several years provide a wealth of additional information and clarification for the designer and builder of cold-formed steel lateral force resisting systems.

Jeff Ellis P.E., S.E. is a branch engineer for the southwest region of Simpson Strong-Tie Co. Inc. He also serves as LGSEA Structural Assemblies Committee chairman and is a member of the AISI COFS Lateral Task Group.

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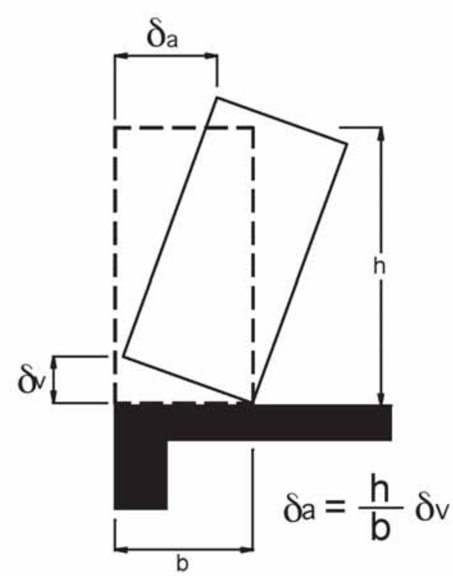

$$\delta_a = \frac{h}{b}\delta_v$$

Figure 4: Drift from anchorage/ holdown deformation

Cold-Formed Steel Framed Shearwalls & Design Example

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A. DESIGN LOADS

AISI Standard for Cold-Formed Steel Framing Lateral Design

Section C2.1 (Seismic Design)

LRFD	$\Phi =$	0.60	Lat.Std.C2.1
Height of shearwall	h =	9 ft	
Second Story:			
LRFD shear load applied	w= wu =	280 plf	
Tributary Width	Trib. Width =	30 ft	
Story shear	V_2=w * Trib Width =	8400 lb	
Total shear wall segment	ΣL_i= 8+8 =	16 ft	
Unit shear force	$v=V_2 / \Sigma Li$ =	525 ft	
First Story:			
LRFD shear load applied	w= wu =	175 plf	
Tributary Width	Trib. Width =	30 ft	
Story shear	V_1=w * Trib. Width =	5250 lb	
Total shear wall segment	ΣLi =	16 ft	
Unit shear force	$v=(V_2 + V_1) / \Sigma Li$ =	853 plf	
LRFD shear wall requirements:			
1st story required shear strength	v =	853 plf	

Nominal Shear Strength:

0.027" steel sheet, double sided for 1st story with screws at 4" o.c. ($v_{nominal}$ = 1000 plf)	Lat.Std.Table C2.1-3

LRFD available shear strength $v = 1000*2*\Phi =$ 1200 plf

LRFD Overturning Force at each shear wall ends (neglect restoring DL effects):

* Using 2 end studs either end of shear wall

Distance btwn holdown and comp. studs	d = L - (2 x flg width + hd cl) =	15.6 ft
1st floor overturning force	$C=(V_2 + V_1)*h / d$ =	7873 lb

B. JOIST RIM TO TOP TRACK

v = 853 plf

#10 screws to 43-mil rim joist to 43-mil top track (Fy=33ksi)	=	394 lbs/screw	NASPEC E4
#10 screws rim to track	**spacing =**	**5.5 in. o.c.**	

C. BOTTOM TRACK TO CONCRETE

v = 853 plf

5/8" dia A307 bolt to 43-mil track to conc.	=	1434 lbs/bolt	NASPEC E3
5/8" dia A307 bolt to track to concrete	**spacing =**	**20 in. o.c.**	

D. BOUNDARY ELEMENTS (END STUDS)

LRFD OT = 7873 lbs

ASD OT = (LFRD OT / Φ) / Ω = (7873 / 0.60) / 2.5 = 5249 lbs

When one uses an R > 3.0 (required for CFS framed shear wall for SDC D - F per the 2003 IBC), the AISI Lateral Standard states the boundary members to resist lesser of : Lat.Std. C5.3

AMPLIFIED SEISMIC LOADS = Ωo x LRFD OT = 3.0 x 7873 lbs = 23619 lbs

OR

MAX. SYSTEM CAN DELIVER = LRFD OT / Φ = 7873 / 0.60 = **13122 lbs**

2 - 550S162 - 54 back to back end studs (Fy = 50 ksi) with mid-height steel bracing

2002 AISI Manual Design Axial Tables	Nominal Axial Strength = Pn =	**15560 lbs > 13122 lbs OK**
	Available Axial Strength = Φ Pn =	**13226 lbs > 7873 lbs OK**

E. OVERTURNING RESTRAINT (HOLDOWN)

LRFD OT = 7873 lbs

ASD OT = (LFRD OT / Φ) / Ω = (7873 / 0.60) / 2.5 = 5249 lbs

When one uses an R > 3.0 (required for CFS framed shear wall for SDC D - F per the 2003 IBC), the AISI Lateral Standard states to design anchorage to resist lesser of : Lat.Std. C5.3

AMPLIFIED SEISMIC LOADS = Ωo x LRFD OT = 3.0 x 7873 lbs = 23619 lbs

OR

MAX. SYSTEM CAN DELIVER = LRFD OT / Φ = 7873 / 0.60 = 13122 lbs

Therefore, choose holdown to resist LRFD OT of 7873 (or ASD OT of 5249 lbs) and has a nominal strength of 13122 lbs.

Continuing a Southern Tradition

By Ryan Smith
Board Member Atlanta/SE Chapter

The Atlanta/Southeast chapter of the Light Gauge Steel Engineers Association has a strong history. The success of the chapter is a reflection of its active membership and Board of Directors.

During our June meeting, the Atlanta/SE Chapter's Board discussed the future of the LGSEA in regards to the Steel Framing Alliance merger. The Board emphasized the importance of local chapters for the overall sustainability of the LGSEA nationally. One strength the Atlanta/SE chapter shares with the SFA is that the members come from all realms of the construction industry, including engineers, architects, contractors, distributors, manufactures, building officials, and students. Through its diverse membership, our organization influences the use of cold-formed steel at many levels. The SFA merger should only attract more members from various sectors of our industry.

Along the same lines, the Atlanta/SE chapter maintains its membership through quarterly meetings. The chapter succeeds in delivering topics that cover the full spectrum of cold-formed steel applications with the most current technical information available. Nationally, the LGSEA provides resources through its publication of the Newsletters, Tech Notes and Research Notes. With the addition of SFA's research and development capabilities and financial strength, the LGSEA and local chapters can offer more opportunities for education and industry feedback. Similarly, the SFA will now enjoy a larger avenue to distribute information. In the past, local volunteers have created presentations for chapter meetings. With SFA support, the LGSEA can establish a national schedule of presentations and reduce the duplication of efforts between chapters. Consistent presentations will also provide regional feedback on topics to the LGSEA/SFA.

The next logical question is, how do we move forward? The Atlanta/SE Chapter's Board identified the need to create new chapter operating procedures and budgets. Working with SFA representatives we hope to reach consensus in these areas in the near future. Once these are established, the individual chapters, LGSEA national, and the SFA will then need to openly communicate their goals and objectives. Previously topics for meetings, technical information and other resources were solicited through local membership and board member suggestions. Aligning the SFA/LGSEA's national agenda with regional needs from the chapters will better serve the industry as a whole.

The Atlanta/SE Board appreciates SFA's support in the past and looks forward to working together to strengthen the chapter and the LGSEA/SFA overall. As the Atlanta/SE Chapter derives its strength from its active membership, we hope LGSEA/SFA will welcome the participation of the local chapters. Together we can achieve the shared goal of increasing the specification of cold-formed steel.

Ryan Smith is the General Manager of Clark Western Design, LLC, Clark Steel Framing and Western Metal Lath's engineering company.

A Victory for Cold-formed Steel

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teer manhours engineers donate to these organizations will be more focused. More money can be directly infused into research projects and spent to develop and disseminate technical information. It takes a tremendous amount of manhours and money to conduct research, develop technical documents, publish documents, maintain a Web site and do all the administrative functions that accompany these processes.

Rolling the Steel Framing Alliance Technology Team into the LGSEA Research and Development Committee will create one cold-formed engineering brain trust, and will provide a venue for the development of ideas and programs that will help everyone in the industry, from the owner through the design team and suppliers, down to the builder and framer.

Recognizing that the LGSEA is a very special arm of the SFA a set of "Operating Procedures" has been created specifically for this committee. These operating procedures define an administrative structure for the committee, as well as a procedure for developing technical research projects and for producing technical documents for publication. These procedures create a consensus process that gives LGSEA technical autonomy to pursue projects beneficial to the design profession and gives SFA oversight on this committee. The procedures will streamline the processes required to get technical documents and information out to the engineering community. Also, the creation of a Technical Review Committee will ensure the quality of technical documents, seminars, and other products distributed by the Steel Framing Alliance.

This is an exciting time to be an engineer involved in cold-formed steel design. Although cold-formed steel has been around a long time, only now are we realizing the structural potential of this material. New products, processes and design knowledge are constantly emerging. Designers are stretching the limits of possibilities. Steel is a very consistent and versatile product, making it a very efficient structural material. Knowing that I can rely on and have the support of the SFA/LGSEA gives me much confidence to recommend and design cold-formed steel for appropriate projects. I am excited at the possibilities that this union will produce, and am extremely pleased to be a part of the Light Gauge Steel Engineers Association and the Steel Framing Alliance.

News Briefs

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gineers experienced with cold-formed steel design, this course will strengthen their understanding of the fundamental behavior of both members and connections, as well as provide a better understanding of the AISI Specification and the AISI framing standards. A preview of future specification changes will also be provided. Both commercial and residential applications of cold-formed steel will be discussed. For additional information and a downloadable application, go to http://campus.umr.edu/ccfss/cont_ed/short_course.html, or call 573-341-4471.

Allen named Secretary of LGSEA

In accordance with the new Operating Procedures of the LGSEA, the association announced the appointment of Don Allen as the first staff Secretary for the organization. In the past, the Secretary has been a volunteer position, elected from the Board of Directors. The new Operating Procedures stipulate that elected officers are the President and Vice President, serving one-year terms. According to the Procedures, "The SFA shall … assign staff to serve as the Secretary of the LGSEA and be responsible for providing support for the LGSEA by performing the following functions:

• Oversee compliance with these procedures and the SFA Antitrust Guidelines.
• Maintain records pertaining to the LGSEA.
• Provide administrative support for the LGSEA.
• Package and disseminate approved work products."

Allen, along with SFA staff members Rose Kuria and Janice Duncan, will be performing most of these duties as required. "I'm pleased to be back in my familiar role, doing many of the same things I did as Managing Director" stated Allen. "Most of the LGSEA volunteers are great folks to work with; and I'm looking forward to a productive year with the organization."

Allen also serves as Technical Director of the Steel Stud Manufacturers Association, and Director of Engineering of the Steel Framing Alliance. Allen can be reached at dallen@steelframing.org, or at 706-597-8076.

LGSEA General Membership meeting in conjunction with METALCON

The 2005 Annual Meeting of the Light Gauge Steel Engineers Association will be held on Wednesday, October 5, 2005, starting at noon at the Donald Stephens Convention Center in Rosemont, Illinois. Additional details will be available at the LGSEA website as well as www.metalcon.com as the date draws nearer. Rather than the traditional committee meetings typically held in conjunction with METALCON, task groups will report to members at the main meeting, giving progress reports and agendas of upcoming committee activities. Lunch will be served, and special recognition will be given to individuals and groups that contributed to the organization over the 2004-2005 year. Also, newly elected officers of the organization will be installed in the first installation ceremony of this type for the new LGSEA.

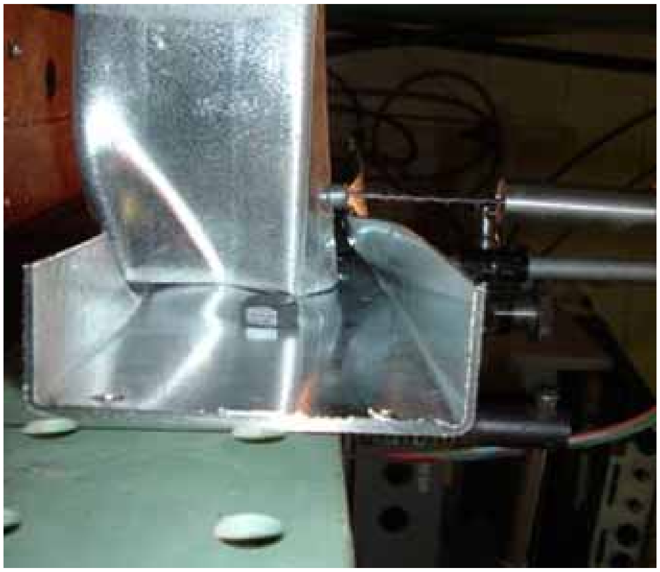

Figure 1: Test specimen showing screw shear/tension failure.

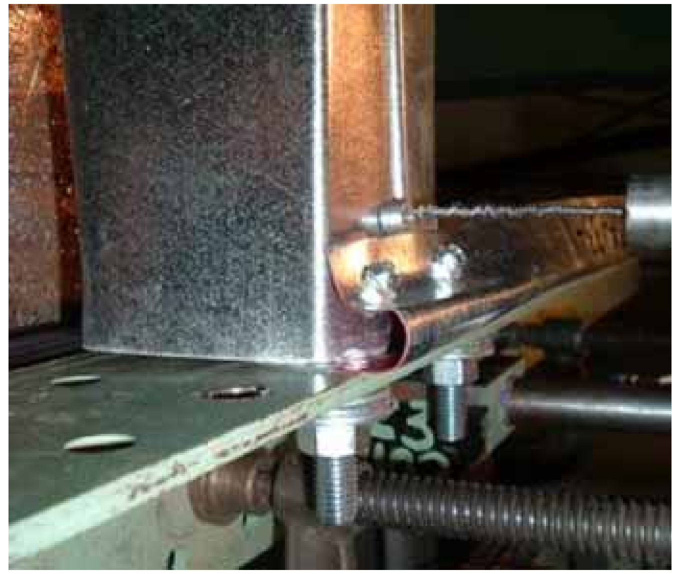

Figure 2: Test specimen showing track failure on built-up jamb.

Preliminary Report Released on Stud to Track Research

By Don Allen, P.E.

Earlier this year, the Canadian Sheet Steel Building Institute (CSSBI) and the University of Waterloo released a preliminary report on the lateral strength of stud to track connections. Although previous tests have been performed on single studs away from the end of a track segment, this research focused on jamb studs, including multiple and built up members. 96 tests have been carried thus far out on various configurations of jamb studs:

- Back-to-back, toe-to-toe, and single jamb studs
- At the end of the track and interior
- 3-5/8” and 6” studs
- Thicknesseås from 33 mil to 75 mil
- Stud and track same thickness
- Effect of missing screws in top flange

Preliminary findings show that:

- The web crippling and punch-through failure modes identified in single studs also occur in jamb studs.
- The strength of the screws connecting the stud to track contribute to the capacity.
- Deformation may be the limit state for many assemblies (i.e. thin track members).
- It could be difficult separating out the different contributing factors.

After issuance of the preliminary report in February, researcher Victor Lewis has been working to combine this data with previous tests on similar stud-to-track connections. Based on initial research, there are over 120 data points to be incorporated. Once this is done, Lewis hopes to develop predictor equations based on the following four failure mechanisms: web crippling, track punch-through, track deformation, and screw failure.

The final report from this work will be published in February 2006.

Figure 3: Single stud failure in track.

Figure 4: Punch-through failure at end of track.

ICC High Wind Committee Charts a New Course

By Robert J. Wills P.E.
Regional Director for the American Iron and Steel Institute

As a result of input from AISI working with other material industry associations, the ICC Standards Council has decided to change direction with respect to the development of a proposed Hurricane Resistant Construction Standard.

The ICC standard had been envisioned as a replacement for the Standard Building Code SSTD10 High Wind Design Standard, which was heavily used in coastal regions. Both the SBCCI standard and the proposed ICC replacement document were intended to provide prescriptive provisions for the construction of residential buildings in hurricane regions. The existing SBCCI document only addressed wood and masonry construction types, but ICC had anticipated that the new document would expand to include cold-formed steel framing and insulated concrete form construction, and potentially allow for mixed construction materials in a prescriptive manner.

The ICC committee was appointed a year and a half ago and had been meeting frequently to develop an initial draft. However, at recent meetings, it had become increasingly apparent that it was going to be difficult and redundant to develop a merged document to cover a wide variety of construction types when all the involved material industries already had ANSI recognized standards of their own to address high-wind applications.

AISI, working with the American Forest Products Association and the National Concrete Masonry Association, participated in a series of conference calls that led to the creation of an issue document that could be used to carry our common concerns to the ICC Board of Directors. Among the concerns expressed by the group were compatibility issues between the design methodologies of the industry documents, the confusion created by multiple documents with potentially differing requirements, and the legal implications resulting from the need to protect the copyrights for the existing industry standards.

These concerns were expressed to the ICC Standards Council, which led to their decision to abandon the development of a new standard. Alternatively, ICC has chosen to rely on industry-developed material design standards, which are already adopted by reference in the IRC and IBC. It was recognized that there are some high-wind provisions that need to be added to the IRC, such as more comprehensive provisions for foundations, and simplified solutions to address high-wind concerns for doors, windows and roofing. The ICC Hurricane Resistant Construction Committee will continue to work to develop provisions to address the full spectrum of high-wind con-

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Constructing Blast Resistant Structures

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FE/BR materials (e.g. louvers, entrances, storefronts) may require additional localized reinforcement.

Rough openings above the first level, in areas where the steel stud wall system is sheathed in 54 mil sheet steel, are addressed differently. In these cases the blast load is transferred directly to the steel studs at the window head and sill. These connections are more detailed to exploit the ultimate strength available from these studs and allowing them to achieve full tension membrane. **Figure 4** depicts these connections in a full-scale blast test. While at first glance this assembly may seem a bit onerous, prefabricating a steel subframe that would be a transition between a blast window and the steel stud wall system that accepts and transfers the load imparted to them could facilitate its implementation. The advantage of this approach is that, if properly designed and fabricated, it could perform the same function as a traditional blast window embed and allow direct bolt up of the window to this transition sub-frame. Additionally, this approach provides the general contractor with vertical adjustability in the rough opening during fabrication of the steel stud frame.

Ideally this system would be executed employing continuous steel studs from the first level slab to the top of the parapet if the overall building height permits this approach. While steel studs are commercially available in the U.S. in 60-foot lengths this design may not be practical in all cases. The DOS and ERDC have developed a stud splice detail utilizing 1/2" steel plate, approximately 16" long and featuring 12 bolts to make the splice. This design is intended to allow the spliced stud to produce its maximum strength and achieve tension membrane over its entire length. The optimum location for these splices would be directly in front of a floor slab. This location is the least likely to interfere with the deformation experienced by the stud pairs under blast loading.

Recent experimentation indicates that if the 54 mil sheet metal is butted to an adjacent sheet they will separate under the blast loading. The deformation and elongation in the studs may create gaps between successive sheets of this steel and allow overpressure and debris to enter the structure. It is recommended that successive sheets be overlapped 1" to 2"to minimize this potential hazard.

Testing by DS and ERDC has revealed the importance of interior sheathing for this construction system. The significant deformations experienced during blast loading have a tendency to detach gypsum wallboard off the interior face of studs at relatively low velocity. Developmental testing of this system has led DS to recommend that the interior face of the stud be finished with a steel-backed composite gypsum board product to prevent this occurrence. Utilizing this material as the interior cladding material also improves the overall performance of this wall system by preventing stud rotation and keeping the studs aligned normal to the blast loads.

Department of State R&D continues to evolve this construction technique. The goal is to move from the prescriptive solution tailored for specific DOS projects to an established design methodology that is adaptable to other combinations of charge, distance and blast load duration. This capability may be of benefit to other organizations and missions. Towards this end the DOS in conjunction with ERDC and the University of Missouri are developing a PC based design tool called the Steel Stud Wall Analysis Code (SSWAC). Once this software tool is completed it will allow designers to tailor this approach to variances in blast loading as well as floor heights, stud size/spacing and different cladding options. If interested in possibly receiving a copy of the SSWAC design tool once it is completed please E-mail norrisrj@state,gov.

Figure 3: Typical window in test wall.

Figure 4: Upper floor window connection.

Light Gauge Steel Engineers Association

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ICC High Wind Committee Charts a New Course

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cerns, however, the provisions that this committee produces will be introduced to the IRC through the normal code change process rather than developed as a self-contained standard.

AISI will continue to work as a member of the ICC committee to provide input with respect to the steel industry's interest in door, window and roofing products and materials, as well as helping to insure that the committee's work is coordinated with the design and construction documents developed by the AISI Committee on Framing Standards. By working together, industry associations have protected their common legal interests, avoided the potential for confusion that can arise from redundant or conflicting standards, and assisted the ICC in the development of construction documents that will provide the level of safety for hurricane prone regions that developers and homeowners expect.