Newsletter for the

Light Gauge Steel Engineers Association

A Council of the Steel Framing Alliance

May 2006

Contents page

Upcoming Events

Steel Framing Alliance Spring Forum May 2-4
Anaheim, California
www.casfa.org

Hawaii LGSEA & Hawaii Steel Alliance May 24
Joint Membership Meeting
www.hawaiisteel.com

Atlanta/Southeast Chapter Meeting: June 8
Mid-Rise Structures presentation
www.lgsea.com

STEEL: Doing it Right (seminar) June 15-17
Houston, Texas
www.awci.org; www.steelframing.com

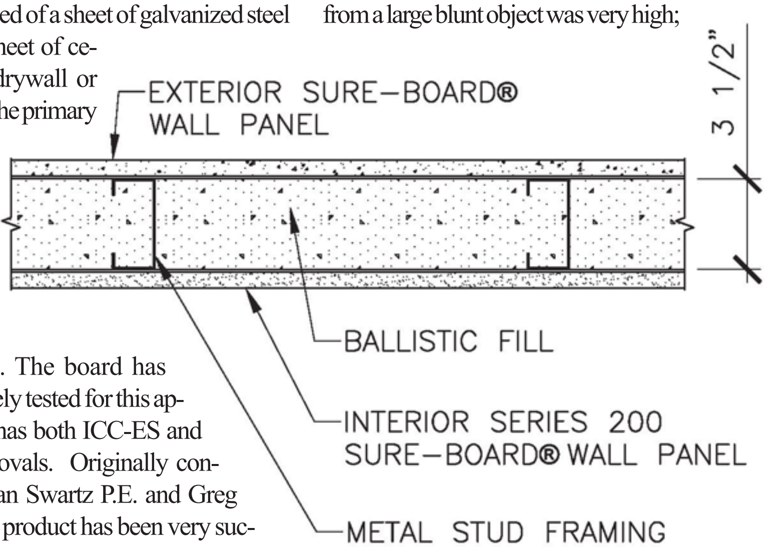
Pacific Coast Builders Conference June 20-23
San Francisco, California
www.pcbc.com

NCSEA Annual Conference Sept. 14-16
Salt Lake City, Utah
www.ncsea.com

Bullet-Resistant Wall Assemblies Using Sure-Board Sheathing

Allan Swartz P.E.
Principle Partner
Swartz and Kulpa Engineering Inc.

Recent tests in Nevada have shown promising results for ballistic resistance of steel framed walls when filled with granular materials and sheathed with a composite gypsum board and sheet steel product. The sheathing, known by its trade name as Sure-Board7, is a patented product that is a composite composed of a sheet of galvanized steel bonded to a sheet of cement board, drywall or MDF board. The primary use of this material has been as shear resistant sheathing on both wood and metal framed walls. The board has been extensively tested for this application and has both ICC-ES and LA City approvals. Originally conceived by Allan Swartz P.E. and Greg Kulpa P.E. the product has been very successful in its role as shear resistant sheathing, and has been used extensively on low- and mid-rise projects across North America. Carl Elliot and Kelly Holcomb have contributed extensively to development of related board products, installation techniques and testing of wall assemblies. Recently the product development team has been actively involved in testing wall assemblies for resistance to ballistic penetrations. The results have ranged from encouraging to excellent depending on the assembly used. All of the samples tested to date have been constructed using an exterior sheet of the cement board version of Sure-Board7 composed of cement board and 27 mil galvanized steel and an interior sheet of "Series 200" Sure-Board7 composed of 5/8" gypsum board and various thicknesses of galvanized steel sheet. Some of the assemblies have included exterior finishes such as ceramic or stone tile.



The design philosophy behind the function of the wall was inspired by the results of wind blown projectile testing in Florida where wall samples were subjected to ballistic impact from a piece of 2x4 lumber fired into the wall at high speeds. Sure-Board7 with 27 mil sheet steel passed all tests with no penetration, even when the test equipment was operated at its maximum possible settings. Clearly the wall assembly's resistance to penetration from a large blunt object was very high; however resisting bullet penetration would be a more difficult proposition. If a bullet were fired directly into the board, penetration of the wall occurred with a 9mm handgun (the lowest penetration projectile tested). Bullet penetration is difficult to resist because the force from the projectile is focused on a very small area. The solution appeared to lie in the development of a system that would spread the load over a larger area, causing the load from the bullet to behave more like a large blunt object. The project team decided to pursue a completely different approach from that used by the currently available ballistic resistant rigid panels. These systems (often composed of Kevlar7 laminates) tend to be very expensive, and provide resistance to penetration by stop-

Continued on page 6

Hawaii Chapter Installs New Directors and President

On February 10, the Hawaii Chapter of the Light Gauge Steel Engineers Association installed Their officers and directors for 2006. Tim Waite, who helped found the organization over 10 years ago, will be serving his second term as president of the organization. Tim was the first president of the LGSEA Council Hawaii Chapter, and in Tim's words "has been recycled" back into the lead position again. Assisting Tim will be newly installed Vice-President Brian Enomoto, Secretary Adrian Lee, and Treasurer Marvin Mestanza. Other members of the Board of Directors are Akira Usami, Will Wong, and Shane Arnold. This was the 10th annual officer installation banquet, and was held at the Oahu Country Club in Honolulu, HI. Outgoing president Jeffrey Hanyu of Allison-Ide Structural Engineers thanked the attendees as well as his outgoing directors (Howard Lau, Glen Isidro, Darin Okuda, Brent Uechi, Jim Walfish & Mike Kasamoto) for supporting him during his term. Don Allen, P.E. director for engineering of Steel Framing Alliance and national Secretary of the LGSEA presided over the installation ceremony.

Director Howard Lau presented the LGSEA-Hawaii Chapter donation to Mr. Greg Chiu for the Dr. Chiu Scholarship grant. After the installation, Glen Furuya of LeadershipWorks made an outstanding presentation on the huge potentials of island leaders.

Don Allen, P.E. director for engineering of Steel Framing Alliance and national Secretary of the LGSEA (left), swears in the new directors.

Newsletter for the Light Gauge Steel Engineers Association

LGSEA

A Council of the Steel Framing Alliance

Newsletter Editor: Ray Grage

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

Technical Review at LGSEA Council

by B.W. Schafer, Ph.D., Chair
LGSEA Technical Review Committee

Designers of cold-formed steel structures take pride in their designs, not just because they provide a safe and an efficient structure, but also because design in cold-formed steel often asks a little bit more out of the structural engineer's bag of tricks. The technical information provided by the LGSEA is dedicated to easing the burden on the structural engineer who is designing in cold-formed steel, and also to adding a few toys to that trusty bag of tricks. LGSEA's Technical Review Committee is dedicated to insuring that the information LGSEA provides is something that the structural engineer can count on.

Charge of the Committee: To ensure that Structural Engineers only receive information from the LGSEA that is of the highest caliber of technical content. To ensure that a complete technical review of the work product has been performed before its release. To provide official resolution of any technical conflicts that may arise in the process of generating a work product. To perform these duties in a timely manner so that the Structural Engineering community may have the most up to date information available.

The Technical Review Committee is a new wrinkle at LGSEA, and was formed when LGSEA voted to become the engineering council of the Steel Framing Alliance. The Technical Review Committee reports directly to the LGSEA Board and the committee evaluates all technical content put out by LGSEA before it is distributed to the members and made available to the public.

Who serves on the Technical Review Committee? Currently the technical review committee consists of Ben Schafer (Johns Hopkins University), Rob Madsen (Devco Engineering), John Matsen (Matsen-Ford Design), and Shahab Khatami (Structural Design, Inc.). At the discretion of the Chair, the committee also includes ad hoc members. Ad hoc members are brought on to the committee to help in the critique of any material outside of the expertise of the standing committee. All of the members of the committee are dedicated to ensuring that LGSEA's materials are reviewed with high standards, without bias, and with an aim to providing structural engineers with state-of-the-art knowledge and guidance.

Can I really count on LGSEA material to be without bias? As Chair of the Technical Review Committee I take particularly seriously the notion that information provided by LGSEA should be without bias. LGSEA is not an advocacy group; it is an association of structural engineers that are designing a sometimes difficult, but always interesting, product. I am particularly sen-

Continued on page 7

News Briefs

LGSEA Council Hiring in DC Office

To facilitate and expedite the development of technical notes, seminars, online content, and other work products helpful for the structural engineer designing with cold-formed steel framing, the LGSEA Council and the Steel Framing Alliance are seeking qualified candidates for a full-time position in the Washington, DC headquarters office. Qualified candidates should have minimum two years experience in structural engineering or construction, hold a bachelors degree from a 4-year accredited college, and be skilled in technical writing and editing. Applicants should...

LGSEA Council Members to Present at ASCE Structural Engineering Institute (SEI) Structures Conference in May

The ASCE SEI will hold their annual Structures Conference May 18-20 at the Adams Mark Hotel in St. Louis, Missouri. This year, the theme of the conference is "Structural Engineering and Public Safety." Special tracks on "Extreme Event Loading," "Special Structures," and "Infrastructure Engineering" focus on this theme and applications for modern practice. There will be a Friday morning session, from 10:30 am to 12:00 pm, entitled, "Loadbearing, Mid-Rise, Cold-Formed Steel Building Design," that will include papers from three members of the LGSEA Council. Nabil Rahman of The Steel Network will present information on "Cold-Formed Steel Stud-Plank℠ System for Mid-Rise Construction." Former LGSEA President Dr. Reynaud Serrette of Santa Clara University will present a paper on "Estimating Drift in Cold-Formed Steel Frame Structures." LGSEA Council Secretary Don Allen will present a paper on "Mid-Rise Construction Detailing issues with Cold-Formed Steel and Compatible Construction Materials." Additional information on the conference is available at http://content.asce.org/conferences/structures2006/.

Dr. Tom Sputo Appointed as new Chairman of ASCE SEI Cold-Formed Steel Committee

Dr. Tom Sputo, Ph.D., P.E. has been named the Chairman of the American Society of Civil Engineers - Structural Engineering Institute (ASCE SEI) Cold-Formed Steel Committee. The retiring chairman of this committee is Dr. Benjamin Schafer, who currently sits on the Board of Directors of the LGSEA Council. Sputo has extensive experience in the design of cold-formed steel framing, and has been a member of the AISI Committee on Specifications (COS) for many years. The ASCE SEI CFS committee meets semi-annually in conjunction with AISI COS meetings; under Sputo, additional meetings are projected for industry events such as the CCFSS Specialty Conference, to get more involvement and interaction with a broader range of the framing community. The Committee is largely responsible for the current presentations at the ASCE SEI conference, the Bracing Design Guide, and the current issue of the ASCE Journal of Structural Engineering, focusing on cold-formed steel framing.

Software issue coming in September: Submittals being accepted in May

The September/October issue of the LGSEA Newsletter will contain our biannual listing of software for cold-formed steel framing structural design. Next month the newly updated LGSEA Council website will include a form for software developers, vendors, and users to include information on their favorite software for cold-formed steel design. Previously, issues of the newsletter from 2002 and 2004 contained this information. With the 2006 issue, the information will be compiled into a technical note for ease of use and reference by members. Note that information presented in the software survey is merely based on information supplied by software manufacturers and users; LGSEA does not endorse the use of any design software or products. For additional information, see the LGSEA Council website in May, or contact us at info@lgsea.com.

TECHNICAL EXCHANGE

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.

Shallow Joist or Ceiling Rafter Support against a Vertical Surface

Most floor framing is platform framing: the joist bears directly over a wall, ledger, or other surface. However, in some instances, the bearing is difficult, or heavy loads from above require the use of web stiffeners. In many cases, it is easier to frame the floor or ceiling members into the side of the wall or other support. This is commonly referred to as "balloon framing." The question arises, "What is the capacity of the joist in the track when this is the configuration?" A series of tests were performed at Cornell University in the early 90s, which led to a simplified equation based on the thickness of the track and track leg length. However, the scope of the testing was limited, and the designer had little information permitting extrapolation to joist sizes. Section C4.2 of the "Standard for Cold-Formed Steel Framing – Wall Stud Design" (AISI © 2004) is based on later research at the University of Waterloo (Fox and Schuster, 2000) and the University of Missouri-Rolla (Bolte, 2003). This section gives two equations: C4.2-1 and C4.2-2, for calculating the nominal strength of the stud- or joist-to-track connection. C4.2-1 can be used under the following conditions:

- Studs (joists) do not carry superimposed axial load.
- Both flanges are connected to track flanges.
- Track thickness is greater than or equal to the stud (joist) thickness.

Equation C4.2-1:

$$P_{nst} = Ct^2F_y\left(1 - C_R\sqrt{\frac{R}{t}}\right)\left(1 + C_N\sqrt{\frac{N}{t}}\right)\left(1 - C_h\sqrt{\frac{h}{t}}\right)$$

(Eq. C4.2-1)

> ### *Technical Exchange Correction*
>
> In the July, 2005 edition of the LGSEA Council Newsletter, the Technical Exchange article gave an example of shearwall design using the Standard for Cold-Formed Steel Framing – Lateral Design. In section D of this example, the statement was made:
>
> MAX. SYSTEM CAN DELIVER = LRFD OT / phi = 7873 / 0.60 = 13,122 lbs
>
> Rather than the shear wall maximum LRFD overturning capacity divided by phi, the example took the LRFD design overturning force divided by phi. Therefore, the last line of part D should read:
>
> MAX. SYSTEM CAN DELIVER = MAX LRFD OT CAPACITY / phi =
>
> (1200 plf x 16ft wide x 9ft tall / 15.6ft) / 0.60 = 18,462 lbs
>
> Please make this correction in your Newsletter library.

Where:

P_{nst} = nominal crippling strength
C = web crippling coefficient = 3.7
F_y = yield point of stud material (ksi)
C_R = inside bend radius coefficient = 0.19
R = stud inside bend radius
t = stud design thickness
C_N = bearing length coefficient = 0.74
N = stud bearing length (track flange length minus gap between
stud web and track web)
C_h = web slenderness coefficient = 0.019
h = depth of flat portion of stud web measured along plane of web
W = 1.70
f = 0.90

If track thickness is less than the stud thickness, the capacity of the assembly is the lesser of the two equations, C4.2-1 and C4.2-2.

Equation C4.2-2:

$$P_{nst} = 0.6\, t_t\, \Omega_{st}\, \Phi_{ut} \qquad \textit{(Eq. C4.2-2)}$$

Where:

P_{nst} = nominal strength for the stud-to-track connection when subjected
t_t = design track thickness
Ω_{st} = $20\, t_t + 0.56\alpha$
α = coefficient for conversion of units
= 1.0 when t_t is in inches
= 25.4 when t_t is in mm
Φ_{ut} = tensile strength of the track
to transverse loads
Ω = 1.70
Φ = 0.90

Both equations are valid within the following range of parameters:

Screw Size: No. 8 minimum

<u>Stud Section</u>

Design Thickness:	0.0346 inch to 0.0770 inch
Design Yield Strength:	33 ksi to 50 ksi
Nominal Depth:	3.50 inch to 6.0 inch

<u>Track Section</u>

Design Thickness:	0.0346 inch to 0.0770 inch

Continued on page 5

Shallow Joist or Ceiling Rafter Support against a Vertical Surface

Continued from page 4

Design Yield Strength:	33 ksi to 50 ksi
Nominal Depth:	3.50 inch to **6.0 inch**
Nominal Flange Width:	1.25 inch to 2.375 inch

Note that there is a 6” maximum member depth for the studs or joists when these equations are used. A designer should use caution if considering using these equations for deeper members, such as 8” or 10” joists.

Design example:

New offices are being added in a 12’ wide strip along the edge of an existing warehouse. The warehouse roof/ceiling is at 25-30 feet above finish floor (AFF). The new offices are to have a ceiling at 9’ AFF, but due to mechanical systems above that level, cannot easily be supported from the roof above. Also, the owner wants the ceiling designed so that future offices can be built above the first floor level. Design the floor system to be supported off of the existing CMU exterior wall, and supported at the other end by full-height 362S162-54 (50 ksi) studs at 16” on center. What floor/ceiling joists could you use?

LRFD Solution:

From load/span tables, you select a 600S250-54 at 16” on center, to span 12’-0”, with one row of bottom flange bracing at midspan.

End reaction calculation: 12’-0” x 1.33’ on center x (10 psf dead load x 1.2 + 50 psf future live load x 1.6) x _ = 736 pounds factored load.

Calculate resistance of assembly, using same thickness of track as floor joists:

Floor joists: 600S250-54, 16” on center
Rim track: using same thickness as joists, use 600T125-54

Because track and joists are same thickness, use equation C4.2-1:

$$P_{nst} = Ct^2F_y\left(1 - C_R\sqrt{\frac{R}{t}}\right)\left(1 + C_N\sqrt{\frac{N}{t}}\right)\left(1 - C_h\sqrt{\frac{h}{t}}\right)$$

C = web crippling coefficient = 3.7
C_R = inside bend radius coefficient = 0.19
C_N = bearing length coefficient = 0.74
C_h = web slenderness coefficient = 0.019
R = stud inside bend radius
N = stud bearing length (use 1.0” for 1-_” track leg length)
h = depth of flat portion of stud web measured along plane of web
t = stud design thickness
Ω = 1.70
Φ = 0.90

Note that the R and t values may be found on page 5 of the Steel Stud Manufacturers Association (SSMA) Product Technical Information Catalog, for a specific mil thickness. First, calculate h, based on R = 0.0849” and t = 0.0566”:

h = 6” web nominal depth – 2 (0.0849” + 0.0566”) = 5.717”

Plugging all values into C4.2-1,
P_{NST} = 1.41 kips, resulting in a design strength:
$\Phi P_{NST} = 0.9 \times P_{NST} = 1.27$ kips.

This is greater than the factored load of 736 pounds (0.736 kips); therefore the connection is adequate for the design load.

One other very important item to consider: what happens at the end of the track section? Shipping and field conditions restrict the length of track which can economically be provided on the jobsite. Therefore, track segments will most likely be in 10’-0” long lengths, meaning that a joist can possibly fall very close to the end or splice point of the track. The Wall Stud Standard covers this in section C4.2 (c), which states, “when both stud [or joist] flanges are connected to the track flanges and the track terminates at the opening [similar condition: stud bearing near the end of the track] the nominal capacity shall be taken as 0.5 P_{NST} using Ω and Φ, as determined above.”

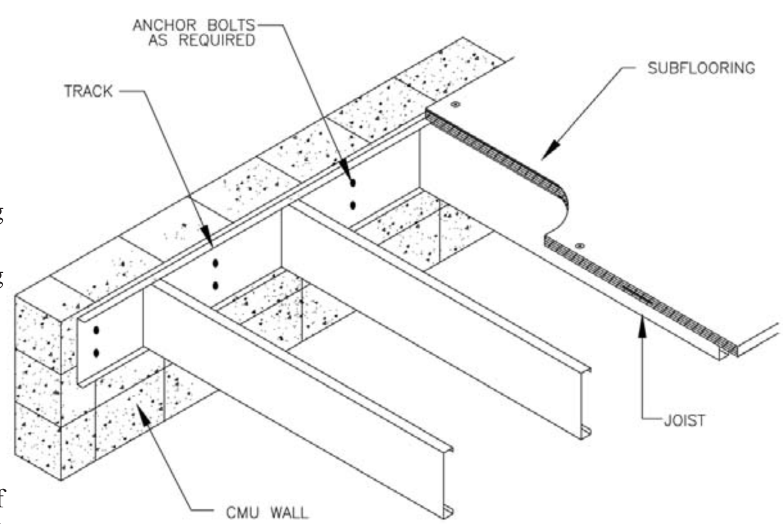
With this statement, one would need to check the situation at the end of the track, where the design strength would be:
$0.5\ \Omega\ P_{NST} = 0.5 \times 0.9 \times 1.41$ kips = 0.634 kips.

This is less than the required 0.736 kips; therefore some sort of stiffener or load transfer device would be required. A possible solution for the structural engineer would be to include a note on the detail requiring a clip angle (or other stiffener/support clip) at joists within a certain distance of track ends or splices.

Track Connection to Supports

Two different connections are required: at the CMU exterior wall, some type of concrete anchors must be used. For light loads, threaded anchors such as Tapcon® or Titen® may be used; for heavier loads, expansion anchors or chemical adhesive anchors may be used.

Continued on page 9



Bullet-Resistant Wall Assemblies Using Sure-Board7 Sheathing

Continued from page 1

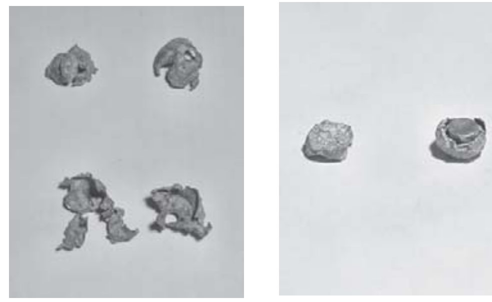
ping the bullet in a relatively short distance (i.e. the thickness of the panel). This appeared to be unnecessary since the entire thickness of the wall could be used to slow the bullet, absorb its energy, and blunt its impact on the interior Sure-Board7 panel.

In order to achieve this objective, several types of "ballistic panels" and "ballistic fills" composed of dry granular materials were tested. Preliminary informal testing has been completed with promising results. The best outcomes thus far were achieved using the granular ballistic fill approach. Three and one-half inch thick wall assemblies tested with ballistic fill have completely stopped penetration from all handgun and rifle calibers tested. Handgun calibers tested included 9mm Parabellum, 357 Remington Magnum and 44 Remington Magnum. Rifle calibers included 243 Winchester with 100 grain Nosler7 partition bullets (muzzle velocity = 3060 fps), 3006 Springfield with 150 grain full metal jacketed (FMJ) bullets (muzzle velocity = 2900 fps) and 7 mm Remington Magnum with 140 grain ballistic tip bullets (muzzle velocity = 3370 fps). All shots were fired from a distance of 10 to 15 feet. All the rifle ammunition tested has much greater velocities and penetrating power than the 7.62x39mm (AK47).

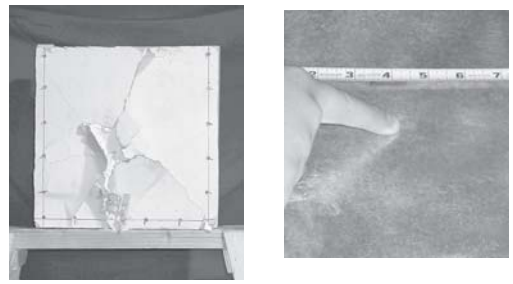
The handgun bullets that were recovered from the granular fill test samples were heavily deformed and flattened. None of the handguns managed to dent the Sure-Board7 on the interior face. No damage to the drywall was observed.

The high velocity rifle bullets were utterly destroyed. The 243 and 7mm bullets were fragmented into small pieces. The cooper jackets of the 3006 FMJ bullets were turned literally inside out. The lead core fragmented and completely separated from the metal jacket.

None of the bullets succeeded in penetrating the wall. The drywall on the inside face was broken by the force of the rifle bullet impact, but no penetration occurred. The 22 gage metal was bulged out slightly and exhibited only minor denting from bullet impact.



Left: *Recovered 30 caliber FMJ bullets.* ***Right:*** *Recovered 357 Magnum bullets.*



Left: *Damaged drywall, but no bullet penetration.* ***Right:*** *Metal was only slightly dented on interior.*

The researchers were very surprised by these results. The bullets fired from the 243 and the 7mm Magnum are designed for controlled expansion on impact. We found that these types of bullets tended to be easier to stop because, once deformed, they presented a larger frontal area for the ballistic fill to act upon. The 3006 full metal jacket bullets, however, are designed not to expand thereby providing maximum penetration. According to Carl Elliot, "We fully expected the 3006 FMJ to penetrate the 3_" wall. It did not. To date, we have yet to find any projectile that is capable of penetrating this wall assembly, but we will keep trying." If the inner board is breached, the researchers feel that they can easily enhance the assembly's ballistic resistance by thickening the wall and/or using heavier sheet steel in the manufacture of the interior Sure-Board7 panel.

After completing preliminary testing, data will be used to construct test samples for formal evaluation at a certified laboratory per UL 752 Ballistic Standards. Based upon preliminary testing, the researchers feel confident that level 8 ballistic performance can be achieved with no difficulty.

The wall assemblies using the prototype configuration could be easily constructed (either on site or prefabricated), would be relatively inexpensive, and show a great deal of promise for use in military or other facilities where reliable resistance to bullet penetration is desirable. Inquiries in the marketplace, as well as calls to the LGSEA Council and SSMA technical office, have shown a marked increase in the interest in blast and ballistic resistance in structures.

The next round of ballistic testing will include various thickness configurations with a 50 caliber heavy machine gun round fired at close range, as well as a flexible ballistic mat. With increasing demand in the marketplace for ballistic-resistant walls and structures framed with non-combustible steel framing, several products are expected to be available to structural engineers and specifiers, including "Ballistic Sure-Board7" panels specially configured for both interior and exterior use. Wall assemblies constructed with this material will provide superior resistance to shear from lateral wind and seismic loads along with highly bullet resistant performance. As these products are developed, design shear values will be available from the manufacturer, and as always, all manufacturers instructions and code provisions must be followed when detailing the product's anchorage to steel framing and addition of the granular fill. Specific inquiries about the current testing may be addressed to **Support@Sureboard.com**

Technical Review at LGSEA Council

Continued from page 2

sitive about author's making casual comments that attempt to dissuade structural engineers from viable non cold-formed steel solutions, particularly when those comments do not pass technical muster. It is my goal that the technical content always be rigorous, and that when design needs are beyond the known state-of-the-art that writer's communicate this fact clearly. If we are truly vigilant in keeping bias out of LGSEA materials, the worth of LGSEA membership to the structural engineering community will be greatly increased.

How is the peer review conducted? No peer review process is perfect, but we aim to provide a thorough and open review. The basic method being employed by LGSEA is similar to that used by ASCE for their technical journals, such as the Journal of Structural Engineering. Each Technical Note, article, etc., is individually examined by the members of the committee and a critique is written. The Chair also provides a critique and synthesizes the individual reviews. The Technical Review Committee then examines the group critique and provides input on what the final action should be: (a) accept as final draft, (b) accept, but modifications are recommended, (c) re-review by Chair required before acceptance, (d) full re-review of the committee required before acceptance, or (e) outright rejection (the material is found to be inappropriate for LGSEA). This critique and the decision are provided to the author.

What about technical review of items other than the Technical Notes? For instance, what about this newsletter? LGSEA members should know that in general the newsletter is not peer reviewed through the Technical Review Committee. Individual articles, or design examples may go through the committee at the discretion of the Newsletter Editor. It is intended that the newsletter provide timely practical information to LGSEA members, as such, a Technical Review cycle would, in general, slow the process down too much. So, a clear distinction is made between the Newsletter and the Notes.

What about LGSEA seminars, presentations, and other materials? The long term goal of the LGSEA is that all products exclusively bearing the LGSEA logo, and thus no personal author designation, will have a formal peer review for technical content. At this stage, it is fair to say that neither the LGSEA Board, nor the Technical Review Committee have a clear solution of how to make this goal an immediate reality. It is our goal to make a distinction between an LGSEA presentation, and a presentation that may be provided by an LGSEA member or staff. For now, the Technical Review Committee is focused on providing a review of all new Technical Notes and all existing Notes which are currently in the process of being revised and re-issued.

How do I write a Technical Note? Any LGSEA member interested in writing a Technical Note on a topic of their expertise should contact LGSEA Council Secretary Don Allen (dallen@steelframing.org.) Once the Note is developed we will take a look at it, you can count on that.

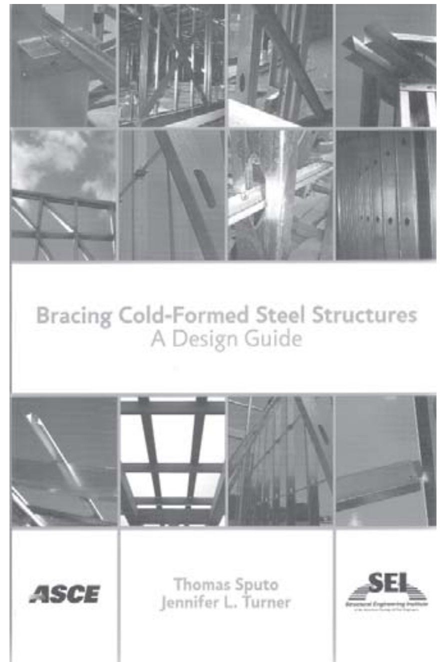
How do I make the process better, or report errors or bias in LGSEA materials? If you have an opinion about how we should be performing the technical review process, or any other opinions related to this article or other LGSEA materials please feel free to share them with committee chair Ben Schafer: schafer@jhu.edu.

Cold-Formed Steel Bracing Design Guide published by ASCE

The American Society of Civil Engineers (ASCE) recently published "Bracing Cold-Formed Steel Structures – A Design Guide" edited by Tom Sputo and Jennifer Turner. Tom Sputo, Ph.D., P. E., is a Senior Lecturer of Structural Engineering at the Department of Civil and Coastal Engineering, University of Florida. Jennifer L. Turner is a recent graduate and Research Assistant at the University of Florida. The Design Guide documents the current practices related to bracing cold-formed steel structure elements and systems. Content ranges from recent research, including some performed by Sputo and Turner, to a historic paper by George Winter from 1958. Heavy on applications and examples, this book contains design examples illustrating bracing design for various types of cold-formed steel structures, as well as an extensive list of primary reference sources. This report is presented as a design guide and will assist the practicing engineer in designing cold-formed steel structures with greater levels of reliability, safety, and economy. Individual chapters were written by experts in the industry, and edited by members of the ASCE Structural Engineering Institute's Committee on Cold-Formed Steel. Over 45 pages of the Guide are devoted to design examples. Topics Include:

- Introduction to Bracing Design
- Cold-Formed Framing, including sheathing-braced design, wall systems, and floor systems
- Cold-formed steel truss system and component bracing
- Shearwalls and roof diaphragms
- Cold-Formed Steel in Metal Building Systems
- Miscellaneous Cold-Formed Steel Elements and Systems

The 144-page softcover Design Guide is available from ASCE ($44.25 members; $59 non-members) or from the LGSEA/SFA store at http://store.steelframingalliancestore.com/brcoststdegu.html ($42.00 members; $59 non-members).



Shallow Joist or Ceiling Rafter Support against a Vertical Surface

Continued from page 5

The connection to the CMU is beyond the scope of this article, but the bolt bearing equations in section E3.3.1 of the "North American Specification for the Design of Cold-Formed Steel Structural Members" (NASPEC) can be checked for the bearing on the track.

For the connection to the stud wall, consider using #10 self-drilling screws. Section E4 of the NASPEC may be used. Attaching 54 mil track to 54 mil wall studs, equations E4.3.1-1 through E4.3.1-3 must be checked. Since the two sheets are the same thickness and yield strength, the last two equations are the same. Therefore, the strength is the lesser of the following:

$P_{ns} = 4.2\,(t^3 d)\text{-}\,F_u$; or (*Eq.* E4.3.1-1)
$P_{ns} = 2.7\,t\,d\,F_u$ (*Eq.* E4.3.1-2 & *Eq.* E4.3.1-3)

Where:
P_{ns} = nominal shear strength of screw connection
d = nominal screw diameter (= 0.19" for #10 screw)
t = stud design thickness (= 0.0566" for 54 mil)
F_u = tensile strength of sheet steel (= 65 ksi for 50 ksi material)

P_{ns} is also limited by section E4.3.3, which limits the value to no more than 80% of the nominal shear strength of the screw as reported by the manufacturer or determined by independent laboratory testing.

Based on the two equations above, P_{ns} = the lesser of 1.602 kips or 1.887 kips. With $\Phi = 0.5$, the design strength = $\Phi\,P_{ns}$ = 0.801 kips.

Since the joist may not be fully seated in the track, there is a slight offset of the load, causing some degree of pullout on the screw. However, if (2) screws are used at each stud, one near the top of the track and one near the bottom, the strength of the connection should be adequate to resist the 0.736 kips required. Note that the maximum allowable stud-to-track gap is 1/4" (section D1 of the wall stud standard.)

Note that since the track is being supported against a CMU wall or screwed to one flange of a series of wall studs, analysis of the track itself may need to be considered in the area between the load from the joist and the support from the studs or CMU. Since multiple fasteners will be used at each stud, web crippling at that support location will not likely be a failure mode. The wall studs themselves, however, will experience eccentric loading and should be checked for axial loading at one flange.

In high-seismic areas, the designer should consider the lateral loads being imposed on this connection. In some cases, this could lead to a sizeable pullout load on the anchors into the CMU and the screws into the wall stud. Tension ties or strap braces may need to be tied from the floor diaphragm into the framing supports to resist these loads if the screw connections are not adequate. Additional screws may be added as well.

The American Iron and Steel Institute (AISI) is considering expanding this design equation so that deeper joist members can be considered. For now, this offers another option in the designer's toolkit for support of cold-formed steel rafters, joists, and other horizontal members without web stiffeners at supports.

April 2006 issue of the ASCE Journal of Structural Engineering features Cold-Formed Steel Structures

Cold-Formed Steel Structures: Special Issue
By Benjamin W. Schafer, Guest Editor

"Cold-formed steel structures" is the theme of the April, 2006 (volume 132, issue 4) special issue of the Journal of Structural Engineering, published monthly by the American Society of Civil Engineers (ASCE.) The majority of the papers appearing are from the Seventeenth International Specialty Conference on Cold-Formed Steel Structures, which was held in Orlando, Florida in October of 2004. This biannual conference, which is an important forum for research and practice exchange in the field, is ably organized by Professor Roger LaBoube of the Center for Cold-Formed Steel Structures at the University of Missouri-Rolla. This issue provides expanded versions of the most highly regarded papers from this conference as selected by the members of the ASCE-SEI Committee on Cold-Formed Steel of the Technical Advisory Committee on Metals. The Committee on Cold-Formed Steel also performed nearly all of the paper reviews, committee members include R. LaBoube, J. Fisher, W. Kile, J. Larson, G. Polard, T. Sputo, W. Easterling, H. Salim, R. Serrette, D. Allen, B. Schafer, R. Lindenberg, T. Roecker, L. Xu, N. Rahman, E. Di Girolamo, and C. Rogers.

Summary of the Abstracts:

Cold-formed steel members and distortional buckling

Behavior and design of cold-formed steel members remains an active area of research. The thin-walled nature of cold-formed steel members requires designers and researchers to explore cross-section stability in great detail. The issue begins with 5 papers covering experimental and numerical examinations of cold-formed steel members; with a particular emphasis on the distortional buckling limit state. Distortional buckling, where the compression flange buckles as a group of plates instead of as individual plates, has only recently begun to work its way into governing design specifications around the world.

Little research and no design guidelines exist for distortional buckling of cold-formed stainless steel columns. In a set of companion papers "Distortional buckling of cold-formed stainless steel sections: experimental investigation" and "Distortional buckling of cold-formed stainless steel sections: finite element modeling and design" Lecce and Rasmussen provide detailed experiments and finite element models exploring distortional buckling. Their work shows that success depends on a detailed understanding of the mechanical properties of a stainless steel section. Extensive cold work in the corner regions coupled with a low proportional stress leads to experimental and numerical results which differ from conventional cold-formed steel sections. The test results coupled with further finite element studies demonstrate that current specifications are unconservative for austenitic stainless steels in distortional buckling limit states. The authors also propose a new set of Direct Strength Method expressions for design application to austenitic and ferritic stainless steels in distortional buckling.

In the work of Yu and Schafer "Distortional buckling tests on cold-formed steel beams" experiments on lipped channel and lipped zee sections commonly used in the United States are performed to explicitly demonstrate the loss of capacity that occurs in the distortional buckling limit state. Current North American specifications are shown to be inadequate when this limit state occurs. The work is a companion to an earlier paper by the authors focusing on similar sections in the local buckling limit state. Taken together the papers provide independent experimental verification for the newly proposed Direct Strength Method of cold-formed steel design.

Post-buckling behavior is a key aspect in the response of cold-formed steel members. Motivated from a series of experiments conducted by Yang and Hancock at the University of Sydney, Silvestre and Camotim employ an improved version of the Generalized Beam Theory in "Local-plate and distortional post-buckling behavior of cold-Formed steel lipped channel columns with intermediate stiffeners" to investigate post-buckling of cold-formed steel columns. The work demonstrates the importance of shear in the post-buckling regime (as opposed to membrane deformations) and explains the asymmetric post-buckling response in distortional buckling; i.e., why post-buckling strength differs whether or not the flange buckles inward or outward. Further, it is shown how and why the introduction of a small longitudinal stiffener in the web can have a marked change in the distortional post-buckling response of the member.

With proper care, nonlinear finite element analysis is shown to be a good predictor of tested behavior and strength for cold-formed steel members comprised of high-strength steel with a nominal yield stress of 550 MPa (80 ksi) in. "Numerical simulation of high strength steel box-shaped columns failing in the local and overall buckling modes" by Yang and Hancock. The paper builds upon an extensive set of tests previously conducted by the authors and provides specific guidance for using ABAQUS to accurately predict high strength cold-formed steel members.

Cold-formed steel walls, shear walls, and frames

The second group of 6 papers presented in this issue of the Journal covers cold-formed steel walls, shear walls, and frames. Conventional cold-formed steel wall systems consist of lipped channels (studs) with unlipped channels (track) capping the top and bottom. The studs generally rely on mid-height bridging to brace against weak-axis flexure. Green, Sputo and Urala in "Strength and stiffness of conventional bridging systems for cold-formed cee studs" provide, for the first time, experimental results on the stiffness and strength of bridging details used on studs in current practice. They conclude that that bridging used in conventional North American practice has adequate stiffness and strength to brace axially loaded and curtain wall steel studs.

Cold-formed steel shear walls have been the subject of considerable recent research, particularly with regard to seismic performance of these systems. Two companion papers from researchers at the University of Naples "Seismic behavior of sheathed cold-formed structures: physical tests" and "Seismic behavior of sheathed cold-formed structures: numerical study" by Corte, Fiorino and Landolfo provide an overview of cold-formed steel shear wall research and add their own testing and analysis results to the body of work. The testing and analysis are used to provide recommended R factors for this building system. The authors demonstrate that adequate ductility in cold-formed steel shear walls can be achieved experimentally, and ensured in design, if seismic capacity based design principles are correctly employed.

Success of cold-formed steel shear walls

Continued on page 11

April 2006 issue of the ASCE Journal of Structural Engineering

Continued from page 10

relies a great deal on adequate performance of the connections. Indeed, much of the observed nonlinearity from tests on shear walls derives from the connection behavior. In "Design criteria for seam and sheeting-to-framing connections of cold-formed steel shear panels" Fülöp and Dubina provide results from small-scale connection tests and demonstrate how these results may be combined with detailed finite element models to replicate full-scale shear wall testing. The work focuses primarily on shear walls employing corrugated steel panels, but also includes OSB sheathed walls.

In "Cold-formed steel frame shear walls utilizing structural adhesives" Serrette, Lam, Qi, Hernandez and Toback examine a wall system where OSB sheathing is attached to the steel studs by adhesive and pneumatically driven pins, instead of screws. Much of the initial static and cyclic research work conducted on conventionally attached, sheathed, cold-formed steel shear walls in the United States was completed by Serrette. Here, Serrette and his colleagues demonstrate that adhesives and pneumatic pins may provide a shear wall with reasonable strength and ductility, and are a particularly promising new solution for narrow shear walls.

Cold-formed steel framing for load bearing low-rise construction generally employs in-line framing and platform construction methods. Walls, floors, rafters, etc. are constructed out of commodity plain channel and lipped channel cross-sections. Lateral resistance of the walls comes from sheathing or adding steel straps to the walls, as discussed in the previous papers. However, other ideas also persist, including the use of specialized cold-formed steel cross-sections and fully connected frames. In "Experimental study of connections for cold-formed steel portal frames" Kwon, Chung and Kim present the details of a portal frame system utilizing high strength, 570 MPa (83 ksi) yield, specially fabricated box sections, with unique connections details, tested in Korea. The authors provide details of finite strip analysis, connection tests, and portal frame tests that demonstrate the behavior of this system.

Cold-formed steel trusses and truss chord members

The third group of 3 papers presented in this issue of the Journal covers research on cold-formed steel trusses. Cold-formed steel trusses may be constructed from conventional plain channel and lipped channel sections, or may use proprietary shapes designed specially for providing strength against local buckling and convenient locations for connections as diagonals frame into chords.

Heel plate configurations for conventional cold-formed steel roof trusses are studied in de-

tail by Dawe and Wood in "Investigation into the behavior of heel connections for used in cold-formed steel trusses." Through a combination of small-scale experiments and finite element analysis the authors demonstrate the sensitivity of the truss strength to detail changes made in the heel connection. The same two authors also examined "Cold-formed steel roof trusses subjected to concentrated panel point loading." In this second paper full-scale testing of conventional cold-formed steel trusses was employed to examine the ramification of different limit states, including those from concentrated loads. The 2001 Canadian code, essentially the same as the current North American Specification for the Design of Cold-Formed Steel Structural Members, is found to be conservative in its strength prediction of the locally loaded truss.

The final paper in this group on trusses examines a variation of the hat shaped chords that are often used in proprietary truss configurations. This paper could have easily been grouped with the first set of papers on member behavior and distortional buckling, as Nuttayasakul and Easterling in "Behavior of complex hat shapes used as truss chord members" focus primarily on distortional buckling of these special truss members. The authors provide design guidance verified by testing and modeling for distortional buckling of these unique shapes.

Technical notes on cold-formed steel research

The special issue concludes with two Technical Notes. The first by Pham, Mills and Zhuge, from Australia, provides testing related to "Experimental Capacity Assessment of Cold-Formed Boxed Stud and C Stud Wall Systems used in Australian Residential Construction". The final note by Chodraui, Neto, Gonçalves and Malite, from Brazil, examines "Distortional buckling of cold-formed steel members" and provides an examination of a simplified design method employed in the Brazilian code for distortional buckling.

To obtain a copy of the journal, or to download articles from the journal website (for a fee,) go to http://scitation.aip.org/sto/.

ASCE
American Society of Civil Engineers

Board Publications Committee
Carl L. Blum, P.E., F.ASCE, *Chair*
Kenneth L. Carper, Ph.D., M.ASCE
Gregory E. DiLoreto, P.E., L.S., F.ASCE
William M. Hayden Jr., Ph.D., P.E., F.ASCE
Robert H. Wortman, Ph.D., M.ASCE
Bruce Gossett, Aff.M.ASCE, *ASCE Staff Contact*

Publications
Bruce Gossett, *Managing Director and Publisher*

Journals Department
Johanna M. Reinhart, *Director, Journals*
Jackie Perry, *Managing Editor, Journals*
Holly Koppel, *Discussions and Closures*

Production Department
Charlotte McNaughton, *Director, Production*
Teresa Metcalfe, *Manager, Journals Production*
Gene Sullivan, *Senior Production Editor*
Nancy Green, *Production Editor*
Noel Pratt, *Production Editor*
Xi Van Fleet, *Manager, Information Services*
Donna Dickert, *Reprints*

Publishing Office
Journals Department
ASCE
1801 Alexander Bell Drive
Reston, VA 20191-4400
Telephone: (703) 295-6290
E-mail: journal-services@asce.org

Journal of **Structural Engineering**

VOLUME 132 / NUMBER 4 **APRIL 2006**

SPECIAL ISSUE: Cold-Formed Steel Members and Structures
SPECIAL ISSUE EDITOR: Ben W. Schafer

Editorial

Priority Survey Results to Guide Alliance's Technology Development Activities

One of the primary objectives of the SFA/LGSEA Technology Development Committee (TDC) is to keep the members on the leading edge of technology improvements. To do so, input is needed well beyond the thirteen volunteers who fill out the roster of the committee.

During the past year the TDC has been busy canvassing the industry to identify barriers to the use of steel framing and opportunities to improve its competitiveness. The work culminated with a survey of the membership in November to identify priority areas for technology development research projects.

"Training of framers, inspectors, and trade contractors continues to be an important issue for the members," according to Mark Nowak, chair of the TDC. SFA will continue to focus on training as an important service to the industry.

On the technology front, respondents to the survey rated inequities between wood and steel framing as the top priority. SFA president Larry Williams noted that "these inequities are a recurring theme in discussions with designers and builders and must be addressed from a research and building codes and standards perspective if we are to create a level playing field for all materials."

Other "top 5" priorities for the TDC that were identified in the survey include the need for more complete information on the use of strap bracing for walls, sheet steel as an alternative to wood-based sheathing products, clip angles for common loading conditions, and pin fasteners in a broader range of steel-to-steel and sheathing-to-steel connections.

"We thank the 130 members who participated in this priority survey. The direction provided will allow the TDC to focus its efforts to develop more complete descriptions and funding plans for the highest priority projects," according to Jay Larson, secretary for the TDC.

For more information on the survey results and the TDC activities, contact Jay Larson at jlarson@steel.org.

AISI Committee on Framing Standards Update

I would like to express my appreciation to the LGSEA for the opportunity to provide regular communication to its membership on behalf of the American Iron and Steel Institute Committee on Framing Standards (AISI COFS). As Chairman of the AISI COFS I will be providing periodic updates on our activities. In this inaugural article I will outline the role of the COFS and how we interact with the LGSEA Council.

Since the 1940s the Market Develop Committee of the American Iron and Steel Institute has actively supported technical research and specification development as part of their ongoing effort to grow the market for sheet steel in construction. In the mid 1990s the lack standards recognized by the model building codes was identified as a major barrier to the growth of cold-formed steel in construction. This was fueled in part by the growing interest in steel in residential construction. The AISI Committee on Framing Standards was therefore formed in late 1997 to address the growing need for standards. The AISI COFS was created to develop ANSI-approved standards for adoption by the model building codes. The first project was the adoption of the Prescriptive Method that had been jointly developed with the NAHB Research Center. The Prescriptive Method was adopted by the IRC in 2000 and was a major achievement for the cold-formed steel industry.

COFS Operations

Today the Committee has published 6 standards and has 30 members. The membership is balanced between general interest, users, fabricators, and producers. COFS operating procedures prohibit any individual group from constituting a majority. The LGSEA Council is well represented on the COFS Committee.

Once a standard is approved by the Committee it is made available for public review. As members of LGSEA Council you will receive notice that the standard is available for your comment. Your input is essential to making sure the standard fully meets the needs of the design community. After the Committee reviews and addresses all public review comments the standard is ready to be published.

The LGSEA Council is a major partner in the transfer of technology from the COFS to the engineering community. Once a standard is published it will immediately be made available to LGSEA members through the newsletter and the website. Technology transfer is a two-way street, from the COFS to the LGSEA and also from the LGSEA to the COFS. As you use these standards in your day-to-day businesses you are encouraged to forward your comments to LGSEA or AISI. The committees within the LGSEA Council are an excellent means of getting feedback regarding the standards. LGSEA Council members can also send comments directly to Jay Larson, Director, Construction Standards Development at jlarson@steel.org. For a list of available standards visit www.steelframing.org.

In conclusion I would like to welcome the LGSEA Council to the Steel Framing Alliance and I look forward to continuing to work closely with the LGSEA Council and its members.

Richard B. Haws, PE
Chairman, AISI Committee on Framing Standards

Light Gauge Steel Engineers Association

LGSEA

1201 15th Street, NW, Suite 320
Washington, D.C. 20005-2842
www.LGSEA.com (866) 465-4732

A Council of the Steel Framing Alliance

Presort
First Class
US Postage
PAID
Nashville, TN
Permit No. 2010

If you or your organization have technical or newsworthy items you feel would be of interest to LGSEA Council members, consider submitting articles for publication in the LGSEA newsletter. All submissions are subject to review and editing. Contact Ray Grage, P. E., Newsletter Editor at rgrage@elixirsteelframing.com, or Don Allen, Newsletter Staff, at dallen@steelframing.org.