A FEW WORDS ABOUT STEEL

STEEL POISED FOR HURRICANE RECONSTRUCTION

BY ALAN MACQUOID

At the forefront of news these last few months is the devastation wrought by hurricanes Katrina and Rita. Consequently, first on the minds of the members of the construction industry is the tremendous task and opportunity to rebuild in their wake.

Naturally, in the cold-formed steel industry, we believe our product stands as the framing material of choice to rebuild in these areas. Several key factors work in favor of steel framing:

- The Formosan termite has already begun motivating builders and homeowners to consider steel as an alternative to wood framing.
- Mold and dry rot will have an adverse affect on wood framing, and consumers readily perceive the advantages of a framing material that will neither host nor be consumed by these fungi.
- The supply of trees used for milling into wood studs has been damaged and will drive up the cost of framing lumber.
- Local energy codes and the climate make thermal conductivity much less of an issue than in other areas of the country.

Our opportunity is to ensure that when these structures are rebuilt, they use a stronger, more durable material—steel framing.

From a business perspective, rebuilding the Gulf Coast is appealing. The Red Cross estimates Katrina and Rita destroyed 356,000 housing units—a total 15 times greater than Hurricane Andrew in 1992. If 50 percent of these new houses were built with steel framing, it would create new demand for an additional 1,608,638 tons of sheet steel. Using the current prices, this represents a potential value of $1,222,564,000 in sheet steel.

An effective, properly resourced response by the steel industry would also profoundly advance the steel framing cause in other significant ways. We will need to train thousands of construction professionals how to design, specify and build with steel. There are too few builders in Louisiana and Mississippi to meet the demand created by Katrina, and it is anticipated that thousands of framers and other construction professionals will be drawn from other states to this area. Once the majority of replacement houses have been built, many of these workers will return to their home markets—exporting these steel framing skills to other states and cities where this experience is needed to encourage the growth of steel framing.

Likewise, our major participation in the rebuilding effort will generate improvements to tools, construction methods, and resources that will lower...
steel framing costs and increase our competitive position in other markets.

To that end, the Steel Framing Alliance has organized a Katrina Response and Rebuilding Team that will develop a plan of action. This new team had its first meeting at METALCON in early October to solidify industry’s approach to participating in relief and rebuilding. The work we’re doing as a team in these preliminary stages will probably lay the groundwork for what we’re doing in a year.

Among the plans laid out were:

- A database that would enable builders and engineers to find local sources for tools, material and services.
- Use of a newly hired technical field representative.
- Availability of technical support.
- Availability of pre-engineered home plan.

The process of rebuilding the Gulf Coast may take up to 10 years. But if we are going to act on this opportunity to participate in the rebuilding effort, the time to make an appropriate commitment and announce that commitment is now.

Alan MacQuoid is a consultant to the steel industry and chair of the Katrina Response and Rebuilding Team.

The COSP has gone through many revisions in its creation, along with reviews by the Association of Wall and Ceiling Industries, American Institute of Architects, SFA, Steel Stud Manufacturers Association, Steel Truss & Component Association and Light Gauge Steel Engineers Association. In fact, SFA and SSMA have given it an official endorsement, while AWCI is expected to also offer its official endorsement.

The purpose of this document is to help define the roles of the owner’s representative, architect of record, engineer of record, specialty engineer, manufacturer, framing contractor and truss/wall panel supplier in the design and construction of cold-formed steel framed structural systems. It is loosely based on similar documents by AISC and SJI, as well as WTCA and TPI. Among the many topics covered in the Code of Standard Practice are contract documents, dealing with discrepancies, approval of erection and installation drawings, material characteristics, erection and installation, quality control and contractual relations.

A formal presentation of this new document was made at METALCON, in Rosemont, Ill., in October. The presenters introduced the many facets of the Code of Standard Practice, as well as use some typical examples from their experience in cold-formed steel framing to illustrate its potential uses.

Finally, our industry has a document to help answer the age-old question of, “Who is responsible for what?” in cold-formed steel framing. As this is only the first publishing, expect to see future versions build upon this one, to further strengthen our industry and protect all parties involved in cold-formed steel framing.

Jeffrey M. Klaiman is senior associate at ADTEK Engineers Inc.
COLD-FORMED STEEL IS CONTINUING TO GAIN ACCEPTANCE IN THE RESIDENTIAL CONSTRUCTION SECTOR. THIS IS DUE IN LARGE PART TO THE DEVELOPMENT OF SPECIFICATIONS AND GUIDELINES THAT AID IN THE DESIGN PROCESS.

One such publication, the American Iron and Steel Institute Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two Family Dwellings, is particularly attractive for residential projects, since it allows typical one- and two-story buildings to be designed without the aid of a design professional.

One significant shortcoming in the current Prescriptive Method is that the design of gable end wall studs is not addressed. Under the direction of the AISI Committee on Framing Standards and sponsored by the Steel Framing Alliance, a study was conducted to develop the design methodology and all tables and details necessary to incorporate gable end wall framing into future editions of the Prescriptive Method. This study was restricted to the same limits of applicability as the current edition of the Prescriptive Method.

Three primary gable end construction methods were explored: balloon gable wall framing, gable end framing with roof trusses, and cathedral ceiling framing. Additional design considerations including bottom track attachment to floors or foundations and requirements for openings in gable end walls were also addressed.

DESIGN METHODOLOGY AND LOADS

All design calculations for this study were performed using the Load and Resistance Factor Design method and the appropriate loads and load combinations as provided in ASCE 7-98. Dead load, live load, snow load and wind load from the Prescriptive Method were used to develop the tables for the study. All appropriate limit states for strength and serviceability (deflection) were used to determine the minimum requirements for the design tables.

Balloon gable wall framing

Construction of full height balloon-framed stud walls is an efficient and economical method for framing gable end walls of residential structures. A typical elevation of this construction technique is shown in Figure 1. These stud walls resist both out-of-plane wind forces and axial roof loads. The two construction options considered for balloon gable wall framing were an unbraced full-height wall and the wall braced by a horizontal ceiling diaphragm.

Unbraced full-height walls

For many low-slope roofs and narrow buildings, it is possible to construct the gable end as a full-height balloon-framed wall without intermediate out-of-plane support. The appropriate full height stud thickness for a given wall height, h (ft.), and wind speed can be selected from design tables as illustrated by Table 1. These tables consider the following design checks: combined axial load and bending, pure strong axis bending, member deflection, and web crippling.

The second option for balloon gable end framing design is to construct a structural horizontal ceiling diaphragm to help resist the out-of-plane loads acting on the wall and reduce the effective stud height. A diaphragm construction consisting of 3/8-inch (minimum thickness) wood structural panels conforming to DOC PS-1 or PS-2 attached to the bottom of the ceiling joists using No. 8 screws at 6-inch spacing at panel edges and 12-inch spacing in the field was evaluated. This system has an excellent out-of-plane capacity based on Table D2-1 of the AISI Standard for Cold-Formed Steel Framing – Lateral Design.

However, construction of a sheathed...
ceiling is cumbersome. Consequently, a gypsum board ceiling diaphragm was also developed. This diaphragm consists of 1/2-inch gypsum wall board secured to the bottom of the ceiling joists with No. 8 screws at 6-inch spacing at panel edges, and 12-inch spacing in the field. While simple to construct, this diaphragm has limited structural capacity, and is therefore only an option for regions with low wind loads.

The required diaphragm lengths (Figure 2 and Tables 2 or 3) vary based on roof pitch, building width, and wind speed. A maximum aspect ratio of 3 to 1 for wood sheathed diaphragms and 2 to 1 for gypsum diaphragms is imposed to establish the given lengths. All calculations are based on unblocked diaphragm capacities. However, a multiplication factor is provided to determine the diaphragm length if blocking is provided at all panel edges.

Gable end framing with roof trusses

For residential projects utilizing roof trusses, the gable end may be framed in with a pre-manufactured gable end assembly as shown in Figure 3. In this design option, the triangular wall portion above the sidewall stud height is provided by the roof truss manufacturer. This assembly is essentially a structural wall with a stud wall framed in under it.

The studs supporting this pre-manufactured assembly are 8 feet, 9 feet or 10 feet tall and resist both out-of-plane wind forces and axial loads from the gable end wall assembly. The stud thickness may be selected from tables to satisfy design conditions. To resist out-of-plane wind forces, a horizontal restraint must be provided at the connection of the wall and the gable end wall assembly. The principle mechanism of providing this restraint is to utilize a horizontal structural diaphragm at ceiling level. Similar to balloon framing, this diaphragm may consist of either gypsum board or wood structural panels, and must be constructed over certain minimum lengths as specified in tables.

Gable infill stud wall is an alternative to using the pre-manufactured gable end assembly. Rather than using a triangular gable end assembly that is provided by the truss manufacturer, the wall can be built as a stud wall, selecting the thickness of studs from design tables. Like the pre-manufactured gable end wall assembly, this wall system must be braced horizontally at the ceiling line where the two walls are attached. The lower wall supporting the triangular shaped portion of the gable end wall will be selected from design tables.

- **Table 2**

<table>
<thead>
<tr>
<th>Exposure A/B</th>
<th>Building Height (ft)</th>
<th>Basic Wind Speed (mph)</th>
<th>Minimum Diaphragm Length (ft)</th>
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- **Table 3**

<table>
<thead>
<tr>
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<th>Basic Wind Speed (mph)</th>
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Full-height balloon gable framing similar to that previously discussed is another option for framing the gable end wall when using roof trusses. The wall studs are full height studs without bracing at the ceiling and studs for this option are selected from tables.

**Cathedral ceiling**

For buildings with cathedral, or “vaulted” ceilings, gable end framing consists of a full-height stud wall without any out-of-plane support, as shown in Figure 4. These studs are considered simply supported between the top and bottom tracks. The proper stud size and thickness for a given stud height, h, can be selected from design tables.

**OPENINGS IN GABLE END WALLS**

Many residential structures have openings for windows and doors in the gable end walls. Care must be given to ensure that members around openings are designed for the redistributed axial and wind forces. This involves design of both the king and jack studs on either side of the opening, and of the header tracks at the top (and bottom for windows) of the opening (Figure 5).

King and jack studs are used on both sides of wall openings to resist the loads transferred around the opening. The numbers of king and jack studs can be selected using the current provisions of the Prescriptive Method.

Due to the limited axial load on gable end walls, use of the bearing wall header tables in the current Prescriptive Method results in overly conservative designs. Consequently, 2-600S162-43 sections were determined to be adequate for openings less than 6 feet wide in gable end walls and for openings over 6 feet, 2-800S162-54 sections are required.

These sections may be arranged in either back-to-back or box configurations. Though the axial loads on gable end walls are minimal, the out-of-plane loads due to wind are quite significant. Consequently, the track is designed to resist a tributary width equal to h/2, where h is the height of the wall at the center of the opening. Design tables were developed which summarize the maximum allowable head track spans.

**BOTTOM-WALL TRACK CONNECTIONS**

Connection design and details for the bottom wall track were also developed. These connections and details are consistent with the current Prescriptive Method. The Prescriptive Method will provide the user options for the design of gable end walls that are not currently available, thus adding to the usefulness of this important document.

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SPECIFYING
PREFABRICATED ENGINEERED
TRUSS SYSTEMS

BY JOHN CRENNE

Prefabricated cold-formed steel truss systems are rapidly becoming the framing product of choice for steel-framed commercial and multi-family structures designed with pitched roofs. With a growing number of building designers specifying CFS trusses, many are asking on a regular basis what information is needed to properly specify trusses.

All trusses are basically triangulated frameworks that may be designed for use as spanning or bracing elements in buildings. The underlying engineering theory used in most truss designs is based on creating a series of triangular sections between the chords, or perimeter members of the truss, and the webs, or interior members of the truss. Due to the triangulated nature of the designs, the forces within the members of the truss are restricted to axial forces, acting in either tension or compression, when loads are applied only at the panel points. Proper truss design creates a framing element that provides high in-plane stability and strength, while reducing the total amount of material required to withstand the forces imposed on the truss and the structure.

Plusses of trusses

The use of trusses in building design can create both economic and architectural value. While typically the same types of building materials are employed in the fabrication of a truss as would be used in the stick framing process, the truss as structural element has a number of advantages over those individual pieces of dimensional materials. Trusses capable of clear spanning long distances will typically be fabricated from smaller dimensional members than the dimensional joist they replace. This gain in span capability and the smaller component members both reduce the in-place cost of the truss and eliminate the need for additional footings and carrying beams.

The combination of strength and design flexibility afforded by trusses allows the designer to create truss profiles to accommodate tray, vaulted or studio ceilings lines, mechanical duct work and service cat-walks, along with external roof lines incorporating many combinations of hip and valley sets. Multi-ply girder trusses can be designed to carry the loads of intersecting trusses and maintain the clear span capability of the roof or floor framing.

When trusses are specified as the roof framing members in a building, the truss designer requires some basic information about both the structure and the site location. These very important pieces of information are the project’s site location, building code(s) of jurisdiction, and the intended use of the structure. This information will assist in determining the specific code requirements and many of the environmental factors that must be accommodated in the design of the roof or floor system. The software used by the truss designer relies on this information, in combination with accepted design practices as set forth in the AISI guideline, “Specification for the Design of Cold-Formed Steel Structural Members,” to create the truss design.

This AISI document is the ANSI-approved standard that is referenced by modern building codes as the definitive source for the design of CFS framing members. The intended building use will determine the building occupancy, which in turn may create construction requirements or establish guidelines for specifications that must be met.

Case loads

Once all the information is received, the truss designer can determine the loading factors, or load cases, that will govern the design of the trusses. Properly determining the external forces that will act on the roof or floor system is essential, before any truss can be designed and engineered for structural capacity. The combination of the live and dead loads, as prescribed by the governing codes, create what is called the total load to be used in the truss design process. The term total load is somewhat of a misnomer in that certain specific concentrated loads, related to the placement of mechanical systems within the trusses, and environmental loads, such as wind, snow, snow drifting and seismic loads, may need to be included as additional load cases to be factored into the final design. Ultimately, the trusses must be designed to adequately accept and transfer all live, dead, concentrated and environmentally created forces to the bearings or diaphragm, where those forces are subsequently transferred down through walls and ultimately to foundation and ground.

While the live-, dead- and many environmental-load cases are prescribed by the code bodies, additional caution should be taken to specify the weight, location and method of attachment of any mechanical loads. To ensure the
proper design of the individual trusses in specific sections of the roof or floor system, the truss designer must be informed of any external factors that may create an unusual load on a truss or group of trusses. In some cases, the exposure of the building to environmental loads, the building’s overall height, the building’s proximity to other buildings, and the relative height of nearby structures can all have additional bearing on the determination of environmental load cases.

A checklist

Once the loading parameters have been established, the designer needs several additional pieces of information to create the desired architectural look of the roof and to engineer the individual trusses. The information needed to create the actual profile of each truss includes the dimensions of the building, the slope or slopes of the top chords, desired on-center truss spacing, width and exact location of the bearing points, bottom chord pitch breaks, sprinkler systems, mechanical ducts, concentrated loads, overhang, cantilevers, and desired chase locations. With this information in hand, the truss designer can begin the process of creating the geometry of the roof and designing individual trusses.

In the specification of any pre-engineered building components like trusses, it is important to remember that the components provide an optimally designed framing member that has been created for that one specified application. The final design and prefabricated members are engineered from the specifications provided and those specifications must be as complete and accurate as possible.

Johan Cronje is national architectural and engineering representative for Alpine/TrusSteel.

MHD
STEEL TO CONQUER LEAKS HOMES IN NEW ZEALAND

BY GORDON BARRATT

New Zealand is a country of magnificent scenery and diverse cultures. It is an island where sheep outnumber the people more than 10 to 1. And it is a place that represents a significant potential for steel framing.

Here in New Zealand, our building industry is small in international terms. During a 12-month period ending in March 2005, 30,255 house and 6,202 apartment consents (permits) were issued. Construction on new structures is usually timber-frame based, but may also include concrete, concrete panels, hay bails and yes, steel framing. Most homes are individually designed so the market is geared for one-off production rather than multi-unit housing.

The cause has also been put down to poor workmanship and detailing. Leaks from claddings, flashings and decks have caused rotting and algae growth, resulting health problems for the inhabitants.

The good news for our industry is that no steel frame homes have been found to be part of the leaky-home crisis!

Industry changes

Major changes in industry legislation and building practices have now been implemented:

- New timber-treatment standards, including untreated lumbers’ being barred from construction, and different treatment grades’ being required for different parts of the building.
- Licensing of building practitioners, who may include designers, builders and subcontractors, and regulations defining who can do certain work and when work must be supervised by an LPC.
- More detailed permit applications.
- Cladding, fixing and flashing details required in building plans.
- More inspections during construction.
- Increase in permit costs.
- Restricted occupancy until a “code of compliance” is issued.
- Cavities required behind cladding in many instances.

A cavity is formed with a 20-millimeter (¾ inch) vertically fixed treated timber batten between the frame and cladding. Steel framing has always required a thermal break between most claddings and the steel frame. The introduction of the cavity has put steel framing on an equal footing as the timber batten meets our thermal-break requirement.

Steel-framing industry

The first steel homes were built in 1940s but the ready availability of timber slowed any growth until the late ’80s. Early in the ’90s, a group formed as a chapter of NASH (National Association of Steel-framed Housing) Australia. 1997 to 2000 saw three main producers close down. NASH struggled for funding with probably less than 150 homes per year. Between 2000 and 2002, interest grew and several more manufacturers opened for business.

2002 to 2005 saw the market share start to grow. Leaky homes become evi-
Steel to Conquer... continued from page 30

The predominant steel used, made at NZ Steel’s Glenbrook mill near Auckland, is 0.75 (20 gauge) and 0.55 (24 gauge) G550 steel; (33KSI) Z275 (G90) is used for framing.

Industry Body

NASH has grown from its early days and is now an independent organization incorporated in New Zealand. At NASH, we still maintain close ties with our Australian counterparts, sharing knowledge and ideas. Our funding is principally from NZ Steel and members fees.

Cameron Bennett was appointed as the full-time general manager in August 2004. Cameron has a long history in the steel industry and came to us from NZ Steel. His function is to represent the interests of the cold-formed steel framing industry in a way that will increase the market share for its members.

Over the last 12 months, NASH has been incorporated and developed into a professional organization. A long-term development plan has been set in place and closer communications with Australia and USA will see the sharing of knowledge for all. We provided submissions on new housing legislation. A change in attitude from builders, the public and the building industry is evidence that our market acceptance is growing. An increase of steel tonnage of 20 percent has been achieved.

The development of a document called NASH 3405 Alternative Solution Guide for Steel Framing is progressing well and will be completed and introduced to Councils shortly. This will make approvals for steel-frame construction a much smoother process.

NZ Qualification Authority has registered seven unit standards specifically for steel framing. Two of these are compulsory for apprentice carpenters to complete during their training.

A testing program on frame bracing at Building Research Association of New Zealand has been undertaken. Its objective is to compare steel-frame bracing systems to timber-frame bracing using same cladding materials and fixing spacing. The first set of results is extremely positive, showing steel performing 20 percent to 30 percent better than timber.

Promotion is expected to play a larger role for NASH in the next six to 18 months with home shows, trade shows, newspapers, magazines and television advertising planned.

We also want to develop an industry accreditation process for manufacturers to ensure a high quality of product by all NASH members—not an easy task, but a necessity as we plan to put ourselves in the position of producing the Rolls-Royce building product of the future.

We intend to build the industry in a way that ensures value to the whole chain.

From suppliers to end uses it must be a worthwhile trip. The end user wants a quality peace-of-mind home. The builders want to reduce construction time and callbacks to increase profit. The suppliers and manufacturers need margins that make a profitable business.

The Future

Our future in steel looks bright. Timber quality is dropping and its cost is rising due to new treatment requirements. Customers are demanding better durability and quality finishes and builders are looking for good solutions. Steel can provide this. The steel industry is putting forward a united front. Over the next few years, our framing is set to become the best product in the building industry for framing.

This is world-wide opportunity, as statistics from around the globe show growth in steel framing. We should take every chance to learn from each other, share knowledge and grasp the moment.

If you are visiting this part of the world, we would be only to pleased to see you and show you our industry. Contact can be made through our Web site www.nashnz.org.nz or www.steel-frame-homes.co.nz

Gordon Barratt is chair of NASH New Zealand.

Steel to Conquer... continued from page 30

A promotional house at a recent Auckland Homeshow.

A completed steel-framed house.
Connections are a vital part of a properly designed and built cold-formed steel-framed structure. The codes and standards specify minimum connection requirements. Additional connection requirements are required for certain load conditions, such as in regions of moderate to high seismic risk, and certain types of members, such as connections for collectors/drag elements.

There are many good references to assist a designer and builder in properly designing and constructing connections for cold-formed steel elements that meet at least the minimum code requirements and will adequately support the connected elements. Some of these references include codes (UBC, IBC, etc), AISI standards (2001 NASPEC, General Provisions, Header, Wall Stud, Lateral, etc.), design texts (Cold-Formed Steel Design, etc), cold-formed steel organization literature (SFA, LGSEA, SSMA, etc.) often available from their Web sites, and manufacturer literature (catalogs, technical bulletins, code reports, etc.) also available from their Web sites. The codes and standards provide equations to determine nominal connection strength and then one may divide by a safety factor (Ω) to obtain an allowable strength design level load or multiply by a resistance factor (φ) to determine a load and resistance factor design (LRFD) level load.

**Weld connections**

Welds, bolts, screws, and powder-actuated fasteners are commonly used to connect elements in cold-formed steel structures. Typically welds or screws are used to attach bridging, studs to the bottom track, studs to the top track, built-up jamb studs, built-up window header, sill track to jamb studs, built-up header to jamb studs, and connectors (hangers, hurricane/seismic ties, etc.). Typically bolts are used to attach the bottom track to concrete or masonry and powder-actuated fasteners are used to attach cold-formed steel members to structural steel or concrete or masonry.

Some of the advantages of a welded connection include quicker connection time for experienced welders, especially for thicker members, and less material cost as clip angles would not be necessary for many welded connections. The disadvantages include possible damage to members, difficulty of field welding due to environmental adversities (wind, etc.), and fumes from galvanized members.

**Bolt connections**

The failure types for bolt connections are either the connected member in bearing or tension or the bolt itself (Figure 1). Bolted connections are typically used at the foundation or when a larger resistance is required with minimal fasteners. One of the disadvantages of a bolted connection is that a hole must be made in the member(s) prior to the bolt installation.

The maximum size of a standard bolt hole for less than a...
1/2-inch diameter bolt is specified to be 1/32-inch greater than the bolt diameter, and for a 1/2 inch or larger diameter bolt is specified to be 1/16-inch greater than the bolt diameter. Proper space is required for clearance for bolt heads, nuts, washers and wrench. Washers or plates are to be used with oversized or slotted holes unless testing has been completed as per AISI specification chapter F. The center to center spacing is to be not less than three times the diameter of the bolt and the end, and edge distance is not to be less than 1.5 times the diameter of the bolt.

**Screw connections**

The failure types for screw connections include bearing, tilting, pull-out, pull-over or the screw strength itself. Screw connections are typically used for most connections because they are relatively easy to install in the field. One of the disadvantages of screw connections is that many fasteners have to be used when trying to obtain high resistance.

When used to resist tension forces, screws must have a head or washer diameter not less than 5/16 inch and if a washer is provided, the washer thickness should not be less than 1/20 inch.

LGSEA Technical Note 565c on screw connections lists questions to ask to determine the proper screw specification. These include:

- What materials are being joined? (steel to steel, rigid materials to steel, etc.)
- What is total thickness of material in connection?
- What is the steel thickness?

Steel thickness is used to determine the screw point. Self-drilling screws are recommended for multiple thicknesses of steel that are equal to or greater than 33 mils, and self-piercing screws are recommended for rigid material to steel with a thickness equal to or less than 33 mils.

It is recommended that cold-formed steel screw connections have a minimum of three threads exposed and the AISI specification commentary recommends a minimum of two screws connecting individual members for redundancy and to limit distortion. One should also be aware of the screw head type; low-profile screw heads are recommended when sheathing will be installed over them (modified truss, pancake head, etc.). Tapered screw heads (bugle, wafer head, etc.) are recommended for wood sheathing attachment to cold-formed steel framing. And larger screw heads (hex, pan head, etc.) are recommended for most other connections. Different screw head types are shown in Figure 2.

Recognizing that stripped screw fasteners occur in the field, the AISI General Provisions standard says stripped screw fasteners in direct tension are ineffective. However, stripped screw fasteners in shear are still effective if only 25 percent or less of the total fasteners in that connection are stripped.

The AISI General Provisions standard calls for a minimum center-to-center screw spacing and edge distance of three times the nominal diameter, except when the force is parallel to the edge. Then 1.5 times the nominal diameter may be used for the edge distance. It also dictates that screw fasteners are only 80 percent effective when the minimum center-to-center spacing is two times the nominal diameter.

**Powder-actuated fasteners**

AISI specifications do not address powder-actuated fasteners, however LGSEA Technical Note 562 covers their installation, behavior and good detailing practices. A drawing from the technical note is shown in Figure 3.

The strength of a PAF connection may be limited to the attached member strength. The LGSEA technical note suggests that the AISI specification screw equations may be used to determine the allowable shear and tension values for PAFs. This is based upon manufacturer testing and engineering judgment. A minimum edge distance of three diameters is recommended for these fasteners.

**Connectors**

Many pre-fabricated connectors are available for many types of connections to help facilitate proper and economical connections for both the designer and builder. The allowable loads for these connectors are typically published in the manufacturer’s catalog and Web site and are typically based upon the minimum load from the ultimate test capacity divided by a safety factor (determined from AISI specification chapter F), the test load at a certain deflection limit, and a fastener and bearing calculation. An ICC-ES Acceptance Criteria (AC 261) has recently been approved and provides a testing and load rating methodology for connectors used for cold-formed steel construction.

Pre-fabricated connectors may be used to attach cold-formed steel elements to concrete, masonry, cold-formed steel, and structural steel elements. These include mudsill anchors attaching the bottom track to a concrete foundation, hangers to attach cold-formed steel joists to beams, hurricane or seismic ties to attach joists to walls, and straps to
transfer lateral or uplift loads. These pre-fabricated connectors have pre-punched holes to ensure proper placement and to ease the installation of fasteners. Some pre-fabricated connectors are **shown at right**.

**SPECIAL CONNECTION REQUIREMENTS**

As previously mentioned, the codes and standards have additional connection requirements for certain load conditions and member types. For example, the AISI Standard for Cold-Formed Steel Framing – Lateral Design section C5 requires “where the seismic response modification coefficient (R) used to determine the lateral forces is greater than 3” that “the required strength of connections for diagonal strap bracing members, top chord splices, boundary members and collectors shall be the lesser of the nominal tensile strength of the member or the amplified seismic load.” It also says that the pull-out resistance of screws is not to be used to resist seismic forces. The standard requires the anchorage of the end studs of shear walls to be designed for the lesser of the amplified seismic forces or the maximum the system can deliver, such as the overturning determined using the shear wall nominal strength.

**SUMMARY**

Connections are a very important part of any building and care must be taken to ensure they have been properly designed for all possible load conditions and properly built to ensure desired performance under loading. There are many references a designer and builder can turn to for assistance in creating connections that will meet and exceed expectations and create safe structures.

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**Jeff Ellis, P.E., S.E., is a branch engineer for the southwest region of Simpson Strong-Tie Co. Inc. He has served as LGSEA Structural Assemblies Committee chairman and as a current member of the LGSEA Board of Directors, AISI Committee of Framing Standards, AISI COPS Lateral Task Group, and the Structural Engineers Association of California.**

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**Circle reader service #9**
From The Forum

On Members’ Minds:
Corrosion Protection and Anchors

Has there been any research on metal-stud endurance and reasons for its failure? My specific question is relative to the harsh coastal conditions during construction and the need for evaluation (and failure criteria) for completed work prior to sheathing or envelope enclosure.

I have had several other questions about specific projects that came to me shortly after last year’s hurricane. One was about studs that had been sitting in pallets on a construction site on the beach. They had literally been “sandblasted” and then submerged, and the contractor wanted to know if he could use them. They were not in any condition to use, and I recommended that they be turned in for recycling. On the other hand, we had a situation where some studs had already been installed in the building, and had been sheathed, but they had been exposed to indirect wind and standing water. After a jobsite inspection by qualified personnel, and drying of the studs and surrounding materials, they were acceptable for use. As you note, it is not always an easy call. The best guidance for coastal corrosion is from the Light Gauge Steel Engineers Association. It has a technical note called Coastal Corrosion Protection (TN#140). Also, the Steel Framing Alliance has a document called the Steel Durability Guide. Both documents are available from the store on the Steel Framing Alliance Web site at www.steelframing.org. Although neither has a checklist, the LGSEA tech note has a table of recommendations on the last page, that gives some guidance as to the protection necessary. The American Galvanizers Association also has some good resources at www.galvanizeit.org. Its resources apply to all steels, however.

One key for cold-formed steel is the presence of red rust. White rust is the evidence of zinc oxide, which is the byproduct of the oxidization of the zinc coating. This typically does not pose a problem. Red rust, as you note, is the beginning of the corrosion of the steel itself, and shows areas of unprotected steel. A repair could be the removal of the red rust, and addition of a cold galvanizing compound. Instructions for types of repair are in ASTM A780, and paints are available that meet this specification. The other concern if you have heavy red rust is how much of the steel is left after corrosion. After removing the red rust, an inspector could use a micrometer (before the steel is repainted or recoated) to see how much of the steel is left. Even if it is not the same as the original design thickness, properties may be calculated with the new thickness, to see if the product is still adequate for the current application.

Wouldn’t enamel-coated steel provide better corrosion protection for a steel-frame home than galvanized steel?

Enamel painted steel without a galvanized coating below does not provide better protection. The reason is that zinc, through its sacrificial galvanic action, can “heal” cuts, scratches, and abrasions in the steel. With the rough handling that construction products receive, as well as the cutting, drilling, shearing and fastening of members, the coating gets cut and scraped away. The galvanized coating works better than the enamel at covering areas that are cut or scratched.

Some of the very best coatings for steel products are painted-over galvanized. The automotive industry has come a long way over the past 20 years in providing better coatings, and this is what they use in several applications. If for some reason the paint is cut or scratched, the zinc below the paint can help provide protection, and reduce the chance of blistering where moisture gets below the paint surface and rust progresses.

Enamel over galvanized would be a very effective coating for steel framing. However, due to the cost, not many manufacturers make such a product for framing applications. There are some specialty coil coaters that will paint material to be rolled into framing members. As part of the interior exposed drum wall in the Georgia Dome, the covered stadium in Atlanta and home of the Atlanta Falcons, studs were galvanized, painted, and then covered with a thin sheet of protective plastic before they were rolled into the “C” shape. As installers put the framing into place, the plastic was removed. After over 10 years of exposed, in-place service, these studs (which can be seen from the seating area and playing field) are still in excellent condition.

For more information, download the document “Corrosion Protection for Life” from the Steel Framing Alliance Web site at www.steelframing.org.

Thanks to all of you for your inquiries!

Don Allen P.E.,
Steel Framing Alliance director of engineering development, and LEED 2.0 accredited professional.

Ask Your Question!
Log on onto the Forum at www.steelframingalliance.com or call the Steel Hotline at (800) 79-STEEL.
Members of the new Board of Directors of the Light Gauge Steel Engineers Association, a Council of the Steel Framing Alliance, were inducted and sworn in, and several key figures were honored at a luncheon held at METALCON in early October.

The new Board of Directors:
Wei Pei P.E., S.E.—chair
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