FROM THE FOUNDATION

Light Steel Framing: Load Bearing Wall Construction

By Marty Williams,
With an Introduction and Conclusion by Bill Soldano

The nineties will witness a marked increase in the demand for steel framed load bearing systems. The depletion of our forests, lumber shortages and price increases will make steel framing more appealing. Model building codes confronting the life safety aspects of structures allow area and height increases when noncombustible steel products are used. Its versatility, coupled with the benefits of prefabrication, make it an attractive alternative to traditional, time consuming masonry construction. The developer benefits from dealing with one party for the erection of the primary frame as well as the application of exterior and interior finishes.

The applications and benefits of a steel framed load bearing wall are numerous:

- Single or multi-family residential
- Modular construction
- Reconstruction of interior spaces such as the addition of office spaces "inside" an existing building or the renovation of a masonry shell.
- Where dead weights must be held to a minimum, i.e. poor existing soil conditions or multi-level residences requiring unique ground level construction such as a parking structure or open areas such as meeting and dining rooms, etc.
- Compatibility with a wide range of floor and roof systems. The use of "C" joists in sloped roof assemblies, coupled with stud bearing walls, has increased dramatically in recent years as more architects shy away from conventional flat roof systems. Additionally, steel studs are adaptable to wood trusses, steel bar joist and composite concrete deck systems.


Williams

As more designers and builders recognize the benefits and versatility of LWSF bearing construction, so will your opportunity to promote and quote this work. Before you do so, however, it is important to become familiar with the unique structural requirements of the system.

As more contractors become familiar with this system, so will the number of prospective contractors that can confidently quote the work. This will promote healthy competition as it would eliminate the reluctance of developers and architects to specify a system knowing there are few, if any, contractors in their area willing to bid the work.

Fortunately, many aspects of load bearing construction follow conventional framing methods. Yet, the system demands attention to structural details and to that end, the following information prepared by Marty Williams of Matsen Ford Design Associates should be of concern to us all.

* * * *

This article will familiarize the reader with the technical considerations of a LWSF load bearing wall. It serves as an overview to the many items one should consider when preparing an estimate, purchasing materials or constructing a bearing

This is the fifth in the Foundation's series of articles on lightweight steel framing systems. Future articles will discuss panelization, estimating, non-load-bearing exterior wall systems as well as joists in floor, ceiling and roofing systems.

wall assembly.

A steel framed bearing wall is unique for a number of reasons. It resembles traditional wood construction using steel components which are sometimes pre-assembled and installed as manufactured frames. Unlike the "secondary" components of a curtainwall application, steel framing used in bearing walls acts as the "primary" frame. It requires a comprehensive engineering analysis coupled with unique construction bracing and installation methods. Heavier framing components are used which add to fabrication and finishing time. It's constructed in predetermined sequences demanding a coordinated effort, particularly if the floor or roofing installation is performed by others.

Beyond those challenges, it's basically the same components and common sense framing methods you have become familiar with over the years. Yet there are some noteworthy differences, and the balance of this article will attempt to bring those forward.

Components in a Load Bearing Steel Stud Wall

A load bearing stud wall (Figs. 1a & 1b) generally consists of the C studs and track framed openings, including header and jambs. Distribution headers, shear walls and miscellaneous hot rolled steel shapes may also be incorporated into the wall system.

"C" Studs used in the construction of a load bearing assembly are characterized by the following:

a. Minimum Flange Width: 1-5/8" Increasing the flange width to 2" or 2-1/2" strengthens the stud's resistance to rotation and thus increases its axial and bending capacities. Consider the benefits of increasing the flange width before increasing the gauge.

b. Gauge & Yield: Based on the following grades of steel, 20 & 18 Gauge = 33 KSI (33,000 PSI); 16, 14 & 12 Gauge = 50 KSI (50,000 PSI) Expect to see more 18 gauge and heavier. Twenty gauge framing has its applications; however, it is generally limited to single story construction involving relatively light axial loads. Note that gauge and yield increases as you descend a multi-level application. Also where a single 12 gauge component is specified, it may be more economical to install a built up section composed of two lighter gauge components.

The track serves to provide end support for the studs and wall anchorage. Contrary to popular belief, the track gauge will not necessarily match the gauge of the stud. As part of a shear wall frame, for example, the tracks resist axial forces in the same manner as a stud, and therefore, track gauge and yield are critical.

To assure proper axial load transfer the stud ends must seat firmly into the tracks (Fig. 2). Failure to do so will result in the addition of expensive shims.

Mechanical bridging is advised in any stud bearing wall application. Failure to include bridging may cause the stud to rotate and fail well in advance of the design loads it was intended to carry Remember the axial loads induced on a frame during the course of construction may exceed any loads it sees during its service life. It is therefore paramount that *the installation of bridging is completed before any axial load are applied to the system.*

Two methods of bridging are commonly employed. Typically, 1-1/2"

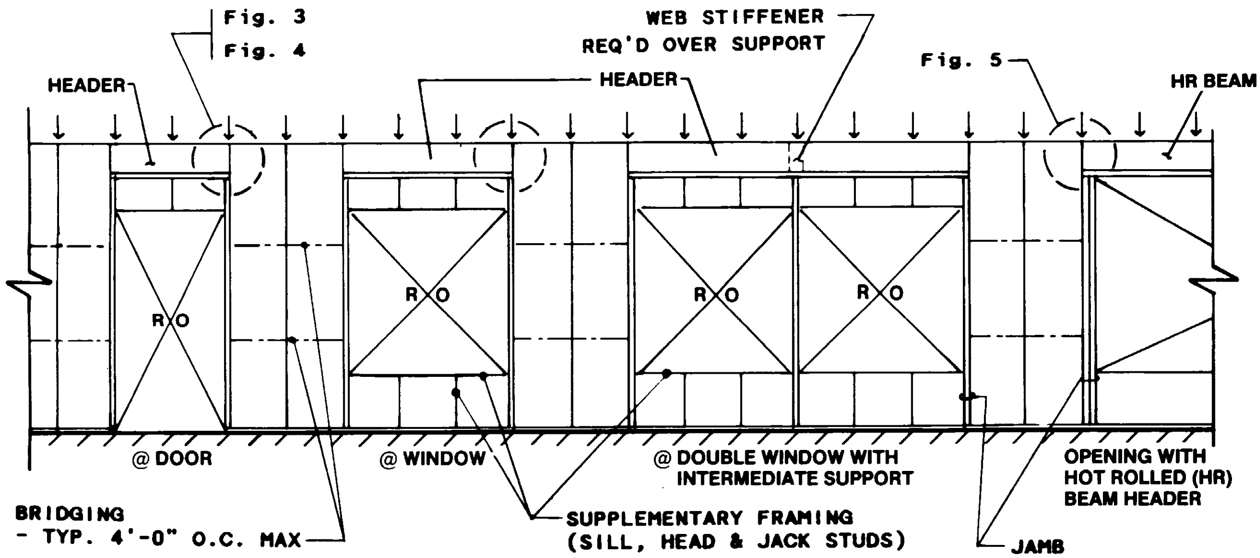

Fig. 1a COMPONENTS OF A STEEL STUD BEARING WALL

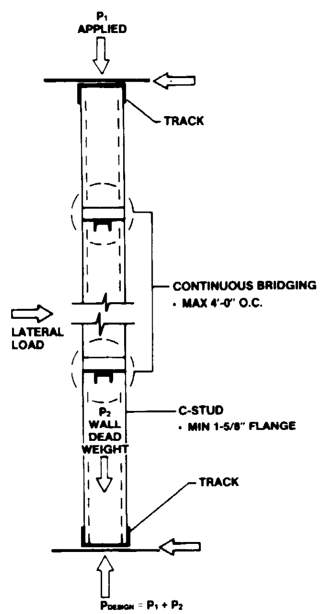

Fig 1b BEARING WALL SCHEMATIC

x 16 gauge channel is passed through the stud's aligned punchouts and attached to the stud with clip angles, or it is welded directly to the sides of the opening. The "Flat Strap and Blocking" method is a permissible alternative in screw attached applications.

A framed opening in a load bearing partition consists of a header, jamb supports and supplementary framing.

Headers are generally constructed using one of three methods. The) include:

1. Turning two “C” shapes to form a box (Fig. 3) or
2. an “I” shaped (Fig. 4) or
3. the substitution of a hot rolled shape where the combination of span and load warrant its use (Fig. 5).

The “I” shaped header should not be used in applications involving a flush (side) mounted floor system. Similarly, a hot rolled tube shape is more accommodating to a flush mount joist than a wide flange beam.

The header is normally placed at the top of the wall in lieu of its traditional location directly above the opening. This allows the load to be carried over the opening without having to seat the jack studs to transfer the load to the header below.

Normally, headers are fabricated from unpunched framing. A punched web lowers the component’s web crippling resistance

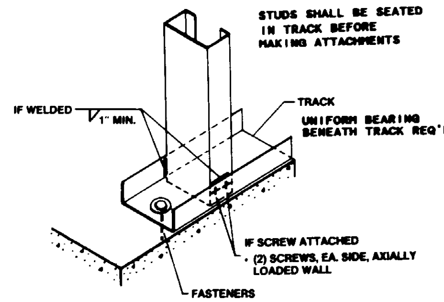

Fig.2 STUD TO TRACK ATTACHMENT ALTERNATIVES

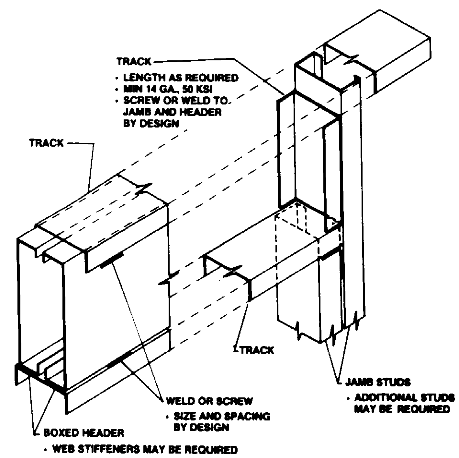

Fig 3. BOXED HEADER AT JAMB

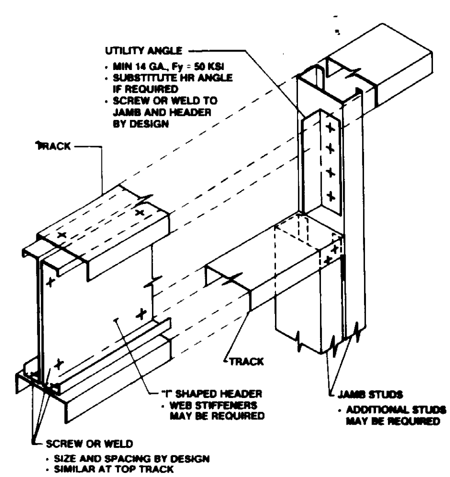

Fig.4 "I" SHAPED HEADER AT JAMB

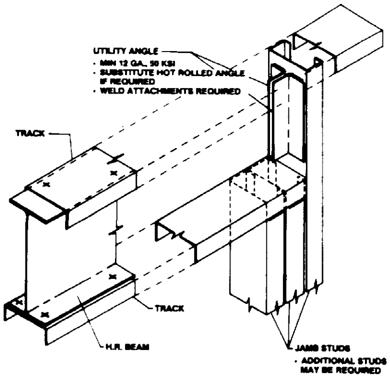

Fig.5 HOT ROLLED BEAM TO JAMB

capacity. Furthermore, end connections are more accommodating when made to a solid web in lieu of one that is punched.

A minimum of two studs should be used in the construction of a jamb, more if the load warrants. In any jamb grouping, extend one stud to the top of the wall and place the remaining studs underneath the header.

Clip angles or track pieces are usually added to make the attachment between the header and the jamb. As an alternative, the header end can be cut to closer tolerances and directly welded to the jamb. This detail is generally reserved for prefabricated assemblies.

The balance of the components beneath the header and between the jambs are considered supplemental framing. Conventional framing methods are used to complete the installation.

Distribution headers are installed continuously over the top of a bearing stud wall. They accommodate non-alignment of a roof or floor joist component with the bearing stud below. Understandably, the distribution header could be eliminated if the layout of the joists and studs are dimensionally coordinated (i.e. each is spaced at 24" intervals) and aligned (Figs. 6 & 7).

Distribution headers aside, a load bearing steel stud wall may incorporate other hot rolled steel shapes. Installing a single tube shape, for example, may be more economical

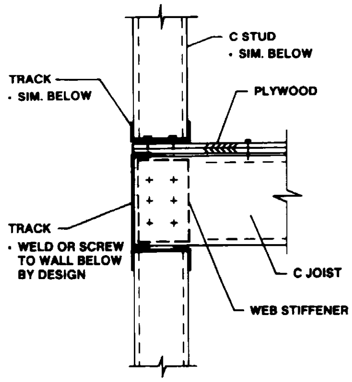

Fig.6a C JOIST ALIGNING WITH BEARING STUD

than a multiple stud assembly, particularly when more than three studs arc required.

If the application involves odd-centered bar joists (Figs, 7a & 7b) it may be necessary to use a hot rolled steel distribution angle or tube also provides an adequate base for the weld attachment of the bar joist to the wall. If a LWSF distribution header is considered, local forces at bearing locations may necessitate the installation of web stiffeners.

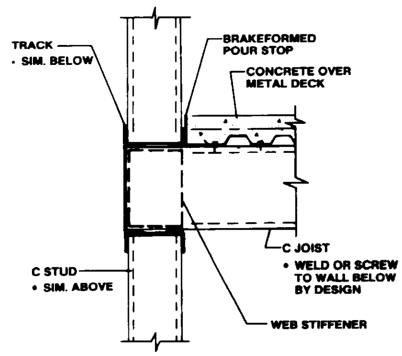

Fig.6b C JOIST ALIGNING WITH BEARING STUD

The shear wall assembly is often the most complex assembly of a load bearing system, particularly in multi-level conditions. Simply stated, when lateral loads resulting from external wind pressures or seismic activity are applied to a structure, they are transferred by means of a horizontal diaphragm (i.e. stiff floors) to a shear wall assembly. The shear wall then transfers the load to the foundation below.

The potential for uplift forces

should be carefully considered when designing a shear wall. It is beneficial to terminate the straps at jamb stud or column assemblies. The dead weight (gravity) loads supported by the jamb or column will oppose or counteract the uplift forces resulting from the action of the shear wall frame.

A conventional steel framed shear wall consists of a series of axially loaded vertical, horizontal and diagonal components. Multiple studs generally form the verticals while track and built-up shapes make up the horizontals. Commonly, flat straps, placed in an "X" formation, are used to transfer the load in tension to the descending levels to the foundation. To balance the distribution of the load, flat straps of equal size are installed to each face of the wall. Base attachments to the foundation must resist the accumulated shear (horizontal) force and uplift (vertical) forces.

In multi-story construction, this assembly requires considerable field labor due to the magnitude of the forces through the system. Weld lengths can be significant. Screws can be used in light load applications.

The sheer wall assembly is often the most complex assembly of a load bearing system, particularly in multi-level conditions.

Definition of a shear wall requirements should precede any estimate. If not clearly defined, check with the Owner's Engineer of Record to see if cold formed steel framed shear walls are used. In some low level structures the attachment of sheathing products (generally plywood) to each side of the wall will form a

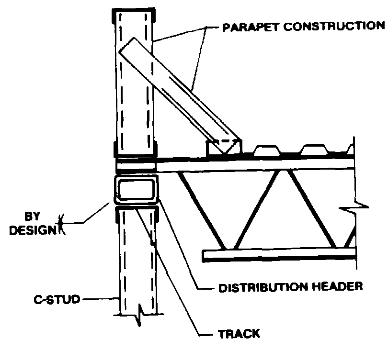

Fig.7a NON-ALIGNING BAR JOIST @ AN EXTERIOR BEARING WALL

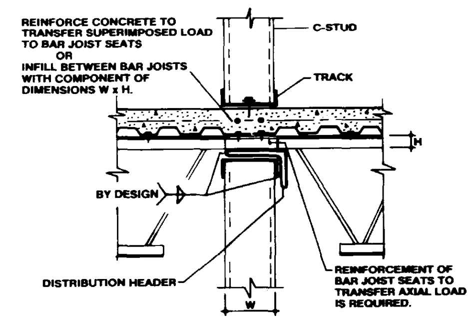

Fig.7b NON-ALIGNING BAR JOIST AT AN INTERIOR WALL

diaphragm that may negate the need for flat strapping. Other times, reinforced masonry walls are used. In any case, investigate the shear wall requirements. Do not assume that because it is not shown, it is not required. You may be told later the A/E classified the shear walls as "supplemental strapping and anchorings."

Also note the thicknesses of the flat straps. As they are often shown in an "X" formation to each side of the wall, appreciate the difficulties associated with hiding the bulge which would result from crossing the straps at a stud location.

Attachment Methods

Welding or screw attachment methods are acceptable in the construction of a load bearing wall assembly Welded frames are preferred when the walls are prefabricated into panels because most of the welds can be made without turning over the frame as would be the case if screws were used. Welded frames also offer greater resistance to racking during shipping and handling. As with any LWSF assembly, take into account the expense of treating all welds with a protective paint coating to restore the component's original coating properties.

Screw attachments are necessary where a 20 gauge product is specified, and they are preferred when stick built methods are employed. The use of two screws, each side, is preferred over the typical single screw attachment used in curtainwall construction. Consideration should be given to the cost of screwing into heavier gauge components. Also, since the walls could be subjected to the elements over an extended period of time, the screws should be polymer coated in addition to the usual protective coating.

Concrete attachments range from powder actuated fasteners (shear loads only) to expansion bolts (adequate edge distances and depth of concrete permitting) to cast-in-place threaded bar and dimensionally oversized embedded plates (the preferred method to anchor a multi-level shear wall frame).

Construction Methods

The virtues of prefabrication in the construction of load bearing assemblies have been well recorded over the years. The prefabrication of repetitive conditions curtails construction time and financing. From a technical standpoint, assembling frames in a compressible fixture table promotes proper seating of the stud ends into the track which assures the transfer of axial force.

Yet many load bearing projects are smaller in scope and quite often removed from the fabrication shop. This type of project would lend itself

Soldano

to a field assembled application. The tilt-up wall, a method borrowed from wood construction, is often used. Commonly carpenters will use extendable clamps in conjunction with a header plate at the ends of the wall to compress the studs into the tracks. In any case, piece by piece stick built applications should be avoided. It is difficult to restrain the top of the wall and the potential for gap between stud and track is great. The installation of shims to achieve complete bearing is unavoidable.

Conclusion

The increasing use of steel stud bearing walls will give you the opportunity to promote and quote this work. Marty Williams has familiarized you with the basic technical concerns of the system, and that should enhance your company's marketability. Understandably, volumes of additional text could be prepared to give a more comprehensive description of the system.

As you position yourself for the challenges and rewards of the LWSF load bearing market, remember to pay close attention to the system's unique design and installation. The bid documents should clearly describe the structural intent, components, spacings and connection requirements. Your questions can be addressed by a qualified structural engineer familiar with LWSF construction. Contact your suppliers of steel framing for manufacturer's literature or further information.

ABOUT THE AUTHORS...

Marty Williams has been an active part of the steel framing industry since 1979. He is employed as a structural engineer by the Baltimore, Maryland office of Matsen Ford Design Associates, a firm specializing in the preparation of engineering and shop drawings for projects involving cold-formed steel framing.

Bill Soldano is the sales/marketing manager for Ware Industries, Inc., a leading manufacturer of quality steel framing systems. Mr. Soldano has been active in the steel framing industry since his graduation from Allegheny College, Meadville, PA.