Lightweight Steel Framing: A Technical Overview

By Greg Ralph

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Introduction: *This is the first in a series of articles on lightweight steel framing systems. Future articles will discuss engineering considerations, how to use the manufacturers published technical data (load tables), load-bearing and non-load bearing interior and exterior wall systems, panelization, joists in floor, ceiling and roofing systems and welding.*

The purpose of this article is to give you an overview of the technical aspects of cold formed flight gage) steel framing. More specifically, it is designed to improve your knowledge in the areas of:

- Basic product applications, terminology, and definitions.
- Benefits and limitations of cold formed framing versus other conventional construction methods;
- Basic technical data and requirements of cold formed steel design.

Basic Uses of Lightweight Steel Framing

Interior Partitions

Curtain Walls

Load Bearing Walls

Floor Joists

Roof Trusses

Interior Partitions

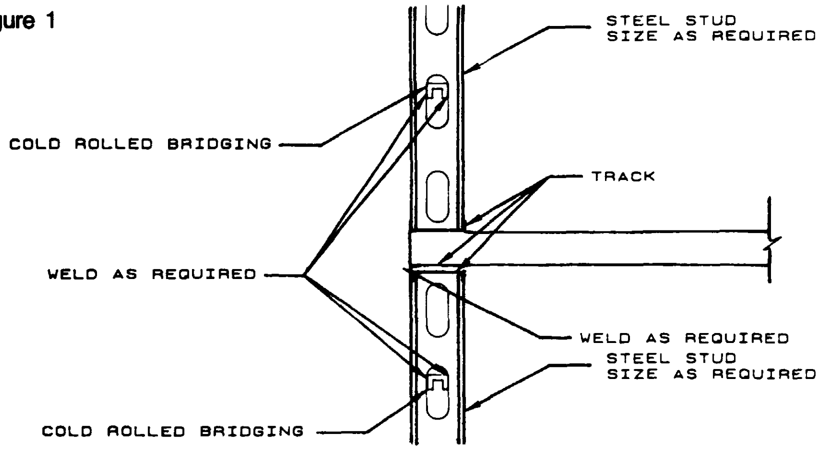
Although there are many different uses for cold formed framing, interior partitions are probably the most common application. The metal stud systems are designed to withstand minimal lateral loads and no axial loads. Their functional requirement is to support the attachment of gypsum board for interior wall systems. The steel studs used range in size from 1-5/8" to 6" wide, and from 26 gage to a maximum of 20 gage, with 25 gage being the most prevalent. Interior partition systems are normally specified by the architect and rarely require any type of shop drawings or submittals from the contractor or manufacturer.

Curtain Walls

Curtain walls systems are also a major component of the lightweight steel framing industry. Curtain walls are secondary framing systems that carry the exterior finish of the building. The steel stud frame is designed to transmit lateral forces to the existing primary structure.

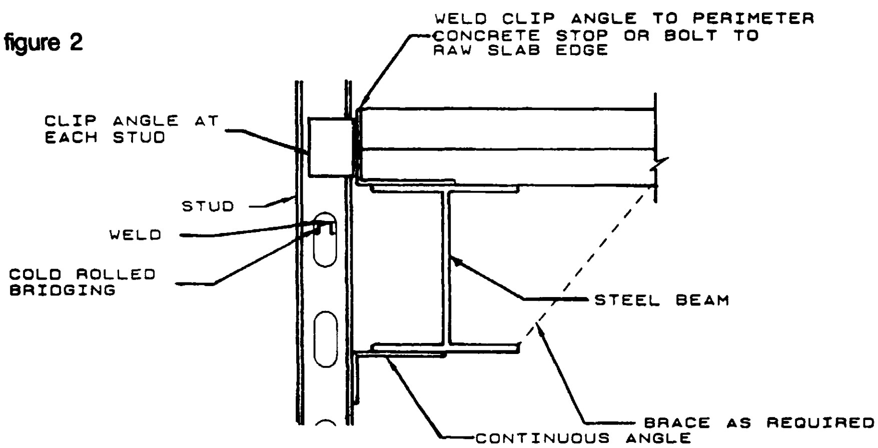
There are many different configurations of curtain walls. The most common are the infill panel, spandrel panel and the bypass parapet. The simplest of these is the infill panel (Figure 1) where the stud framing system fills the void between the surface of a floor slab and the bottom of the next floor slab or to the bottom of an I-beam. Infill panels are simply supported, which means that the stud has supports at the two extreme ends. Architects can achieve interesting lines with infill panels and exposed structural framing.

The spandrel panel (Figure 2) is commonly used in modern office complexes and other mid- to high-rise buildings. It is attached outside of the structural frame and clads the building. The spandrel panel is a very useful system and is popular with architects, but it has some unique design requirements. The difference between the spandrel panel and the infill panel is that the spandrel is not simply supported, as the infill figure 1



STUD INFILL PANELS

figure 2



SPANDREL PANEL

type panel previously described and illustrated in Figure 1. As can be seen in Figure 2, the spandrel panel is supported with an additional connection at approximately mid-span and slightly below mid-span with a connection to the spandrel beam, or it is connected near the bottom with a kicker, back to the floor or roof deck. This connection scheme leaves the spandrel panel with one or two cantilever overhangs, and normally a concentrated end load from the window it supports.

The other unique condition created by the use of spandrel panels is the stub or knee wall, (Figure 3) that begins the system on the first floor. The knee wall is also a cantilever section with a concentrated load, and requires engineering analysis for sizing the connection to the floor slab. This detail is one that cannot be sized directly from the vast majority, if not all, of the manufacturers catalogs. Spandrel panels must be analyzed and a design given to the contractor by either the architect, engineer, or manufacturer's engineer.

Often the architect requires the contractor to supply shop drawings for a curtain wall system. Most manufacturers have the capabilities to supply the shop drawings, either with an in-house engineering staff or by using outside consultants. When a specification requires shop drawings, the contractor should take this into consideration at the time of the bid, as most manufacturers charge a fee for their engineering services. Most manufacturers will quote a lump sum or hourly price for shop drawings and/or engineering calculations if plans are provided for the project.

The third type of curtain wall system is the bypass parapet (Figure 4). This system is often used in conjunction with both infill and spandrel panels, as the top panel of the exterior wall system. This permits clean, efficient parapet construction without the necessity of building a separate parapet on the roof deck. The same member sizing and connection problems associated with spandrel panels are evident in bypass framing, necessitating a qualified engineer review the design of this system. Architects normally require the same detail drawing submittals with this system as with a spandrel system.

Load Bearing Walls

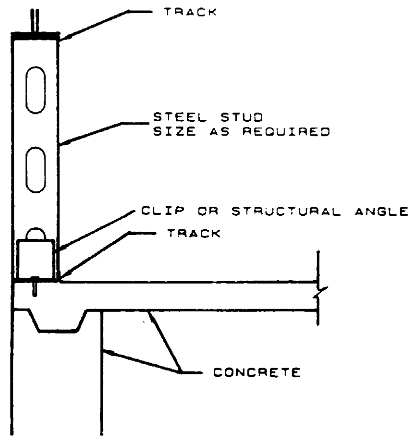
Load bearing systems use the steel stud framing system to support the entire structure. Bearing walls can be integrated with a variety of combinations of cold formed steel floor-joists or other systems, such as bar joist or concrete slab systems. Steel stud bearing wall systems have been successfully used in buildings from a single floor to seven stories high. The design of lightweight steel framing systems for load bearing buildings, although a very viable and proven alternative, requires an extremely complex engineering analysis and should not be taken lightly. Since there are many design parameters that must be examined, this system will be described more thoroughly in a future article. It is a complex system and should be fully engineered before installation of this type of project is undertaken.

Cold Formed Floor Joists

Cold formed floor joists, as mentioned earlier, can be an integral part of a load bearing structure. Steel joists are best applied in conditions with light to medium loads and short to medium spans. A reasonably sized joist can span 20 feet with a 100 psf load. These spans can be increased with lighter loads or larger members. Under certain span and load conditions, cold formed joists are a very economical design solution.

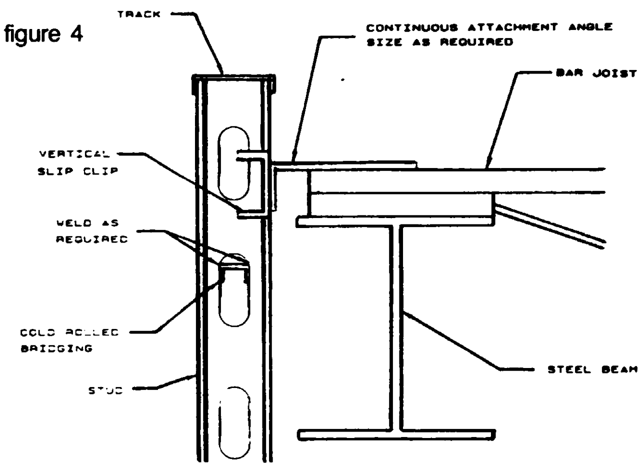
Roof Trusses

The last area of application for cold formed steel studs is the construction figure 3



KNEE WALL SUPPORTING WINDOW

figure 4



ROOF PARAPET

of trusses or rafter and joist systems. A trussed unit can provide remarkable capabilities with regards to loads and spans. Cold formed steel trusses have not enjoyed wide-spread use because of the complexity of connecting the members together when constructing the truss. There are, however, applications where this is a viable design alternative due to the inherent load carrying capabilities of the steel system. With improved technologies in connection, design and fabrication, lightweight steel framing systems for roof trusses will some day be a very competitive alternative in a variety of building applications.

Benefits of Steel Framing

Now that we've discussed the options available for the applications of cold formed steel framing, we should examine the advantages of using these systems.

1. One of the key reasons is economy. When steel studs replace other backup systems, such as concrete blocks, poured concrete walls, or structural steel, construction costs can be reduced.

2. Indirect savings resulting from reduction on the structural frame and foundations is an added benefit.

3. A strong case for steel studs is noncombustibility. In many cases governing building codes require noncombustible construction in higher buildings and allow them to be together, producing a higher unit density.

4. It is most likely that fire insurance premiums will be reduced on the project.

5. Another benefit of steel studs is design versatility. With the vast product line available anything can be built, from a simple soffit to a seven story load-bearing building.

6. Possibly the biggest cost

saving factor is speed of installation. Most manufacturers provide cut-to-length products, eliminating costly field cutting; and with prepunched holes, the electrical and plumbing trades save time.

7. Steel framing also lends itself to prefabrication with high quality and tight product tolerances available from production line fabrication in a controlled plant environment. Shipment and installation of entire wall systems make year-round working conditions possible by reducing the worker's exposure to inclement weather, which speeds the field erection process.

8. Additional benefits include consistency of the product and the elimination of dimensional shrinkage, which improves the application of finished materials.

9. Lightweight steel framing is resistant to rodents and vermin such as termites.

Considering the many uses and benefits of steel studs, it is not surprising that the number of applications of lightweight steel framing grows daily.

Building Codes

There are many technical considerations that must be addressed when designing and constructing a safe building. The design criteria are listed in the building codes. There are three major model codes which have been adopted in many states and numerous other state and local codes. It is imperative to examine all codes that are applicable to a project because the most stringent requirements are considered to govern. The major codes, Building Officials and Code Administrators International, Inc., (BOCA) has been adopted in most north and northeast states; Southern Building Code Congress International (SBCCI), has been adopted in the southern states; and International Conference of Building Officials, (UBC) has been adopted in most of the western states. All three provide data based on research and experience unique to their individual regions. All building codes address issues such as wind pressures, snow-loads, seismic design and other factors relevant to lightweight steel framing in building design.

Engineering Criteria

Although the jurisdictional building codes relate to the design criteria for buildings, the allowable load capabilities of steel studs are governed by the American Iron and Steel Institute's *Specification of Cold Formed Steel Design.* The specification is written, reviewed and researched by a staff consisting of university officials, industry consultants, and manufacturers. The *Cold Formed Steel Design* manual is continually researched, analyzed and revised to improve the code and make it easier to use. The research is compiled and published in the form of a new manual every six years; the latest edition was published in 1986. Due to the constant updating of the manual, the designer must be certain to use data published in accordance with the latest issue.

Specifications

Taking all of the available information and design criteria into account, the architect can begin the design of a safe building that meets his clients needs. In developing the project specifications, most architects use the CSI format. Under this format, pertinent information for interior partitions is located in section 09250, and curtain walls and load bearing systems in section 05400. The appropriate section includes specific information on the requirements of the project. These requirements include the size of studs, minimum gages, acceptable coatings, and the type of submittals for approval they will require (i.e., brochures, certification letters, shop drawings) from approved manufacturers. If a manufacturer is not listed, designers can normally get an approval to use an equivalent product by submitting the manufacturers' design data, product samples and literature prior to the final bid.

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The architect's specification will be explicit for the type of submittals that the project will require. In many instances, the architect assigns the contractor the responsibility and expense of

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supplying an engineered design.

The yield strength of the steel will normally be part of the specification. In many instances there is a "common" specification such as:

18 Gage and Lighter—33 KSI

16 Gage and Heavier—50 KSI

The, yield strength designation is much like the 16 gage minimum requirement. It is a starting point or a bench mark. Both gage and yield strength are part of the analysis that the manufacturer's engineers can supply. Consult with the manufacturer since there are an equal number of cases where the specification is undersized, oversized, and correct. Designers should obtain the manufacturers written recommendation, present it to the architect, and he will normally be receptive.

During the bidding phase of the project, the quality of technical information required can be overwhelming. Most manufacturers have personnel to assist in the technical aspect of the bid. After reviewing the specifications and drawings, designers should contact the stud manufacturer to assist in selecting the most economical stud that will meet the design requirements.