Light gage steel trusses have been used for 20 or more years. Truss configurations are similar to those built of conventional steel (but with lighter loading) and those built of wood (with comparable loading). Light gage steel trusses generally are used for roof construction, and as such fit the same niche as light wood trusses: single family dwellings, apartment complexes, retirement villages, small offices, schools and churches. The trend toward fire resistant construction in many types of buildings is currently giving steel an advantage over wood. The truss usually is spaced at 16" or 24".

Terms and Definitions

A truss is an assemblage of members that make a single unit to span a longer distance than a single member could span. Most trusses are built of a series of triangles because the triangle is inherently stable; thus, a truss has a minimum of three members. See figure 1.

Trusses consist of three main members: the top chord, bottom chord, and web members. The top and bottom chord generally have the roofing and ceiling material attached to them either directly or with furring channels. These are the main load distributing members and the greatest depth. The web members provide the transfer of loads between the chords and ultimately to the bearing points.

The members of a truss resist three types of stress: (1) tension stresses are those which tend to stretch the member, thus elongating its length; (2) compression stresses are those which tend to shorten its length; and (3) bending stresses are those which tend to rotate or bend the member out of its straight configuration. See figure 2.

Chords are usually designed for bending loads in addition to axial (tension or compression) loads only.

A panel point is the location where two or more members of a truss are connected. The ridge is where the two slopes of the top chord meet or the highest point of the monoslope truss.

The bearing point is where the truss is supported by a wall or some other structural member such as a column or beam. Usually the bearing occurs at a panel point. If bearing occurs at a point other than a panel point, additional bending stresses occur which may increase the size of the member significantly. There is a minimum of
two bearing points, but there can be more depending on the truss spans.

Two types of buckling must be considered in the design of light gage steel truss members. The member under axial bending load may curve out of its straight shape and become unstable and collapse. This is individual member buckling. Localized buckling is when a portion of a member, such as the flange or web, warps or crimps when loaded.

**Leads**

Considerations are live load dead load and wind load. Live load consists of people on the roof, snow and ice. This would occur on the top chord only. The bottom chord live loads would consist of people in the attic, and storage of goods in the attic. The dead load is the weight of the truss, roof material, ceiling material, lights and other ceiling fixtures. The dead load is also broken down by top and bottom chords. Special loads include mechanical units, dormers, and other single or widely dispersed loads. The wind load is applied to the top chord only. Local building codes determine what and how the wind load is to be applied. In most, but not all, cases the wind creates an uplift on the truss.

The loads to which a truss is subjected come from a number of sources. Some are known quantities, such as the “dead loads” of the weight of the truss, roofing and ceiling materials, and the equipment attached to or supported by the truss (such as lighting and HVAC units). Some are unknown quantities which have been codified by authorities, such as the roof “live loads” of rain and snow, “wind loads,” and the “seismic (earthquake) loads.” The required amounts of unknown loads to consider in the design of a truss are listed in the code accepted by the local building code department.

**Types of Trusses**

There are many different truss configurations. Since a light gage truss is configured to support the roof and ceiling, the basic shape of the truss is set by the design of the building. The roof or the ceiling can be level. The roof or the ceiling can be sloped. Some
common shapes are shown in *figure 3*.

Some considerations need to be made as to the type of truss selected. If the roof is steep, a pre-manufactured truss may be too tall to deliver in one piece. If the ceiling is not level, a scissors truss may be used; but thought must be made that a scissors truss spreads as it is loaded or additional axial (tension or compression) loads are added. A scissors truss is also more difficult to handle during erection. If the span is long, trusses may need to be delivered in a number of pieces and assembled in the field before erection.

### Design of Trusses

The design of trusses should be performed by a professional engineer familiar with light gage framing systems.

The design of light gage steel trusses can most easily be accomplished using a computer. Some of the process can be standardized, such as minimum nominal stud sizes or minimum steel gage. Some standard trusses can be built, if a series of trusses with the same roof slope and different spans and loading conditions can be assembled in a manufacturer's catalog of designs. Generally, however, each truss must be designed individually.

Designing the truss starts with sketching the truss shape, determining the dimensions, and entering the configuration, member sizes and loading into the computer. After the computer has analyzed the truss, each individual truss member must be checked for all the loading conditions from the output. Most members will have tension or compression loads, and many will have bending loads. These combined loads may change for different loading conditions.

### Connections

Truss member connections occur at the panel points. These connections can be welded, screwed or bolted. The strength of the connection depends on the type of steel, the thickness of steel and the allowable load of the fastener as tested. The author’s preference is that pre-manufactured trusses be welded and job site fabricated trusses either be welded or
Truss members can be assembled using pre-fabricated connectors, lapped back to back, or connected with sheet material or direct welding. Examples of each are shown in figure 4.

**Individual Member Bracing**

The individual member of a truss must take into consideration whether the loaded member can buckle. The buckling of a member depends in great part on its length and properties. If a member’s buckling length can be reduced by attachment to other material, then a lighter truss can be designed. Thus, the roof sheathing can be used to brace the top chord, and the ceiling can be used to brace the bottom chord. Individual web members, and unbraced top and bottom chords, can be braced by bridging or bracing placed perpendicular to the members. See figure 5. Care must be taken to show this individual member bracing on erection drawings, and inspection must be made to insure...
that this bracing is installed. Failure to properly brace individual members could result in collapse of the roof structure.

**Roof Stability Bracing**

As with individual member bracing, the entire roof structure must be braced to insure stability of the roof. This is particularly important during the erection phase and in cases where the top and bottom chords are not suitably braced by roof sheathing and ceiling. Any single truss would have a difficult time standing by itself, but when two or more trusses are braced together, they become stronger and more stable.

Bracing is required in at least three locations during erection and before the roof sheathing and ceiling are placed. The plane of the roof should have a flat strap bracing and horizontal struts on the top chord. The plane of the ceiling should have flat strap bracing and horizontal struts on the bottom chord. The trusses themselves should be braced together, generally with X-bracing and horizontal struts composed of studs. All of this bracing is in addition to the individual member bracing. The amount and location of the erection bracing should be determined by the truss designer.

Permanent stability bracing is composed of the roof sheathing and
ceiling additional X-bracing and struts may also be required. In fact, if the designer is careful, the erection bracing may be left in place as the permanent bracing. See figure 6.

**Truss Fabrication**

Truss fabrication can be done in a factory, on the job site, or “stick built” in place. The potential for better quality control and well made connections is inherent in either factory or job site fabrication. Trusses can be treated as panels and fabricated in a panel shop, thus allowing for greater utilization of the panel shop.

**Truss Erection**

Comprehensive knowledge of the design of the trusses, bracing and roof as a whole is necessary. This information is imparted to the erector through the use of shop and erection drawings and job site meetings.

Since the trusses are designed to be light, the shorter spans may be erected using manual labor and experienced foremen. The longer or more flexible trusses will necessitate the use of lifting equipment. Many times, erection can be simplified by ganging trusses together on the ground and then lifting an assembly of units complete with bracing. In any case, a system of bracing the first trusses is essential to the safety of the installers. Each truss erected after the first must be braced back to the other trusses to maintain stability.
Summary
The use of light gage trusses is increasing, and the fabrication process is improving. Combining wall panels and steel trusses allows for fabrication during the construction of building foundations. This shortens construction time. This advantage, along with the longer spans available in steel and the noncombustible material, makes light gage steel trusses a very attractive construction solution.

About the Author
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Richard is a structural engineer and has been designing light gage steel systems since 1972. He graduated from Clemson University in 1971 with a Bachelor of Architecture and a Masters Degree in Civil Engineering. Richard works directly with architects, contractors and other engineers, drywall subcontractors, panel fabricators and light steel gage producers.

More on Roof Trusses

by Brad Beczkalo

With a major emphasis on public safety, the construction industry is continually providing products and systems that provide sound structural integrity, are economically feasible, and can provide protection from fire hazards. Light gage metal framed roof trusses provide all of these.

Using a wide range of depths and gauges, trusses can span up to 70'-0" clear span and on center spacings limited by the roofing materials to be applied. Any configuration is available including monoslope, Fink, Howe, truss joists and scissors trusses.

Trusses are capable of transferring heavy loads in the vertical direction but can carry almost no load in the horizontal direction. Due to this fact, horizontal bridging, running perpendicular to the trusses, is attached at the panel points. This allows the truss to be positioned in a true vertical plane and prevents the load from distorting the truss in the horizontal plane. More horizontal bracing may be required, or if the truss span is short, less may be required.

A jig is made to build the trusses. This can consist of a table, at least as large as the truss itself, and some angle fastened to the table at the location of the various members. The top and bottom chords as well as the web members are cut to the needed length, put into place and either welded or screwed together. Top chords must bevel cut at the peak, and web members must be beveled to fit onto the chords. Since most truss jobs require repetitive trusses, the bevel cuts can be made at one time in a separate step.

To avoid weather delays and on-site crowding, trusses may be prefabricated off site. This will enhance the quality control of the project and allow the contractor to control the labor force. Materials are generally on hand and work may proceed into the night hours if needed. Consideration must be given to the following:

1) Size of truss—Shipping restrictions may require the truss to be built in several different sections. This will require connections to be made at the site as well as utilize additional material on the truss.

2) Measurements will need to be taken in the field and relayed back to the shop. This might result in erroneous information and cannot be double-checked without causing further delays.

3) Trusses will have to be handled at least three or four times before the final placement on the job. The size of the trusses might require heavy cranes or many employees to manhandle each truss. The more a truss is handled, the more likely it is to be damaged.

4) Trusses must be stored wait-