Building Construction: Lightweight Steel Framing

BY GREGORY HAVEL

To earn continuing education credits you must successfully complete the course examination. The cost for this CE exam is $25.00. For group rates, call (973) 251-5055
Building Construction: Lightweight Steel Framing

When a building with the low cost of a wood-frame structure and the characteristics of a Type II (noncombustible) building is needed, today’s solution often is a building framed of steel studs. This type of building could be a small commercial structure, parts of a new or remodeled noncombustible (Type II) or fire-resistive (Type I) structure, an apartment building, or sometimes even a single-family residence. Once it has been sheathed and the interior and exterior finished surfaces have been applied, this type of construction is indistinguishable from wood framing.

**MATERIALS**

Steel studs are manufactured in the same sizes as dimensional lumber: 2 × 4 and 2 × 6. For floor joists and roof rafters, they are available in 2 × 8, 2 × 10, and 2 × 12. These studs, joists, and rafters are manufactured for use in both nonload-bearing partitions and load-bearing walls. The studs used in partition walls are usually 25-gauge galvanized steel; those in load-bearing walls are usually 20-gauge or heavier-gauge galvanized steel. As in wood framing, steel studs can be doubled or tripled for extra strength (photo 1).

Instead of wood plates bolted or nailed to the floor and ceiling or other top support, steel studs are attached to a galvanized steel channel of the same size and gauge as the studs. These channels are fastened to the floor with bolts, screws or self-threading concrete anchors, nails, or air-driven or powder-driven pins. (2) The floor channel for this partition wall is made of 25-gauge galvanized steel and is fastened to the concrete floor with powder-driven pins. The steel stud framing at the right has been attached with self-drilling sheet metal screws.

(3) This curved soffit includes flexible top and bottom channels that are manufactured in sections so they can flex horizontally but not vertically. After they are in position with the proper curve, they are screwed to the bracing attached to the bar joists to support the assembly, and additional screws are added to ensure that the curve is not deformed while gypsum drywall board is added. These studs are on eight-inch centers to support the curved drywall board.

---

**Educational Objectives**

On completion of this course, students will:

- Identify the types of construction where lightweight steel is used
- Describe the methods used to construct lightweight steel assemblies
- Identify hazards of lightweight steel framing and utilities
- Gain an understanding of the fire hazards associated with lightweight steel framing

---

(1) This five-foot-wide main entry doorway will support the ends of lightweight steel roof trusses that span the width of the building. All of the studs, headers, channels, and braces are galvanized steel. The other ends of the trusses will be supported by the rear wall, visible in the background. (Photos by author.)

(2) The floor channel for this partition wall is made of 25-gauge galvanized steel and is fastened to the concrete floor with powder-driven pins. The steel stud framing at the right has been attached with self-drilling sheet metal screws.

(3) This curved soffit includes flexible top and bottom channels that are manufactured in sections so they can flex horizontally but not vertically. After they are in position with the proper curve, they are screwed to the bracing attached to the bar joists to support the assembly, and additional screws are added to ensure that the curve is not deformed while gypsum drywall board is added. These studs are on eight-inch centers to support the curved drywall board.
der-driver pins (photo 2). So that architects can produce the effects desired by owners and tenants, these top and bottom channels are available as flexible units, for building curved walls (photo 3).

The floors in this type of construction are usually concrete. They may be slab-on-grade, concrete topping over a steel deck, a structural concrete deck (waffle slab or post-tensioned concrete), or concrete topping over prestressed concrete plank or Double Tees.

**ASSEMBLY**

Steel-frame walls can be assembled as units, tipped up, plumbed and leveled, and attached to the floor and top supports. The bottom and top channels can also be attached to the floor and ceiling, and the studs can be attached individually to them. Studs for load-bearing partitions will run from the floor deck to the underside of the floor or roof structure above. Fire-rated partitions will run from the floor deck to the underside of the floor or roof deck (photo 4). The drywall board will be cut precisely the underside of the corrugated steel roof deck. It will be used to mark the top edge of the drywall board for cutting on both sides of the fire-rated partition. (6) This soffit is assembled from 25-gauge steel studs, braces, and channels. The curve is so gradual that it was made by crimping the flange of the channel at intervals on the inside of the curve. This framing will be covered with layers of drywall board attached with screws.

Utilities are installed in steel-stud walls as they are in wood-frame walls. However, since the studs are metal and very thin and sharp-edged compared with wood studs, the...
cables and pipes must be protected from damage during installation and during the life of the building. Plastic bushings are used to isolate and protect cables and some pipes from contact with the sharp edges of the steel (photo 8). Plastic bushings are also used to prevent contact between the steel studs and copper plumbing pipes and aluminum-jacketed cables, which can be damaged by the galvanic corrosion that takes place between dissimilar metals. Even steel-jacketed cables are protected from sharp edges, since the jacket could be damaged by years of vibration (photo 9).

If the jacket of an electrical wire or cable or a communications or data cable were to be cut by the sharp edge of a steel stud or joist, the building’s entire steel frame could become energized from the voltage in the wire or cable. This could present an electrocution hazard to anyone in the building, even at a distance from the damaged cable, since not all short circuits blow fuses or trip circuit breakers.

Avoid direct contact between galvanized steel studs and aluminum window and door frames, to prevent galvanic corrosion. Wood blocking and liners are frequently installed to prevent this problem. Blocking is installed inside steel stud walls to support cabinets, hand rails, appliances, door frames, and windows (photo 10). This is sometimes made up of pieces of steel studding, but more often fire retardant-treated lumber is used. Sometimes ordinary lumber is used for blocking, if the building code or the code official permits.

Insulation is installed in exterior walls between the studs to reduce heat loss. In interior partitions, it is frequently used to reduce sound transmission. Specific types of insulation can be required if the partition is to be fire-rated (photo 11).

### SHEATHING

Exterior walls will be sheathed with one of the fiberglass-faced gypsum sheathing materials or fire retardant-treated plywood (photo 12). Sheathing is usually attached with bugle-head, self-drilling drywall screws. The code may require a layer of house wrap over the sheathing, and the exterior can be finished with a variety of exterior finishes such as aluminum, vinyl, or cement board siding; brick veneer; cultured stone; or another surface selected by the owner (photo 13).

Inside, the exterior walls will be filled with insulation and covered with a vapor barrier after all utilities are installed. The most common interior is gypsum board. This can be of the ordinary variety, moisture-resistant for damp locations, fire-resistive “Type X” for fire-rated partitions, or impact-resistant in heavily used areas. The gypsum board is usually attached with bugle-head self-drilling drywall screws (photo 14).

### FIRE-RATED PARTITIONS

Partitions framed with steel studs can be fire rated—if the studs are spaced properly and at the proper gauge, if the proper insulation is used between the studs, if the studs extend from the floor to the bottom of the roof deck, if the drywall board is properly attached with the proper number of screws, and if the drywall also extends from the floor to
the underside of the deck above. The following are examples of fire resistance-rated assemblies:

- one-hour: one layer of 5/8-inch Type X board on each side of wall [load-bearing Underwriters Laboratories (UL) U423; interior wall UL U425, U432].
- two-hour: two layers of 5/8-inch Type X board on each side (load-bearing UL U423; interior wall UL U425, U432, U411). (5)
- three-hour: four layers of 5/8-inch Type X board on each side (UL U462). (5)
- three-hour: three layers of 5/8-inch fire code board on each side (UL U419). (5)
- three-hour: two layers of 5/8-inch Type X board on each side; three-inch mineral wool insulation (UL U490, U435). (5)
- four-hour: two layers of 5/8-inch Type X board on each side; three-inch mineral wool insulation with a density of four pounds per cubic foot (UL U490). (5)
- four-hour: four layers of 1/2-inch Type X board on each side (UL U435). (5)

Ratings of systems from agencies other than Underwriters Laboratories and of systems using combinations of materials other than those listed above are also available.6

**STEEL JOISTS**

Where steel studs are used for framing, steel joists can be used to support ceilings, roofs, and upper floors (photo 15). As in wood framing, this structure could be built using platform construction or balloon-framed construction. These ceiling-floor and ceiling-roof assemblies can be constructed to achieve fire ratings. (6) Steel studs may also be used to build curtain walls to enclose multiple-story steel-framed noncombustible and fire-resistive buildings.

In effect, this can be platform construction if the studs extend from the floor to the underside of the floor above, or it can mimic balloon-framed construction if the studs are attached to the edge of the floors passing in front of the edge of the floor slab and may span multiple levels. In the latter case, fire-stopping is supposed to be installed at all floor levels.

**FIRRING**

If the steel stud structure abuts or is inside a fire-resistive or noncombustible building, steel firring is likely to be attached to the existing concrete, masonry, or precast concrete walls so that all of the walls of the finished room can be finished in the same way and utilities (electrical, telephone, and data cables and conduits; plumbing; and heating pipes) can be concealed (photo 16). The steel firring can be 2 × 4 or 2 × 2 steel studs or two-inch-wide “hat channels” and will be finished with drywall board and an interior finish. This creates void spaces between the old wall, the new wall, and the steel firring. Although these void spaces are noncombustible,
they are likely to be interconnected and to provide another way for smoke and fire to travel.

**ROOFS**

If the steel-stud structure is within or part of a noncombustible or fire-resistive structure, the roof may already be in place. This roof will usually be of steel bar joists supporting a steel roof deck topped with lightweight or gypsum concrete and a roof membrane or topped with a layer of fire-rated fiberglass-faced gypsum board, a layer of extruded foam insulating board, a rubber roof membrane, and stone ballast to stabilize it in windy conditions.

If it is a stand-alone structure, the steel stud walls will support the roof. If the roof is to be flat, the framing is likely to be steel joists screwed to the steel studs covered with a steel deck, a layer of fire-rated fiberglass-faced gypsum board, a layer of extruded foam insulating board, a rubber roof membrane, and stone ballast (photo 17).

If the roof is to be pitched, it is likely to be supported by steel trusses fabricated from load-bearing galvanized steel studs or galvanized steel members designed specifically for that purpose in dimensional lumber sizes (photo 18). In either case, the trusses are usually assembled using self-drilling screws and delivered to the job site in bundles like wood trusses (photo 19). They will be set on top of the walls with a crane and attached to the top plates of the walls with self-drilling screws, usually on 24-inch centers. Sometimes, units of six or eight trusses with their bracing are prefabricated on the ground and set in place with a crane, to reduce the need for the fall protection measures the Occupational Safety and Health Administration has established for workers (photo 20).

The roof sheathing can be fire retardant-treated plywood, fire retardant-treated oriented strand board (OSB), or fire retardant-treated tongue-and-groove boards. A moisture membrane of plastic or felt is usually applied over the sheathing. The roof can be of rated shingles of fiberglass and asphalt; slate or imitation slate; tiles; metal panels of copper, aluminum, or steel; or fire retardant-treated cedar shakes. If slate or tiles are used for roofing, the walls and roof truss system must be designed for the extra weight, since these materials are significantly heavier than shingles, shakes, or metal roofing.

**FIRE BEHAVIOR**

As in any noncombustible or fire-resistive building, early
stages of fire are most likely to involve room contents and interior finishes. Furniture, furnishings, paper, upholstery, and combustible finishes burn as readily in a noncombustible structure as in a combustible structure.

Although the structure is noncombustible, it will still be affected by heat. Since there is not much mass to the steel studs and joists in this type of construction, they are as likely as steel trusses and bar joists to be weakened quickly by heat and as prone to early collapse. Although the self-drilling screws used to assemble steel studs and trusses are less likely to release in a fire than the gang-nailers used in wood trusses, they may be no more stable if the screws or the steel is rusted or if the screws were overtightened and the threads stripped.

Even if fire-stopping is installed inside the walls between floors and where pipes and cables penetrate fire-rated assemblies, an entire wall or floor assembly can be considered to be a single void space, since the sheet metal of the steel studs and joists has holes punched through it at the factory for ease in installing cables, pipes, and conduits (photos 6, 8, 10, 15, 17). Since void spaces inside walls are often connected to the void spaces inside floor assemblies, and since fire-stopping is not always perfect, expect that smoke will travel through the void spaces to other parts of the building as readily as it would in truss construction. Where smoke can go, fire can follow.

Even if this type of noncombustible structure has an automatic fire sprinkler system, the void spaces will be unprotected. The fire can spread into the voids if the sprinklers are ineffective in controlling the fire in its room of origin or if the fire breaks through the drywall board enclosing the voids.

OUR BEHAVIOR

We need to know which of our buildings use this type of construction and show this on our prefire plans so the incident commander can use the information in the size-up.

If we don’t have a prefire plan for the fire building, we must use extra caution in committing to an interior firefight, since we will not know what is supporting the roof and providing strength to the walls. Gypsum board provides some protection to the steel studs as long as the fire is confined to the room of origin even if it is not fire resistant. However, the heat of the fire will cause steel studs to fail more quickly than wood studs, especially if the fire has extended inside a wall or ceiling void. This is especially important if the partition or ceiling assembly is fire rated.

If the sprinkler system does not contain or control the fire by the time the fire department arrives, and if the first fire attack is not successful in controlling the fire, consider that the fire will break through into void spaces, if it has not done so already. Also anticipate that you might not have time for a second attack before the structure might collapse.

ENDNOTES

1. The Steel Framing Alliance, Washington, DC, http://www.steelframing.org/index.php/. Manufacturers supply steel studs and joists as heavy as 12 gauge, or 0.1017-inch or 2.5832 mm (almost 7/64 inch) for heavier structural applications. Internet search “steel studs and joists,” for examples.

2. These fasteners screw directly into holes drilled into concrete or masonry. Internet search “self-threading concrete anchors” for more information on these fasteners.

3. Exterior insulating foam system is a synthetic stucco. Internet search “EIFS” for more information on these systems.

4. “Type X” indicates that the gypsum core has additives that make it even more fire resistant than natural gypsum. Internet search “Type X drywall board,” “mold-resistant drywall board,” and “impact-resistant drywall board” for more information on these products.


6. A Guide to Fire and Acoustic Data for Cold-Formed Steel Floor and Wall Assemblies, the Steel Framing Alliance and Canadian Steel Construction Council. It summarizes the contents of individual UL and other agency fire resistance ratings. This publication can be downloaded free at http://www.steelframing.org/sfa_fire_acoustic_directory.shtml/.

7. Internet search “gypsum underlayment” and “gypsum roof board” for more information on these types of materials.

● GREGORY HAVEL is a member of the Burlington (WI) Fire Department, a retired deputy chief and training officer, and a 30-year veteran of the fire service. He is a Wisconsin-certified fire instructor II and fire officer II, an adjunct instructor in fire service programs at Gateway Technical College, and safety director for Scherrer Construction Co., Inc. Havel has a bachelor’s degree from St. Norbert College and has more than 30 years of experience in facilities management and building construction.
Building Construction: Lightweight Steel Framing

COURSE EXAMINATION INFORMATION

To receive credit and your certificate of completion for participation in this educational activity, you must complete the program post examination and receive a score of 70% or better. You have the following options for completion.

Option One: Online Completion

Use this page to review the questions and mark your answers. Return to www.FireEngineeringUniversity.com and sign in. If you have not previously purchased the program, select it from the “Online Courses” listing and complete the online purchase process. Once purchased, the program will be added to your User History page where a Take Exam link will be provided. Click on the “Take Exam” link, complete all the program questions, and submit your answers. An immediate grade report will be provided and on receiving a passing grade your Certificate of Completion will be provided immediately for viewing and/or printing. Certificates may be viewed and/or printed anytime in the future by returning to the site and signing in.

Option Two: Traditional Completion

You may fax or mail your answers with payment to PennWell (see Traditional Completion Information on following page). All information requested must be provided to process the program for certification and credit. Be sure to complete ALL “Payment,” “Personal Certification Information,” “Answers,” and “Evaluation” forms. Your exam will be graded within 72 hours of receipt. On successful completion of the post test (70% or higher), a “Certificate of Completion” will be mailed to the address provided.

COURSE EXAMINATION

1. Noncombustible construction is classified as:
   a. Type I
   b. Type II
   c. Type III
   d. Type V

2. Steel studs in partition walls are typically:
   a. 22 gauge
   b. 20 gauge
   c. 28 gauge
   d. 25 gauge

3. Steel studs are attached to floors through the use of:
   a. galvanized steel channels
   b. wood plates
   c. PVC channels
   d. polyethylene planks

4. Fire-rated partitions run from the:
   a. floor deck to the underside of the floor roof deck above
   b. floor deck to 6” above the ceiling
   c. floor deck to 18” above the ceiling
   d. floor deck to 24” above the ceiling

5. Studs are connected to the channels with:
   a. nails
   b. bolts
   c. self-drilling screws
   d. powder-driven pins

6. The primer used to coat multiple studs welded together for strength contains:
   a. zinc
   b. aluminum
   c. iron
   d. copper

7. Electric cables are run through studs using:
   a. aluminum bushings
   b. glass grommets
   c. glass bushings
   d. plastic bushings

8. Contact between steel studs and copper pipes can cause:
   a. galvanic corrosion
   b. electrical shorts
   c. contact welding
   d. explosive degradation

9. A break in an electrical cable due to cuts from a sharp steel stud edge can:
   a. cause breaks in adjacent water pipes
   b. break down gypsum wallboard in close contact
   c. energize the entire steel building frame
   d. rot wood

10. To prevent corrosion of aluminum window frames in contact with steel studs:
    a. wood blocks are placed between them
    b. electrical wires are bonded to them
    c. a glass coating is placed on the windows
    d. sprinkler and other water piping is attached to them

11. Blocking to attach kitchen cabinets is often made of:
    a. wood
    b. steel
    c. fire-retardant plastic
    d. both a and b are correct

12. Exterior sheathing for steel studs often is fiberglass-faced gypsum and:
    a. fire-retardant treated plywood
    b. concrete block
    c. brick
    d. glass

13. Interior gypsum board sheathing is attached to steel studs using:
    a. set screws
    b. rivets
    c. nails
    d. bugle-head self-drilling screws
14. A one-hour fire-rated steel stud wall assembly uses:
   a. 3/4” Type F gypsum board
   b. 7/8” Type F gypsum board
   c. 5/8” Type X gypsum board
   d. 1/2” Type F gypsum board

15. Concrete walls abutting steel studs often use:
   a. steel firring
   b. aluminum studs
   c. wood firring strips
   d. plastic tubing

16. Which of the following is not a component of a flat roof structure supported by a steel stud wall?
   a. steel roof deck
   b. a layer of fire-rated fiberglass-faced gypsum board
   c. a layer of extruded foam insulating board
   d. a plastic roof membrane

17. During a fire, an entire steel stud wall assembly can be considered one large void space since:
   a. steel rivets may fail
   b. holes are placed in the studs to allow the installation of wiring
   c. there are no sprinklers inside the wall
   d. there are no smoke detectors inside the void

18. A fire inside a steel stud wall will cause the wall to:
   a. be protected by sprinklers inside the wall
   b. be immediately detected by a smoke detector in the void
   c. vibrate uncontrollably
   d. fail more quickly than a wood stud wall

19. Pitched roofs often use galvanized steel studs that:
   a. are designed in dimensional lumber sizes
   b. are twisted
   c. are bent in a “V” shape
   d. are fire-resistive

20. Steel-jacketed electric cables in steel stud walls:
   a. do not require any special protection
   b. must be thermally insulated
   c. can only run vertically
   d. must be specially protected

Notes
# Building Construction: Lightweight Steel Framing

## PROGRAM COMPLETION INFORMATION
If you wish to purchase and complete this activity traditionally (mail or fax) rather than Online, you must provide the information requested below. Please be sure to select your answers carefully and complete the evaluation information. To receive credit, you must answer at least six of the eight questions correctly.

Complete online at: www.FireEngineeringUniversity.com

## PERSONAL CERTIFICATION INFORMATION:

<table>
<thead>
<tr>
<th>Last Name (PLEASE PRINT CLEARLY OR TYPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>First Name</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Profession/Credentials License Number</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Street Address</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Suite or Apartment Number</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>City/State Zip Code</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Daytime Telephone Number with Area Code</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fax Number with Area Code</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>E-mail Address</td>
</tr>
</tbody>
</table>

## TRADITIONAL COMPLETION INFORMATION:

Mail or fax completed answer sheet to Fire Engineering University, Attn: Carroll Hull, 1421 S. Sheridan Road, Tulsa OK 74112

Fax: (918) 831-9804

## PAYMENT & CREDIT INFORMATION

Examination Fee: $25.00       Credit Hours: 4

## PROGRAM COMPLETION INFORMATION

To receive credit for this course, you must answer at least six of the eight questions correctly.

## COURSE EVALUATION

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 1.

1. To what extent were the course objectives accomplished overall?  S  4  3  2  1
2. Rate your personal mastery of the course objectives.  S  4  3  2  1
3. How would you rate the objectives and educational methods?  S  4  3  2  1
4. How do you rate the instructor's effectiveness?  S  4  3  2  1
5. Rate the overall administration of the course effective?  S  4  3  2  1
6. Do you feel that the references were adequate?  Yes  No
7. Would you participate in a similar program on a different topic?  Yes  No
8. If any of the continuing education questions were unclear or ambiguous, please list them.  
9. What additional continuing education topics would you like to see?  

## PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

Please photocopy the answer sheet below for additional participants.