BIGGER SPANS & HEAVIER LOADS

by Harris Hyman

Bar joists can span up to 50 feet on 8 foot centers in most parts of New England.

An introduction to the concrete and steel systems that support light-commercial buildings

Making the move from porches, kitchens, and small houses to light-commercial buildings can be exciting for the small contractor.

The money is usually well into the six digits. The owner wants the job done on time, but is not likely to hassle you on each and every ding in the drywall. If the plans look straightforward and the subs give good prices, things may look great.

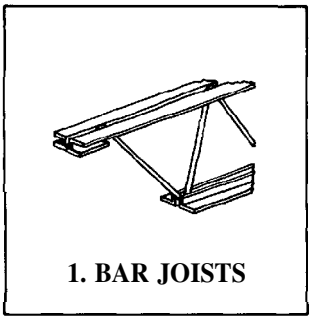
Maybe they are. But your skills in residential construction will not automatically carry over into light-commercial buildings. The manner in which you adapt to the differences will determine your success or failure in this new arena.

Commercial and residential construction projects differ on three fronts: financing, personnel, and technology. This piece examines problems with the last two. Knowing the headaches you'll run into with construction details will help clarify the ones you'll run into with people. So we'll start with technology.

Lots of Steel

The first major technical difference is the amount of steel used. It is an unusual house that uses more than three pieces of structural steel. Generally, steel is used only for the main girders across the basement, although it might be used as a problem-solver for headers over wide openings. But the large spans of commercial and institutional buildings require lots of steel. In houses, spaces are usually less than 16 feet across. Commercial spaces are often 50 to 60 feet wide—a distance difficult (although not impossible) to span with sticks. Other systems are needed.

The most popular is the *bar joist.* We've all seen bar joists, but they are worth a closer look. A bar joist (Sketch 1) is basically a steel truss, with a pair of angles for each of the top and bottom chords. These chords are connected with rods or straps in the conventional diagonal pattern of a truss. They are available in standard sizes, with several strengths for each depth, where depths run from about 8 to 30 inches in the lightest series. The deepest of these bar joists, placed 8 feet on-center, will allow a 50-foot roof span in most areas of New England.



Sketch 1. *A bar joist is a steel truss with a pair of angles for each of the top and bottom chords.*

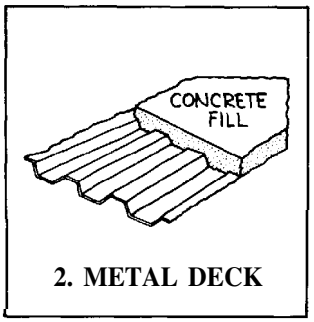
The joists are fabricated to order, in lengths required by the job. This is usually handled by the local steel yard. "Local" here might mean halfway across the state, so it is often prudent to do some serious shopping, even calling several states away. Delivery schedules and shipping charges can be as important as prices.

When the joists arrive, the next surprise comes: they are very heavy. A crane of some sort is needed for erection, and this must be planned and scheduled so that the job flows properly. Machines like cranes are expensive—the meter runs whether they are lifting or just sitting around—so careful scheduling is very important (See Starobin, "The Critical Path Method," this issue). Residential jobs are accomplished with a crew of four or five, and there is no real dead time. There is always something to be done. Your first commercial jobs, however, probably can't be done with the in-house equipment, so there are new subs—like crane operators. It takes work to schedule them.

The next problem is rigging the steel: setting it in place and integrating it into the building system. A good set of drawings handles most of the details, but there are always some assumptions made by the architect. As a carpenter, you had sufficient experience to meet the assumptions about wood framing, but steel is a little different. There is a collection of guidelines that can be obtained from the Steel Joist Institute, (1205 48th Ave N. Suite A, Myrtle Beach, SC 29577), well worth reading before you start work.

Concrete Decks

The steel joists are usually placed eight or ten feet apart; what happens on top of these? *Steel decks* (Sketch 2) are most common. These are formed of corrugated sheets, which can be cut using a hand circular saw with a sheet-metal-cutting or masonry blade since the metal is only about 1/32-inch thick. The sheets are overlapped and tack-welded to the bar joists.



Sketch 2. *Bar joists are often covered with 1/32-inch-thick corrugated steel sheets, which are then filled with concrete. Reinforcing is usually unnecessary.*

Steel decks are often filled with concrete. The corrugations form the undersurface and the concrete top can be used directly for a floor without additional construction. The decks are fairly strong and can take the wet concrete quite readily. Inexperienced contractors sometimes throw in reinforcing bars "just to be sure," but these are usually unnecessary. As a roof, the top is covered with several inches of rigid insulation and a rubber or plastic membrane for waterproofing.

This system is simple enough, except for holes and irregularities. For these, the decks (or "pans") must be cut and reinforced at the edges, usually with angles welded to the pans. Circular holes for stacks are clumsy to cut, even with a saber saw. Waterproofing requires special techniques, which are detailed in the manufacturers' literature.

Steel vs. Wood

Structural steel—I-beams, angles, and rectangular and round tubes—is often used for the framing. In most areas, steel pieces can be fabricated at a yard, delivered to the site and assembled with bolts or welding. Prior to cutting and welding the steel assemblies, the steel yard sends shop drawings

to the contractor for approval. At this point, some extremely careful checking is in order. Steel can't easily be cut to tit on the site, like wood. This seems an elementary point, but at some time, we have all missed, adding cost and inconvenience. Check carefully and all of the steel parts should go together without a hitch.

It isn't all steel though. *Wooden trusses* are becoming larger and larger, and it's possible to obtain them 70 or 80 feet long and 12 feet deep. This is the maximum size that can be shipped on the roads. The trusses are reliably engineered and fabricated and they are a fairly common part of larger buildings. However as the horror story detailed in the April 1987 issue of *New England Builder* shows, big trusses are not as easy to handle as little ones.

A few years back, it was rare to find trusses over 30 or 35 feet long. These short trusses were very convenient and economical. They were also fairly easy to handle and a couple of men could horse a 24-foot roof truss into place. Since they worked well, we all—designers, builders, and fabricators—started stretching the trusses and they became larger and larger.

All of the sudden, they were out of control. A 24-foot truss is nice and light and rigid; an 80-foot truss can be a nightmare. It is ten times as heavy as the 24-footer and soft and flexible when it is waving around at the end of a crane hook. It needs lots and lots of bracing and lots and lots of care. Big trusses are used on a lot of buildings and they obviously work; I use them myself quite a bit. Making them work, however, requires experience and attention, and an appreciation for the fact that they are really *not* the same as small ones. My rule-of-thumb calls 40 feet the dividing line between small trusses and large trusses, and I suspect that we have overused the very large ones somewhat.

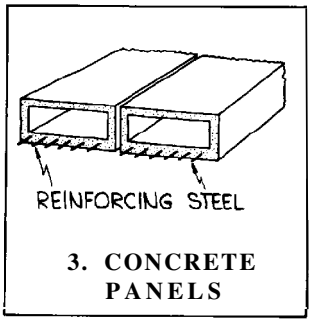
Metal studs are generally used in place of wooden ones. Used in quantity, they are more regular, lighter, stronger, and less expensive than wooden studs. They are perfectly straight, can be cut with a hand circular saw, and have pre-cut holes for electric and other utilities. They are also easier to handle than other forms of steel since they are not welded. Steel studs are put together with self-tapping screws and the power screwdriver that is now in everyone's toolbox.

Steel studs are one of the easier aspects of light commercial construction to master, and carpenters can usually come up to speed in a week or so. U.S. Gypsum (101 S. Wacker Drive, Chicago, Ill. 60606) puts out a complete manual on working with steel studs, and this should be a part of the office library. About the only big concern is to wear gloves to save some wickedly ripped hands.

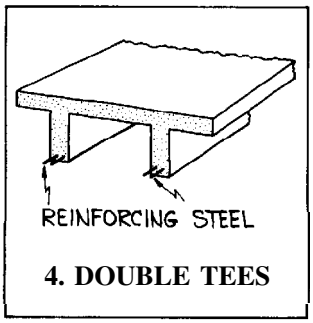
Structural Concrete

Structural concrete is occasionally used in this construction. It's really a material for heavy construction, but like steel in a wooden building, reinforced concrete is a problem solver. It is particularly good for decks, where it provides finished upper and lower surfaces in one shot. You can hold up extremely heavy loads like automobiles, and span 40 feet with a 6-inch thick slab. It also has excellent fire resistance.

Like other masonry work, structural concrete is sub-contracted. Ideally, it should be done by a firm with experience in this work, and an engineer should check the rebar before the concrete is placed, and be there during placement for slump tests and preparation of test cylinders. Structural concrete is economical, and has almost unlimited capabilities and flexibility, but it takes great care—more than most other building techniques.



3. CONCRETE PANELS



4. DOUBLE TEES

Sketches 3 & 4. *Precast concrete planks offer the strength of structural concrete without the fussy construction. In longer lengths—up to 100 feet—they come in double tees.*

Precast concrete planks (Sketch 3) offer many of the advantages of cast-in-place reinforced concrete, without requiring the fussy construction. These, like trusses, are engineered and fabricated in a plant and shipped to a site ready for installation. They are available up to 100-feet long and run 8- to 16-inches thick. In the longer lengths, they come as double tees (Sketch 4).

Concrete planks are so heavy that no one even contemplates erecting them without a crane. They are quite rigid, and easy to manipulate into place, and are just laid on the supports. The planked surface is often topped with a thin layer of concrete which is finished in place.

Most of the concrete pre-fabricating yards will provide engineering for the planks, working from the architectural plans to shop drawings. They work out the problems of holes and other openings in the system, and often stamp the drawings for structural design integrity. Here, as with all shop drawings, checking is extremely important.

Fire Safety

Fire protection is important for light commercial construction, since most of the buildings are either public or workplaces. The National Life Safety Code is quite explicit in the requirements for public buildings. When fires do occur in properly designed buildings, they can be contained, and people can escape easily. The code gives "ratings" for walls, partitions, floors and doors. These are minimum times that the walls and doors will resist a fire without burning through.

Doors and frames are specifically fire-rated by the manufacturer, but wall and partition systems are designed by the architect. The typical material is fire-rated gypsum board. It is mostly recognizable because it is 5/8-inch thick, and very, very heavy. This extra weight is the main problem. A strong man can handle a 4x8 sheet, but two people are required for the larger sized sheets. The extra weight slows the job down and tires out the crew, making a fire-rated job somewhat more expensive than conventional drywall hanging. This is another place the inexperienced contractor can trip up.

Personnel Considerations

Relationships with your building crew may be a far more serious problem than the actual construction techniques. Much more of the job requires specialists if you employ them, subs if you do not. A house can be built in reasonable time by a four or five-person carpentry crew. After a few jobs the folks get used to one another, and a good manager can help the crew to function fairly smoothly. They can do most of the tasks required in building a house, since most of a house is carpentry.

One commercial job can destroy this harmony, since a relatively small amount of a light-commercial job is carpentry. Here, the carpentry is generally confined to the finish, with the framing, roofing, and partitions all constructed by subcontractors. With a house, the subs—often just plumbers, electricians, and foundation crew—are casual visitors. On a bigger job, integration of the subs, who do most of the hands-on work, is the principal job of the general contractor.

In this environment, the old boys on the crew don't do everything as they are perhaps used to. And they don't work together as closely as they used to. This can be an uncomfortable situation for the workers and the boss.

A big job is particularly difficult for the "kid" on the crew: the least experienced person. A carpentry job has lots of opportunity to grow and assume responsibility, but it is hard to learn the trade of a welder or mason or crane operator without some specific training and work. So, the kid becomes even more of a "go-fer," doing nothing but fetching and sweeping, which can be disheartening.

This happened to my son, a young but capable carpenter. Bill's employer moved into a couple of big jobs—a bank and a school. Bill did some construction work, but mostly carried materials in and trash out. After a year he realized that the situation would not let him learn or progress very rapidly, so he had to leave. His former employer continues to do well on the big jobs, and Bill also does well, but on smaller jobs where he now leads a crew.

Another personnel consideration is a welder and a couple of thousand dollars worth of welding equipment. There must be a metalworker in-house. Even if most of the erection work is subbed out, a captive welder is still necessary for coping with the numerous odd jobs that surround the project. But, the welder is a specialist, which introduces another (and different) line of communication. The building process can seem very complex for a while.

Someone once suggested, "There are no problems, only opportunities." Light-commercial construction offers both: big rewards to those who master it, and anxiety and occasional ruin to those who miss. Whichever way you go, it should be a real open-eyes, conscious decision. Good luck. ■

Harris Hyman is a "rural G.P. engineer" in Lamoine, Maine.