How Cold-Formed Steel Framing Solves Design Challenges for Architects

BuildSteel

Cold-Formed Steel Framing Resource Center for Building Professionals

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Every building is as fundamentally unique as the people that inhabit it, so it's not surprising that the choice of construction materials inherently changes from footprint to footprint. Selecting the material for a building's framing structure is perhaps one of the most critical decisions made during the design phase. Often, architects and engineers select cold-formed steel (CFS) framing for its ease of installation, durability, design flexibility, and cost-effectiveness. CFS framing can be used to meet many standard design requirements, as well as to solve complex architectural challenges.

This eBook will highlight five unique projects that architects and structural engineers completed successfully with CFS framing. We will explore:

- **How CFS framing can quickly and cost-effectively allow for greater building heights and areas.**
- **Where CFS framing has been used to create unique aesthetic features**
- **How a multi-family project achieved reduced time to occupancy and generated additional revenue by using CFS framing**
- **Where CFS framing was used to enable prefabrication and facilitate design-build construction**

What Is Cold-Formed Steel?

Cold-formed steel (CFS) was originally a product of the 19th century, although it started to become more of a mainstream material in 1946 upon publication of the first edition of the AISI "Specification for the Design of Cold-Formed Steel Structural Members." From 1946 to present day, CFS has been making its mark on architecture and providing building owners with new design options that were previously not available due to the lack of design codes and standards.

The American Iron and Steel Institute (AISI) defines cold-formed steel as "shapes manufactured by press-braking blanks sheared from sheets, cut lengths of coils or plates, or by roll-forming cold-rolled or hot-rolled coils or sheets; both forming operations being performed at ambient room temperature, that is, without manifest addition of heat such as would be required from hot forming." As a result, CFS members are typically thinner than hot-rolled steel sections, and offer a high strength-to-weight ratio.

Architects choose to use CFS framing for a range of reasons, including:

- Possibilities for innovative design concepts, such as the Walt Disney Concert Hall, designed by Frank Gehry
- High strength-to-weight ratio, expanding the possibilities of adding function and space to existing buildings
- Ability to prefabricate framing and structural members to ensure the backup envelope gets framed and windows are installed quickly and seamlessly

Altogether, the qualities of CFS framing make it an ideal building material to solve many design challenges and bring architects' visions to life.

Credit: Photographs in the Carol M. Highsmith Archive, Library of Congress, Prints and Photographs Division.

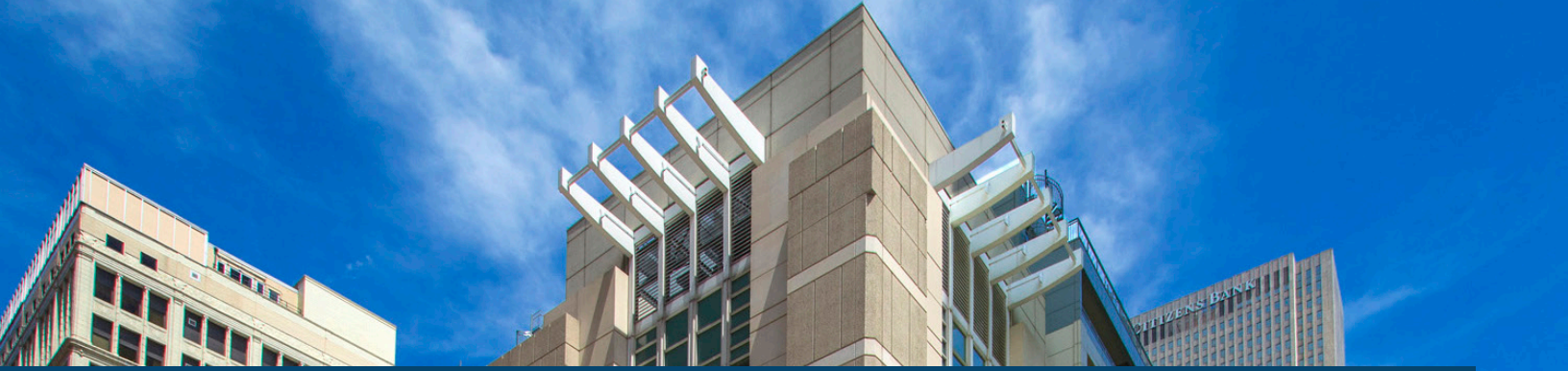
Frank Gehry's Walt Disney Concert Hall in Los Angeles

Frank Gehry's Walt Disney Concert Hall in Los Angeles is the epitome of multifaceted architectural solutions. Gehry described his architecture as "liquid architecture," where the exterior surfaces are curvilinear, resembling billowing steel sails made from thousands of uniquely shaped CFS structural members. To make Gehry's eccentric architecture possible, teams of engineers created complex BIM drawings that worked in unison with computer numerical control (CNC) fabrication. The surfaces may have as many as 50 curvatures on a single piece of CFS.

Workers on-site were able to bend interior studs into flawless curvilinear shapes with a precision bending system that enabled workers to fabricate thousands of steel members down to accuracy within 1/8 inch in a span of 36 feet. As a result, this concert hall, among all of Gehry's subsequent works, are truly some of the most amazing examples of architecture of our modern day.

Sustainability

In today's building designs, sustainability has become a necessity, rather than an additional upgrade. Architects now look for ways to construct buildings with low environmental impact. Many are turning to the most recycled material on the planet: steel. CFS framing has many sustainable advantages. CFS framing can be recycled and reused in new construction materials. Perhaps the most significant sustainable feature of CFS framing is its longevity. The longer the building is standing, the less the environmental waste. Using CFS framing reduces the need for repairs and reconstruction, and helps preserve the building for future generations to enjoy.



Challenge 1:
Adding Height and Utility to an Existing Structure

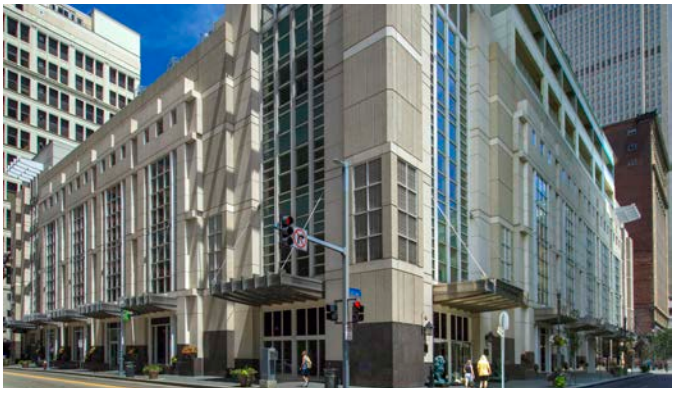
PIATT PLACE, PITTSBURGH, PENNSYLVANIA

CFS framing can add lightweight height to an existing building. A building that exemplifies this concept is the Piatt Place in Pittsburgh, Pennsylvania. When the character of a neighborhood in Pittsburgh changed, and consequently the retail store that had formerly occupied the building failed, the owners, Millcraft Investments, decided to renovate the building and change its purpose into a mixed-use structure. To accomplish this vision, they needed to build several new stories above the original structure to add a significant number of new residential condos. Located in the center of Pittsburgh, the Piatt Place had previously been a retail building with a parking garage.

Along with project architect Tom Price of Strada of Pittsburgh, structural engineers SWSG of Herndon, Virginia, selected CFS framing for the project due to its light weight and high-strength qualities.

According to Ted Welti, P.E., division manager of cold-formed steel for SWSG, "The use of cold-formed steel allowed us to minimize the additional weight on the foundation and footing so the existing structural framing could be used … making the project economically feasible."

The structural system consists of CFS framing as the primary axial load-bearing and lateral load-resisting system. In this case, the CFS joists and decks of the floors and roof were designed to act as diaphragms to transfer the lateral loads from the corners and exterior walls of the building to an inner core of beefed-up and overlapped x-braced shear walls. This structure was engineered to accommodate an open floor space layout with continuous glass exterior walls. **The building's new design posed a structural challenge that was solved only by using CFS framing.**



Images courtesy of Millcraft Investments

Expanding potential of existing buildings

There are many reasons to add to or extend an existing building. The use of a building may have changed over time, requiring more space and flexibility. It may need improvements or added efficiency to meet code requirements. Or an owner may want to increase property value and attract tenants by adding special features such as rooftop terraces, balconies, or circulation spaces.

Such expansions can be challenging and design-intensive. The additional space adds to the load of the existing structure, and if the building is an urban infill, multi-story or multi-tenant, or part of a larger development, there are fire safety and other codes and regulations that must be addressed.

With CFS framing, architects can structurally modify or add to an existing building more easily and cost-effectively than is possible with heavier or less fire- and moisture-resistant materials. They can take advantage of precision modeling of complex geometries and off-site fabrication of CFS components to cut back on on-site disruption and waste. CFS framing also allows for longer spans and a commercially rated construction methodology to meet local codes and conditions. The precision and modularity enabled by CFS framing further supports an architect's potential to design for confined and otherwise challenging spaces.

Challenge 2:
Building Higher While Avoiding Higher Costs

EMBASSY SUITES, COLUMBUS, OHIO

When Bird Houk Architects and Jezerinac Geers, Structural Engineers, sat down to design the Embassy Suites hotel in Columbus, Ohio, the team faced the challenge of developing a cost-effective structure that was seven stories high. Ultimately, the team chose CFS framing as the structural system based on cost estimating and a unique structural design.

The design teams calculated that CFS framing saved them $10 per square foot over the use of concrete.

The team found that CFS framing was also ideal for the design of the building, and was used for both the interior and exterior load-bearing walls, floors, and roof joists. This distinctive structural design hinged upon CFS's strength. Thicker studs were used on the lower floors, while thinner studs were used on each subsequent, upper-level floor where the loads were lessened. All the load-bearing framing throughout the building consisted of six-inch studs spaced 24 inches on center from the bottom floors up to the top.

So, when the studs needed to support more weight, the thickness of the material was increased, while leaving the size of the wall still at a minimum six inches. Leaving walls at six inches maximized the useable space throughout. Not only was the CFS material less expensive, but the team was able to garner even more savings during the construction phase by avoiding concrete formwork and lengthy drying times.

Images courtesy of Brackett Builders, Inc

Affordable growth

Adding height to a building doesn't have to break a project's budget. **CFS framing and truss systems can help cut costs while supporting a design vision**. In fact, CFS construction methods are the same as those used with other materials, but CFS products provide greater flexibility and functionality.

Although modular vertical expansion may not be appropriate for all buildings, it is ideal for structures with repetitive plans and elements as found in many multi-family and multi-story buildings. In addition to savings in construction through use of lightweight, code-compliant systems, building owners receive return on investment through the finished space itself. Building vertically on existing buildings is a way to achieve more space and revenue within the same footprint. In dense urban areas, where real estate comes at a premium, savings can be significant. CFS construction also provides architects with opportunity to make a creative and environmentally friendly impact with the additional height and more complex rooflines.

Challenge 3:
Incorporating Unique Aesthetic Features

CHART INDUSTRIES FACTORY OFFICE, LA CROSSE, WISCONSIN

Sometimes, particular designs cannot become a reality without the use of cold-formed steel. For example, CFS framing made the design a reality at the Chart Industries Factory Office of La Crosse, Wisconsin, designed by the architect and structural engineer Construction Express, Inc. also of La Crosse.

The project used CFS framing to create a building that has more light, glass, and openness than many other comparable building types.

Sometimes, particular designs cannot become a reality without the use of cold-formed steel. For example, CFS framing made the design a reality at the Chart Industries Factory Office of La Crosse, Wisconsin, designed by the architect and structural engineer Construction Express, Inc. also of La Crosse.

Perhaps the most elegant aspect of the Chart Industries Factory Office design is the use of a rainscreen, which is becoming an increasingly popular façade design. Rainscreens provide excellent weather and insulation protection. CFS framing is the predominant and perhaps only possible structural material useful for the creation of a rainscreen because of its strength and resistance to corrosion.

The design team saved an estimated $2.50 per square foot in project costs with the use of CFS framing over the use of masonry wall construction. In addition to project cost savings, the exterior walls — rainscreens — achieve a remarkably high R-value due to the addition of continuous insulation. According to Holstrom, "The energy code is getting so difficult to allow plain block walls to perform at high enough energy efficiency levels."

Additionally, the architect selected CFS studs and a thin-coat plaster system instead of traditional gypsum board for the interior walls. The result is that these walls are much more durable and industrious. CFS framing lends itself well to these types of hybrid wall construction innovations.

Rainscreens and other special features

CFS framing is not an aesthetic material in and of itself. However, its thinner profile supports lighter construction than other materials. And its safety and durability make it ideal as a substrate and backup for veneer facades and special features, including rainscreens.

Because CFS framing can be customized to allow for wider stud spacing and varying thicknesses, architects have greater freedom to design a modern, open building without compromising structural integrity or insulative qualities.

Getting in the LEED

CFS framing provides numerous environmental benefits and can help buildings achieve the prestigious Leadership in Energy & Environmental Design (LEED®) certification.

LEED®, developed by the U.S. Green Building Council, aims to improve occupant well-being, environmental performance, and economic returns of a building. CFS framing helps buildings meet LEED® standards in the areas of innovative practices, standards, and technologies.

These products are strong, durable, and endlessly recyclable. According to the Steel Framing Industry Association (SFIA), steel is "...the only true cradle-to-grave building material" because it can be recycled without loss of product quality.

Furthermore, CFS framing resists corrosion and can last well beyond the life of a building. The material also results in less construction waste because it's pre-manufactured and cut to length before being delivered to a project site.

Because of the use of recycled content, high recyclability, low emissivity, limited waste, and "exemplary performance," CFS products can help projects qualify for up to:

- **9 points under LEED v4 for BD+C**
- **13 points under LEED 2009 LEED-NC (Version 2.2 and 3.0)**

To learn more about CFS framing and LEED®, visit the SFIA website.

Challenge 4:
Reducing Time to Occupancy

255 COLBURN STREET
BRANTFORD, ONTARIO, CANADA

When constructing a multi-family project, building professionals must take timeline into consideration; the quicker they complete the building, the sooner they can begin to fill units and generate revenue. While 255 Colburn Street in Brantford, Ontario, Canada was initially constructed with CFS framing to save the owner high insurance premiums, more meaningful and significant savings came into play because of a condensed construction timeline.

The use of CFS framing shaved at least six weeks from the construction timeline of the mixed-use, first-floor retail and four-floor residential building, compared to poured concrete or masonry. That allowed the owner to begin collecting rent much earlier than anticipated — adding up to approximately $100,000 in extra revenue.

Prefabricated CFS wall panels and roof trusses were constructed off-site to reduce the construction time and costs dramatically. Additionally, the CFS studs went up so quickly on each of the five floors of the building that the project shaved off one week per floor in constructing the interior studs alone.

"There was the added benefit of using CFS framing to reduce call-backs due to cracked drywall from lumber shrinkage," said Brock Martin, president of Majesty Building Systems and Colborne Street project manager.

Additionally, by using CFS framing, the team garnered even more savings by reducing the need for a crane, and other trades were able to access the building more quickly to finish the project. When a high-stakes, tight construction schedule is on the horizon, CFS framing may likely be the optimal structural solution.

Prefabrication

Designers select CFS members most often for prefabrication projects because of the material's durability. It is easier to transport the CFS structure to a new location without fear of damage. Furthermore, the lighter weight material (as opposed to concrete, for example) is easier to transport and lift into place on-site.

The indoor conditions of a prefabrication warehouse typically lead to a better-controlled project completed in less time than it takes in the field, because workers do not have to account for rain, snow, or other elements that can impact an outdoor jobsite. Building and designing technologies also have evolved to the point where prefabrication is much more attainable. While there are advantages and disadvantages to each construction method, CFS framing makes prefabrication one of many viable choices.

Increased revenue from accelerated occupancy

Reduced time to occupancy is crucial for building owners seeking to start operations and collect revenues. In fact, the longer it takes to finish construction, the more revenue is lost.

By specifying CFS framing, architects contribute to a project's success by ensuring that the backup envelope gets framed and windows are installed quickly and seamlessly. This allows the veneer portion of the wall system to follow and accelerates interior construction. By contrast, masonry and other wall systems are slow, especially as you go higher up on a building.

Challenge 5:
Facilitating Design-Build Projects

VICTORY HALL AT THE UNIVERSITY OF NORTH TEXAS, DENTON

With design-build or shovel-ready projects, CFS framing is more of a readily available building material. The building's design can still be in the process of finalization when the shop drawings are shipped off to the steel manufacturers. Consider Dubai, where many architects and structural engineers have gone to the edge of building design as they create the plans sometimes only one day before those plans are underway in the construction phase on-site.

Design-build can be intense, but CFS framing helps to make it more of an attainable reality. For example, architects and engineers at Jacobs Engineering Group of Pasadena, California designed the Victory Hall dormitory on the University of North Texas, Denton, campus. In a way similar to building in Dubai, the contractor for Victory Hall started to change out the structure from concrete to CFS structural framing while the building's construction was already underway.

"I got to know all the architects and the design-build people at UNT," said Virgil Strange, president of Axiom Commercial, Denton, and then a consultant to Nuconsteel. "One night at a social event, the Victory Hall project came up in conversation. I learned the university was having trouble with its scheduling and costs." The university needed the dormitory to be open for the start of the school year, and the construction had only begun in June. Then, as construction began, they ran into infrastructure problems on the campus that set the team back even further from finishing by the deadline.

Triple these challenges with a sudden increase in concrete costs at the time, and contractor Strange took the initiative to convince the professional team to change the structure from concrete to CFS framing. By doing so, there was a significant saving in materials costs, labor, and time so they could stay on pace with the targeted project schedule.

The architects designed the new CFS-framed structure to fit upon the existing freshly-poured foundation walls. In fact, many design-build projects work this way — to pour the foundation and let it strengthen over 30 days while designers complete the construction document phase.

This sudden change over to a CFS structural system allowed the project to hit its deadline and enabled the end cost to come down to a much more reasonable price.

Images courtesy of Steel Framing Industry Association

A competitive advantage

The design-build process is about delivering streamlined, high-quality service at the lowest cost possible cost. This explains the appeal to building owners, particularly in the public sector. As a result, design-build teams are continually pushed to provide competitive alternatives that help reduce costs and increase speed, while retaining adaptive flexibility.

By turning to CFS framing products, architects can take advantage of this flexibility to create responsive design that meets an owner's needs and delivers a high-performance solution for all occupants and users — all while keeping costs under control. Doing so enables the entire design-build team to provide competitive a best-value bid.

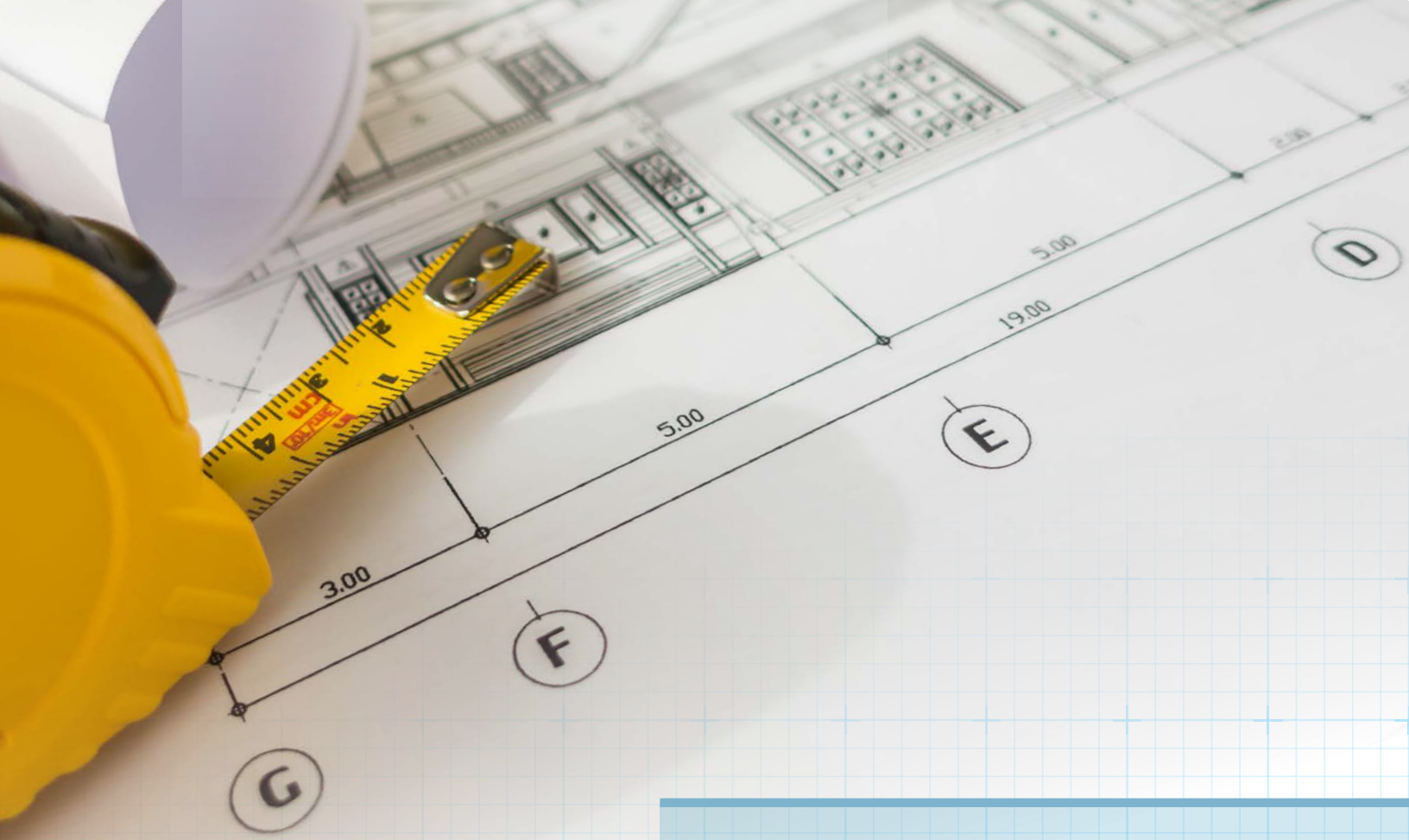
Innovative cold-formed steel features

While CFS framing is already a classic manufactured marvel, many engineering innovations continue to come to the market, augmenting the usefulness of CFS framing. Below are a few examples of recent CFS innovations:

- **Adjustable CFS studs that can adjust to their surroundings, such as in an area where the concrete slab has some variations.**
- **Curved CFS track and studs provide ultimate customization for contemporary architectural demands.**
- **Integrated framing systems include a host of different innovations, such as concrete/CFS hybrid walls.**
- **Hybrid CFS joint systems are durable and dimensionally stable steel parts that connect structural CFS members together.**

"Each material has its specific characteristics which we must understand if we want to use it. This is no less true of steel and concrete. We must remember that everything depends on how we use a material, not on the material itself," said modern architect Ludwig Mies van der Rohe in his inaugural address on taking his position in Chicago at the then-called Armour Institute of Technology, where Mies van der Rohe created many of his iconic, steel minimalistic buildings.

CFS framing makes its mark increasingly more noticeable in contemporary architecture. From prefabrication to design-build, to Gehry's "liquid architecture," CFS framing is perhaps the hidden giant, behind the scenes, holding up building innovation at its most cutting edge. From Mies van der Rohe to Gehry, the steel makes the building.



Conquer Your Next Design Challenge

Building professionals have had great success taking advantage of the benefits of CFS framing – including its strength and cost effectiveness – to solve unique and complex design challenges. From adding height to an existing structure to creating aesthetic design features, CFS framing can help architects and building professionals achieve their desired vision for a project.

If you have an upcoming CFS framed project and need help during the design or planning process, request complimentary assistance from the BuildSteel team of experts. Request assistance now.

About **BuildSteel**

BuildSteel provides valuable resources, education, and complimentary project assistance related to the use of cold-formed steel framing in low and mid-rise and multi-family construction projects.

As a centralized source for information, BuildSteel offers resources to help move your next cold-formed steel framing project forward efficiently and effectively.

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