

The latest in metal building systems (MBSs) provides architects with great design freedom and high-performance construction for safe, durable buildings.



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# Creative Design Alternatives Using Metal Building Systems

There are differences between design perceptions and realities

Sponsored by Metal Building Manufacturers Association (MBMA)

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**M**etal building systems (MBSs), sometimes referred to as pre-engineered metal buildings, have been popularly used in this country for more than 60 years. Many people, including architects, often associate them with rather simple, box-shaped buildings such as industrial warehouses, manufacturing or agricultural facilities, vehicle garages, aviation hangars, etc. While it is true that they have become the go-to solution for many low-rise buildings of this type, they are also now being used for many other types of buildings. Architects are applying creative ideas that often utilize wall finishes such that it

is hard to tell it is a MBS. In this course, we look at some of the common perceptions and misperceptions surrounding MBSs. We also explore the reality of the many different building types that are incorporating MBSs into creative, affordable, sustainable designs all around the country every day.

## METAL BUILDINGS OVERVIEW

MBSs have been in widespread use since World War II and currently account for almost 40 percent of low-rise, nonresidential construction in the United States. The trade association representing the industry is the Metal Building

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### Learning Objectives

After reading this article, you should be able to:

1. Identify and recognize the characteristics of high-performance metal building systems (MBSs) as compared to traditional construction.
2. Investigate the design potential to create low-rise, nonresidential buildings of all types that use metal building packages or metal building components integrated with traditional construction.
3. Assess the inherent efficiencies in design and construction by using a metal building.
4. Design buildings of all types using an MBS or components that break the perception of limitations for their use.

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Manufacturers Association (MBMA) ([www.mbma.com](http://www.mbma.com)). It collectively represents more than 40 building systems member companies who operate 65 manufacturing plants throughout the United States, employing more than 12,000 people. Further, more than 70 suppliers of materials, components, and services are associate members of MBMA. Metal building manufacturer members generally provide a complete package of products and services (e.g., a custom-engineered structure and enclosure.) These include the needed in-house structural-steel engineering and shop drawings for their products. They also provide full fabrication of primary and secondary structural-steel framing, metal roofing, metal wall cladding, and all accessory and trim components. They can also provide supporting products and materials such as insulation, fenestration, and roll-up doors. On-site erection and installation of the entire structural and building enclosure package is typically carried out by an independent erector/installer or general contractor.

The notable design and construction attribute that sets metal buildings apart from others is the common use of a single-source supplier to provide a full, coordinated building enclosure package. That can allow a significant portion of the building to be specified under a single specification section. Nonetheless, that does not mean they are all the same; rather, each metal building is a custom-designed solution to suit the needs of a particular project of virtually any type. Further, extensive research and testing

has helped produce advanced engineering and innovative systems to perform better and at less cost compared to a non-package approach. Naturally, it is entirely at the discretion of the design and construction team to employ a full-package approach or create a hybrid one that blends, for example, a metal building structural frame and roofing with non-metal wall cladding such as masonry, concrete tilt-up, fenestration, and others.

The process of incorporating an MBS starts when an architect provides the overall building design and specification requirements to one or more manufacturers, directly or through a general contractor or builder. Based on this information, the needed in-house structural engineering is performed for the metal building products with a corresponding price quote. Once that is reviewed and approved, then fabrication can take place not only for the structural-steel framing system but also for any of the full building enclosure components desired. Those are custom fabricated to meet the design, then the full building package is trucked to the project site. The on-site erection and installation of the metal building package can then be performed by either a local contractor or preferably a certified and trained contractor/installer.

With this working model as a basis, it is easy to see that it is more streamlined and usually more cost-efficient to design and construct a single-source metal building compared to conventional, multi-party construction. However,

those who have not worked with MBSs or manufacturers may have some misperceptions about their advantages or disadvantages. In that light, and with the benefit of the long-term experience of the MBMA, we look at some of the common misconceptions about MBSs and share some of the truths about their use.

### PERCEPTIONS VERSUS REALITY

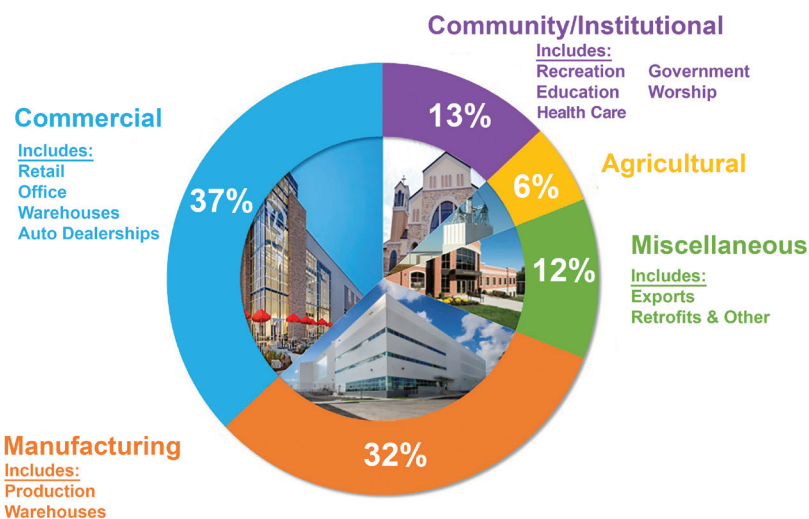
The term “metal building” often conjures up a particular look or aesthetic. However, upon completion, metal buildings can have virtually any aesthetic and not necessarily be distinguishable from conventionally constructed buildings. In fact, they have the inherent design freedom to look like anything the architect chooses. That is because metal buildings are engineered and fabricated to meet the drawings and specifications just like any other nonresidential building. Also, there is no limit on the size, shape, configuration, or finishes used in designing and constructing a metal building. Many are finished with metal wall panels, but many others are finished with other exterior building materials, such as tilt-wall concrete, CMU, brick, wood, stucco, or EIFS. Virtually any common construction material can be incorporated for the exterior design. Accordingly, some of the most typical building types to take advantage of MBSs include aviation facilities, government buildings, health-care facilities, recreational buildings, open structures, restaurants, retail stores, auto dealerships, K–12 schools, higher-education buildings, offices, places of worship, manufacturing plants, and warehouses. Virtually any low-rise building type that has a need or interest in a faster, more cost-effective delivery process than using multiple suppliers and installers is an excellent candidate for an MBS.

According to the MBMA, it is clear that architects are the biggest decision makers and/or influencers of the choice to use either an MBS or other form of construction, including conventional steel construction (i.e., hot-rolled structural-steel shapes and members). There are a lot of different reasons for this, but it really boils down to a design choice.

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## MBMA MEMBER MARKET SHARE BY BUILDING TYPE



MBSs account for a significant share of many different building types.



The Metal Building Manufacturers Association (MBMA) serves to promote the metal building systems industry. Its membership represents more than \$2.7 billion in annual sales and accounts for approximately 40 percent of the total nonresidential low-rise construction market in the United States. Follow MBMA on LinkedIn or Twitter @LearnAboutMBMA.

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Since the process of making this fundamental design decision is informed by the architect's perceptions and information about different construction methods, the following is intended to provide insights into the realities of capabilities, options, and production processes of metal buildings and components.

## DISTILLERY/BREWERY CASE STUDY



**Project:** Vista Brewing  
**Location:** Driftwood, Texas  
**Building Type:** Distillery/Brewery/Restaurant  
**Architect:** OPA Design Studio

**The Project:** Vista Brewing is a 5,000-square-foot facility that includes a production area and a 2,500-square-foot tasting room and restaurant. The brewery is in Driftwood, Texas, just outside of Austin. The founders, Kent and Karen Killough, used local architect OPA Design Studio to guide their design.

**The Design:** An MBS was chosen for its organizational and functional workspace options. Vista Brewing needed easy and quick access to barrels when making and brewing its varied selection of beers. The metal structure's 30-foot ceiling height permitted the team to easily stack the wine barrels used for aging beer.

**The Performance:** An MBS fit the brewery owners' desire to effectively control energy costs. The intense Texas heat called for some unique cooling solutions. The builder chose a very high insulation value within the structure to aid in keeping out the summer heat. Karen says, "The 30-foot ceilings help with the hot air rising above where our production team is brewing and working daily. We have been very happy with the ambient temperatures and energy bills."

**Sustainability:** For the owners of Vista Brewing, being environmentally friendly is one of their core values. So an important factor in choosing a metal building was the environmental footprint during construction. The Killoughs felt a metal structure allowed for a less-invasive environmental disturbance to the natural surroundings. They have trees that come right up to the walls of their building, so construction was carefully choreographed to accommodate the natural setting. Karen says, "We actually changed the roofline in the design in order to showcase and accommodate the tree canopies toward the rear of our building."

**The Results:** Karen says the metal building "speaks" to visitors and customers, calling attention to the organic atmosphere of the brewery, restaurant, and farm.

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## **Cost of Construction**

Generally speaking, most people, including architects, presume that it costs less to construct an MBS than most other forms of construction. In this case, that perception matches reality in almost all cases. Economical design and construction is achieved primarily from the fabrication and delivery of all metal building components being together from one source, the building manufacturer. This single-source purchasing gives the architect and owner control over every aspect of building cost, design, and construction. This single-source approach can also provide faster, more consistent, and more efficient construction, which can save on labor costs. Beyond the initial construction, expansion of an MBS can be very cost-effective too since it can be built into the original design. In many cases, removal of just one wall opens the opportunity to many add-on configuration options.

## **Speed of Construction**

The generally held perception about scheduling is that it is quicker to build using an MBS. Once again, this is generally true. According to the MBMA, construction of a metal building structure is at least 30 percent faster than conventional construction. This is because the parts of an MBS are custom designed and fabricated in a plant ready to be bolted into place on-site. This allows greater precision, reducing the likelihood of errors and omissions such as material clashes, system conflicts, or measurement mistakes. All of that means the parts and pieces can be more quickly put together with more predictability of the needed labor hours, allowing construction time schedules to be more accurate. The customized nature of the package means that only what is needed is shipped, so there is very little waste to clean up or remove, saving more time and labor cost. These attributes are not only good for the contractors but also welcomed by owners who need minimum disruption or to have a facility open as quickly as possible.

## **Durability/Long-Term Performance**

Some architects and others assume that if something is faster and less expensive to build, then it may not be as good or durable as other construction methods. That may be the case for some other products, but the reality when it comes to MBSs is very different. In fact, metal buildings have been shown to be just as durable and strong as any other type of construction. The speed and cost savings come from better engineering design, more efficient processes, and inherent economies. The quality of the materials and products remain high throughout. To that point, a metal building structural system can routinely last for many decades—longer than many buildings constructed with other typical building materials.

Over the long term, metal roofing in particular is essentially maintenance free and long lasting. This is due to the superior life-extending coatings that are routinely used on the metal panels to retain color, resist dirt, and otherwise hold up well. In fact, it is not uncommon to see metal roofing on a conventionally built building which lasts as long as or even longer than the building itself. The smooth surfaces also mean that sloped metal roofing is essentially self-cleaning. Further, the coatings on the steel do not support mold growth, resist rust and decay as well as or better than other building materials, and generally retain their appearance and integrity over time. That helps the building owner with lowered maintenance and operating costs for the life of the building. If metal wall panels are used, many of these traits would apply there as well.

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**MBSs offer structural integrity, durability, and great design flexibility by being custom fabricated to suit variable needs for structure, interior, and exterior design.**

### **Structural Standards**

The perception about the structural standard that metal buildings are held to and the integrity of MBSs seems to vary based on the experience (or lack thereof) of the person involved. Some may think that the structures are not as strong or capable as using hot-rolled structural-steel shapes. Others are unsure what to make of the use of the steel tapered frames or “bents” that often form wall and roof structural support in a single angled piece. The truth is that strength is designed and manufactured into each structural metal building component by combining proven engineering with lighter cross sections and higher-strength steel. The optimized tapered steel building frames are designed that way to “put the steel where it is required,” thus maximizing strength and efficiently using only as much material as needed. That translates into less dead-load weight and material cost. Of course, the primary advantage of steel is its strength, which can allow for significant load-carrying capabilities as well as resistance to abuse and wear. Steel used in an MBS is delivered to the manufacturer from a mill with very exacting specifications, enabling engineers to design each structure with a high degree of accuracy. If the situation warrants, hybrid structures can be used that blend the advantages of MBS construction with the conventional steel members.

The configuration of combining steel structural members with metal panels also provides substantial increases in panel strength. This is based on using standard details such as the longitudinal raised profile of a metal building panel or a stiffener lip added to the flange of cold-formed structural members. Through coordinated design, extensive research confirms that metal buildings withstand significant imposed forces such as earthquakes. This has been demonstrated in a test building subjected to a simulated earthquake at University of California San Diego. Metal buildings also stand up well against strong wind events. Further, metal roofing achieves the highest classification (Class 4) for hail resistance when tested to UL 2218: Standard for Impact Resistance of Prepared Roof Covering Materials.

### **Code Compliance/Safety**

Similar to the perception about structural standards and integrity, it appears that some architects do not always think that MBSs are code compliant or meet safety standards for fire and other hazards. The reality is just the opposite: all MBSs are designed, constructed, and inspected to be fully code compliant and as safe (or more so) than any other construction type. All bear the stamp and seal of a licensed design professional, and virtually all require building permits, which means they are reviewed and inspected just like any other building.

To assist with code compliance and quality control, the MBMA has taken the proactive role of developing a recognized accreditation program in conjunction with the International Accreditation Services (IAS). Participation in

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this program is mandatory to be a member of the MBMA. It is referred to as the Inspection Program for Manufacturers of Metal Building Systems or by its accreditation number IAS AC472. This is a comprehensive accreditation program based on the requirements of Chapter 17 of the International Building Code (IBC).

Any architect or code-enforcement official can require IAS AC472 accreditation of the manufacturer as a quality and safety qualification for a project. Doing so means that the building official and others are assured that suppliers have passed the stringent audit requirements of the IAS AC472 accreditation program. Among other things, this accreditation requires that the manufacturer only use raw materials meeting applicable ASTM specifications. When the building supplier is also doing the structural design, accreditation assures that the product is being designed by professional engineers who have demonstrated knowledge of building systems and applicable codes. It also requires that all letters of certification, design calculations, and drawings are clearly communicated and stamped by a fully qualified design professional.

Specifying only accredited companies and facilities is straightforward by checking the complete list of accredited companies and facilities on the IAS website. If a company is being proposed that is not listed, then it is reasonable to ask why the manufacturer has not been accredited or simply reject it as not qualified under the specifications.

### **Energy Usage**

Meeting energy codes or voluntary standards for green and sustainable buildings (i.e., IgCC, LEED, Green Globes, etc.) is another area where the perceptions of some people does not match the reality of built projects. The building envelope and all of the building mechanical and electrical systems can be completely customized just like any other building to achieve any level of energy performance or green building construction that is sought.

Metal buildings achieve energy and sustainability goals first by utilizing any of a multitude of high-performance insulation options—from mineral fiber batts to rigid boards or even spray-on insulation—all of which can meet or exceed energy conservation requirements. The International Energy Conservation Code (IECC) and the recognized equivalent standard ASHRAE 90.1 both have prescriptive insulation requirements specifically identified for metal buildings. This is not because the codes find MBSs to be inferior from an energy standpoint but because they recognize that there are alternative approaches to design and construction using MBSs. (The rest of the prescriptive requirements of the energy codes are based on very conservatively defined traditional framed construction.) Of course, the codes also offer performance methods of showing compliance utilizing software tools, such as COMcheck or energy modeling. This approach allows designers to select a balance of high-performance roof and wall insulation, windows, doors, and foundation insulation that works best collectively to save the most energy and money when considering all of the project requirements. In terms of the mandatory code requirements for air-sealing, the interlocking and gasketed edges of metal building panels provide excellent weather and airtightness if designed and installed properly. In addition, insulation manufacturers have products and systems specifically designed for metal buildings that integrate vapor retarders and liners that provide airtightness. The MBMA Energy Design Guide for Metal Building Systems is available at [www.mbmamannual.com](http://www.mbmamannual.com) to help with energy analysis of MBSs.

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**Among the many traits of metal buildings, good stewardship of the environmental resources and sustainability have been demonstrated in the many LEED-certified metal buildings that have been constructed.**

### **Sustainability**

Can an MBS be documented as a green or sustainable building? Yes, in fact, many MBSs have achieved LEED certification at all levels (Certified, Silver, Gold, and Platinum). In addition to energy-conserving building enclosures, metal buildings are routinely displayed as good for the environment because they are made from recycled steel, are 100 percent recyclable, and thus produce a low carbon footprint. Similarly, cool metal roof coatings repel heat, reduce the urban heat island effect, increase solar reflectivity (decreasing energy consumption), and are designed to simply clip on optional solar panels. From a construction perspective, off-site fabrication reduces construction equipment emissions while faster cleanup is achieved because metal buildings generate more than 50 percent less job-site waste than other construction approaches. For a complete look at the lifetime impacts of an MBS, it is readily possible to conduct whole building LCA calculations during the design phase of a project. More information is available at [www.mbma.com/Environmental\\_Performance.html](http://www.mbma.com/Environmental_Performance.html).

### **Solar Installations**

Directly related to sustainability, metal roofing provides a preferable substrate for crystalline/silicon solar photovoltaic (PV) arrays. Solar panels are easily installed on a standing-seam metal roof with fasteners that lock directly onto the standing seams and are hidden from view. The clips are especially beneficial because they do not require any penetration of the roof itself, thus avoiding possible water seepage. They also provide an installation advantage since on most other roofing types, a separate racking system is needed that is anchored to the roof by drilling into its surface. Mounting to a standing-seam metal roof is a better option since it eliminates the need for the racking and associated penetrations. Life expectancy is another reason metal roofs are best suited for solar arrays. The expected service life of a metal roof—recently shown to be 60 years or more—is a better match for the service life of solar panels. The current warranted life of solar panels is 20–25 years, and many of them prove to remain functional well after that. Few commercial roofs, other than metal, will last as long as the solar panels. Hence, if metal roofing is not used, all solar panels will need to be removed and reinstalled each time a roof is replaced, adding time and cost plus potentially causing damage to the system.

### **Complete Design Flexibility**

Architects sometimes think there are too many design limitations involved in using a metal building. However, as noted already, every metal building is treated as a unique package and custom fabricated to meet the needs of each project. That means that there is more inherent design flexibility than many architects may realize. This flexibility is achieved in a variety of ways. The structure of an MBS can be designed to allow for custom dimensions and shapes with maximum flexibility to create a variety of plan configurations including ells, U-shapes, squares, rectangles, etc. Column-free interior

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space is achieved with long-span framing that allows complete freedom in the design (and potential future reconfiguration) of interior layouts. Since metal buildings are highly fire resistant, they allow more options in building size and layout when calculating fire areas under the building code. Further, ease of expansion can be built right into the original design by engineering end walls to become future interior structural frames.

From an exterior design standpoint, the opportunities when using MBSs are virtually endless. Visible or hidden metal roofs, coordinated or contrasting siding, detailing, and fenestration are all exterior design elements that can be selected and controlled. Among the other design features that have been successfully used are the following:

- Intriguing options for defining mass, space, proportion and symmetry
- High slopes in building designs creating dramatic roof lines that become signature building elements
- Exteriors clad with steel siding, wood, glass, aluminum, masonry, or concrete
- Clearstory roofs and daylighting elements to create rich, open environments
- Variable building panel and roof colors and textures to allow unique architectural statements
- Metal walls and insulated panels with vertical, horizontal, deep, or shallow lines that may be embossed, smooth, or flat to accommodate architectural aesthetics
- Decorative columns and varied arch forms that are coordinated with the overall design

In essence, the style, materials, and detailing of an MBS are all variable and limited only by the imagination and skills of the designer.

## RETAIL CASE STUDY



*Photo courtesy of MBMA*

**Project:** Costco Stores  
**Building Type:** Retail/Wholesale  
**Location:** Nationwide  
**Building Owner:** Costco Wholesale Corporation  
**Architect:** MG2

**The Owner's Viewpoint:** According to Ali Moayeri, senior vice president of construction for Costco Wholesale Corporation, the technology used for fabricating and constructing metal buildings has improved so substantially over the past few decades that this multinational retail corporation now uses MBSs to construct 90 percent of its new warehouse stores.

"Costco first tested using a metal building system 32 years ago in California," Moayeri says. "Since then, the technology and process for completing metal building projects have improved considerably. For example, metal building manufacturers can now achieve 60-foot spans between rafters. That has enabled us to eliminate three bays, 200 joists, and 33 columns. These changes result in a cost savings of about \$150,000 per warehouse store and increase our flexibility for merchandising."



Speed of construction, durable and attractive exterior finishes, innovative coating processes, and the ability to achieve a lightweight, strong structure are also key benefits described by Moayeri and others involved in the design and construction of Costco stores.

**The Architect's Perspective:** Russ Hazzard, AIA, president of MG2, an architecture firm that has designed more than 700 Costco warehouse stores across the United States and abroad, says MBSs help architects to efficiently achieve the client's practical goals while also meeting the aesthetic requirements of local jurisdictions.

"Costco's philosophy is simple: keep costs down and pass the savings on to Costco members," Hazzard says. "The prototype set we have developed for Costco serves as the basis for designing the warehouse stores. How the parts of the metal buildings are put together is fairly consistent because the prototype is based on Costco's merchandising and logistical requirements. However, like other retailers, Costco must address the architectural requirements set by local zoning authorities. All kinds of nuances can influence the design of an individual store."

**The Contractor's Standpoint:** "It is important to Costco for cash registers to ring as soon as possible after the decision to build has been made," says Ernie Brandi, vice president for Span Construction, which has built more than 100 million square feet of space for Costco. "The less time we spend in construction, the earlier the store can open, and the sooner Costco members can start shopping."

"We can enclose a metal building in 45 days," Moayeri explains. "Once the roof is on, the building is 100 percent watertight. The installation of electrical, plumbing, fire protection, and lighting systems can proceed while the exterior details and features are being completed. We have a very aggressive schedule. We can build a metal warehouse store—from foundation to opening—in 110 days. The typical schedule for a conventional construction process is 160 to 180 days."

**Results:** "At the end of the day, we are all committed to bringing the right solution to the owner," Brandi concludes. "Using metal building systems enables us to provide a high-quality product that costs the owner less while performing to expectations."

## INDIVIDUAL METAL BUILDING SYSTEMS COMPARISONS

With a better understanding of the realities of MBSs, we can turn our attention to some of the details of designing and specifying an entire building package or just parts of an MBS to incorporate into the rest of a traditionally constructed building. For discussion purposes, each of the following portions of an MBS will be reviewed independently, allowing either a complete metal building package to be specified and delivered or a hybrid design that uses some metal building components and some traditional construction. Of course, keep in mind that using more traditional materials means less of a single-source supplier and some of the benefits that go with it, but with proper attention to details, excellent results can still be achieved.

### Primary Structural-Steel System

The primary structural members in an MBS are typically the tapered frames that are engineered and fabricated to meet the structural demands of the building. One such member can be used to create a single-slope profile, or two of these members can be joined together to form a gable-style roof that is

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either symmetrical or asymmetrical. The slope of the roof can vary from as little as ¼:12 (low-slope roofing) up to 12:12 (45 degrees) or steeper, meaning that the overall building heights can be customized accordingly. Since these components are custom engineered, the loading is site and building specific, allowing them to be sized economically and efficiently. They can be designed as clear-span welded built-up frames without any interior columns or for very wide buildings as multi-span layouts, incorporating interior columns as needed. There are also some systems available as long-span roofing members that can provide column-free bay spacing up to 70 feet across and other clear span designs that can be on the order of 400 feet.

Note that the primary frames in the interior of an MBS are designed to carry the loading on either side of it (i.e., half of the structural bay on either side) as per typical structural design practice. Since the building end frames of an MBS only carry half of what an interior frame does, they can be downsized accordingly to save more material and cost. However, if the plan is to allow for a future expansion of the building on an end, then that end frame can be designed as an interior one, allowing it to remain in place and streamline the expansion when the time is right.

In between the building frames, regardless of type or size, bracing is used for structural requirements related to shear loading, wind, or seismic conditions. The custom-engineered solution in this case may include diaphragm bracing from attached sheathing whenever used but will often be supplemented and/or replaced with rod, angle, or cable “X” bracing. In some cases, cantilever columns or portal frames can be used where “X” bracing cannot be accommodated.



**Primary and secondary metal building components can be combined with other building materials and systems to create unique and satisfying designs for buildings of all types.**

### **Secondary Structural-Steel System**

With the primary structure in place, squared, and braced the secondary structural elements can be added. Secondary framing is commonly made from cold-formed steel components that meet established standards for quality and grade. They can take various forms and shapes but generally fall into three common categories:

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- **Girts and purlins:** These are terms for similar but different components. A girt is a horizontal structural member in a wall that provides lateral support to resist wind loads. Girts are also used to create a framed opening around windows and doors. Purlins, on the other hand, perform the same lateral support but for the roof system and are usually run across the top of the primary steel. Both girts and purlins are roll-formed “Z” sections that are typically 8, 10, or 12 inches deep.
- **Eave struts:** These are secondary members that are installed along the roof eaves to support the edge of the roofing panels. They are typically roll- or brake-formed “C” sections with varying width and depths to suit the eave conditions.
- **Wall-base angle/trim:** These provide support for metal wall panels and closes off the open ribs at their base. This one-piece member can be fabricated with or without a panel notch in the concrete foundation.

The secondary framing can also be open-web steel joists (bar joists) when the distance between the primary frames is greater than 30 feet.

Note that the primary purpose of the secondary framing is to support and secure metal roof and wall panels to the primary framing. It is a proven system that has complete structural integrity thus saving time and money during installation. Nonetheless, other types of secondary framing, such as metal studs and sheathing, can also be incorporated where desired or detailed as part of the building design.

## Roof System

The most common roofing provided as part of an MBS (or provided as a separate product) is metal roofing. However, since very-low-slope roofs are possible, an MBS can accommodate any type of roofing, including single-ply membranes or built-up roofing systems. In those cases, coordination with the MBS manufacturer is a good idea to review details for drainage, flashing, coping, etc.

If metal roofing is selected, then there are many options. The profile can be a standing seam, ribbed, lapped, or other choice with either concealed or surface fasteners. The roofing is available in a variety of thicknesses (gauge) related to the needed strength for site conditions or building structural design. The finish and color of metal roofing can be selected from a wide range of standard offerings with custom colors also available. Roof insulation may be integral to the roofing panels in the form of insulated metal panels (IMPs), which provide a continuous layer of rigid insulation interrupted only by the panel seams. Alternatively, or in addition, roof insulation can be provided in conventional manners, such as batt or board insulation or spray foam. The details of the insulation need to be coordinated with the MBS manufacturer so that the depth of the purlins can correctly accommodate the depth of the insulation. In addition to the above, a complete roof system will include all fasteners, sealants, soffits, flashing, and roof trim as part of the package.

## Wall System

Similar to roofing, MBSs can incorporate any type of wall finish, including tilt-up concrete, masonry, metal studs with cladding, EIFS, or other common wall systems. All of these will secure and attach to the primary framing, but the details of any modifications to the secondary framing will need to be coordinated based on the wall materials used. If metal wall panels are used, the fabrication details will be the basis for coordination with the secondary and primary framing.

Metal wall panels are essentially long sheets of finished steel siding that are available as part of an MBS or as an individual product. They come with the

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options of being flat (architectural) or ribbed (rounded or squared) and capable of being installed in horizontal or vertical patterns. In all cases, the finish and color of metal wall panels is customizable from standard or custom offerings—both for the exterior and interior of the panels. Wall insulation can be installed in traditional manner or insulated metal panels, similar to IMP roofing panels, are also available for walls. Matching trim, corners, fasteners, and sealants are all available to complete the wall package.

### Other Items

In addition to all of the fundamental components described above, there are also a variety of support items available from metal building manufacturers. The most common are metal gutters and downspouts that are designed to blend in with the building trim and are custom sized to meet the needs of the roof and rain-collection area. Fenestration can be included as well in the form of windows, doors, and frames or translucent roof panels that act as skylights. These will typically be held in place with girts and purlins that are coordinated and sized during the engineering/shop drawing phase. Finally, any miscellaneous accessories, including fasteners, specialty trim, flashings, etc., are usually all available as coordinated products from the MBS manufacturer.

### CONCLUSION

Architects have a choice in how low-rise, nonresidential buildings are designed and constructed and can be very well served by integrating MBSs into projects. Despite some misperceptions, the reality is that they are used very successfully in all types of low-rise commercial and institutional buildings, including retail buildings, wholesale centers, office buildings, schools, health care facilities, university buildings, etc. They are not limited to big, boxy shapes with sloped roofs. In fact, many look like anything the architect chooses such that no one thinks of it as a “metal building” when it is complete—just as a well-designed building, which is exactly what it is.

## RECREATION/FITNESS CASE STUDY



*Photos courtesy of MBMA*

**Project:** Evans Fitness Club

**Location:** Evans, Georgia

**Building Type:** Recreation/Fitness

**Architect:** Studio 3 Design Group

**The Project:** Evans Fitness Club is a 50,000-square-foot, two-story health and exercise facility. The building includes racquetball courts, a rock climbing wall, a golf simulator, an indoor running track, a two-story spin room, a cardio room with cinema, batting cages, and individual Zen yoga, meditation, and aerobics studios. The club also provides a 4,000-square-foot daycare center, steam and sauna rooms, and two additional businesses: Smoothie King and Evans Medical Weight Loss.

**The Design:** Architectural services were provided by Studio 3 Design Group. Owner and General Manager Mike Montarbo envisioned a contemporary, industrial appearance for the fitness center. To achieve this, an MBS was

recommended with a design scheme consisting of exposed columns, bar joists, wide-open interiors, and a warm color palette. The MBS is complemented by a second-story mezzanine that was designed independently, but its conventional steel tied seamlessly to the metal building.

“The metal building frame allowed us to maximize clear story height and long spans without sacrificing interior space with additional columns,” says John Martin, executive vice president with R.W. Allen, a general contracting firm in Augusta, Georgia. In addition to being highly durable, the structure’s framing system was designed to accommodate future expansion needs.

**The Construction:** The speed of construction was another important consideration on this project. Steel placement was optimized and manufactured in accordance with the project’s specific needs, which moved the construction process along more quickly in comparison to site-built construction.

“The building’s low price point was also a major advantage,” Montarbo adds. “It gave us the opportunity to incorporate additional elements as we went along, including a center deck.” He further notes, “Compared to conventional construction methods, the savings of going with a pre-engineered roofing system was essentially the equivalent of getting a roof at no additional cost.”

**The Results:** Once Evans Fitness Club turned operational, the end result more than met Montarbo’s expectations. “We were amazed and wowed by the way it turned out,” he says. “Since we have opened, we have had about 30 gym owners tour the facility. They have all been blown away by its design, particularly the interior!”

Regarding performance, he continues, “Everything is better than we anticipated, meeting or exceeding all of our performance standards. The energy efficiency alone is phenomenal. We are paying for energy at two-thirds the cost of a conventional 20,000-square-foot building that we also operate.”

Overall, Montarbo sums up his experience as an owner this way: “It has really been a win-win situation, and we would highly recommend a metal building system to other owners and developers.” He is following his own advice, concluding, “It is our goal to build another fitness club with similar aesthetics later this year.”

## QUIZ

1. Metal building systems (MBSs) have been in widespread use since World War II and currently account for approximately what percent of low-rise, nonresidential construction in the United States?
  - a. 10
  - b. 20
  - c. 30
  - d. **Almost 40**
2. Which statement is TRUE for the exterior design of a metal building?
  - a. Only metal wall panels can be used.
  - b. **Virtually any common construction material can be incorporated.**
  - c. CMU and masonry cannot be used.
  - d. Tilt-up concrete walls are the only concrete walls that can be used.

## ONLINE PORTION

3. According to the MBMA, construction of a metal building structure is at least how much faster than conventional construction?
  - a. **30 percent**
  - b. 25 percent
  - c. 40 percent
  - d. 35 percent
  
4. Which of the following characteristics of optimized tapered metal building frames is FALSE?
  - a. They are designed that way to “put the steel where it is required.”
  - b. **They use more material than needed.**
  - c. They maximize strength.
  - d. They create less dead-load weight and material cost.
  
5. Both the IECC and ASHRAE 90.1 have prescriptive insulation requirements specifically identified for metal building because:
  - a. the codes find MBSs to be inferior from an energy standpoint.
  - b. the codes hold MBSs to a higher standard.
  - c. **the codes recognize that there are alternative approaches to design and construction using MBSs.**
  - d. None of the above
  
6. Design flexibility in metal building is achieved by:
  - a. designing the structure to allow for custom dimensions and shapes with maximum flexibility to create a variety of plan configurations.
  - b. creating column-free interior space with long-span framing that allows complete freedom in the design of interior layouts.
  - c. allowing more options in building size and layout when calculating fire areas under the building code.
  - d. **All of the above**
  
7. If the plan is to allow for a future expansion of the a metal building on an end, then the primary structural end frame can be designed:
  - a. to carry half the load of an interior frame.
  - b. with more columns across the span.
  - c. **as an interior one, allowing it to remain in place and streamline the expansion when the time is right.**
  - d. to be removed and discarded.
  
8. All of the following are true regarding a girt EXCEPT:
  - a. A girt is a horizontal structural member in a wall that provides lateral support to resist wind loads.
  - b. **Girts refer to lateral support for the roof system and are usually run across the top of the primary steel.**
  - c. Girts are used to create a framed opening around windows and doors.
  - d. Girts are roll-formed “Z” sections that are typically 8, 10, or 12 inches deep.
  
9. Roof insulation may be integral to the roofing panels:
  - a. **in the form of insulated metal panels (IMPs), which provide a continuous layer of rigid insulation interrupted only by the panel seams.**
  - b. in the form of spray-on insulation exposed to the interior.
  - c. only with field-applied insulation.
  - d. It can never be integral to the roofing panels.
  
10. Metal wall panels can be:
  - a. flat (architectural) or ribbed (rounded or squared).
  - b. installed in a horizontal pattern.
  - c. installed in a vertical pattern.
  - d. **All of the above**