Photo courtesy of MBMA

Metal building systems are used very successfully for many building types to meet green building and sustainability goals throughout the United States and Canada.

Advanced Sustainability Potential Using Metal Building Systems

Sustainability and affordability come together using available technology

Sponsored by Metal Building Manufacturers Association (MBMA)

By Peter J. Arsenault, FAIA, NCARB, LEED AP

The nonprofit Metal Building Manufacturers Association (MBMA) has been an advocate for consistent and continuous improvement in the efficiency and sustainability of metal buildings since the association's inception in 1956. Recent MBMA research has advanced the engineering understanding of metal buildings in various areas including energy usage, life-cycle assessments, carbon content of products, and resiliency including resistance to wind, fire, snow, seismic events, and hail. MBMA performs this research through collaboration with many well-respected universities and credible industry leadership organizations, such as the Metal Building Contractors and Erectors Association, the North American Insulation Manufacturers Association, and the Door & Access Systems Manufacturers Association. This course explores some of the results of this ongoing work to update architects and other design professionals on the ways that metal buildings can provide very

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Learning Objectives

After reading this article, you should be able to:

1. Describe the latest research that affirms sustainable attributes inherent to metal building systems.
2. Explore the products and processes that contribute to the sustainable attributes of metal buildings, including reductions in embodied energy and carbon.
3. Determine which metal building attributes contribute to green building codes, standards, and voluntary programs, especially LEED.
4. Explain how metal building energy reduction strategies directly impact operational energy use as well as opportunities for on-site solar energy generation.

To receive AIA credit, you are required to read the entire article and pass the quiz. Visit **ce.architecturalrecord.com** for the complete text and to take the quiz for free.

AIA COURSE #K2203R

sustainable solutions in a highly customizable and affordable manner. Throughout the discussion, project examples and case studies are used to illustrate real world solutions based on the principles described. This course is an extension of two previous introductory courses on "Using Metal Buildings to Meet and Exceed the Energy Code" (AIA Course #K2012M) and "Sustainable Metal Buildings" (AIA Course #K1812J).

METAL BUILDING SYSTEMS REVIEW

To set our context, metal buildings account for a significant percentage of all the low-rise commercial buildings constructed each year in the United States. With that in mind, it is important to remember that metal buildings take several forms.

Total Metal Building Systems

The first is a total metal building system where most (or all) of the essential structural and building enclosure components are provided by a single source—a metal building systems manufacturer. These components include the primary steel structure (columns, beams, etc.), secondary structure (purlins, girts, etc.), the wall enclosure (metal wall system or panels including inside and outside surface and insulation) and the roof system (metal roof system or panels including metal roofing and insulation).

Hybrid Metal Building Systems

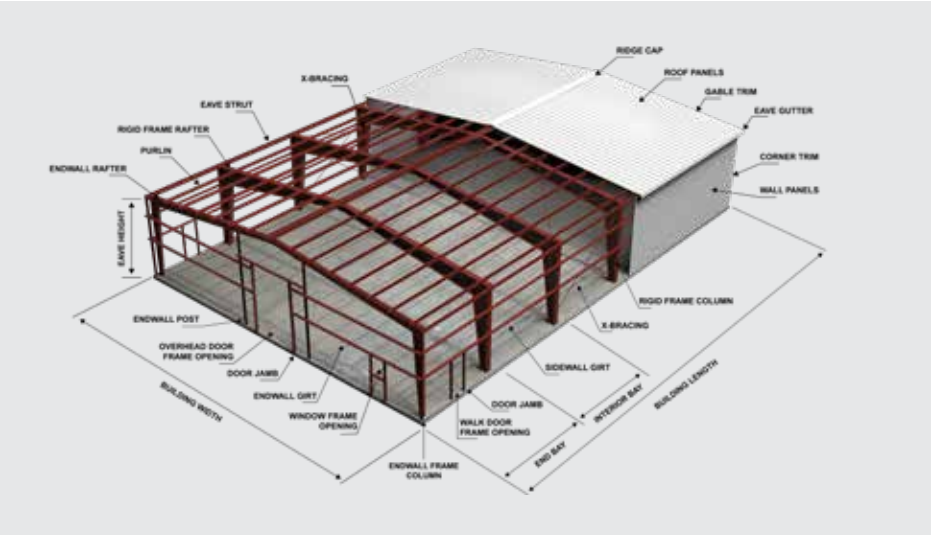
The second common form of metal building combines traditional materials with metal building system components for a hybrid system. In this case, the primary steel structure and a metal roof system or panels are provided by a metal building systems manufacturer while other components or systems are provided by others. Those could include some combination of exterior and interior wall materials including concrete, masonry, wood, glass, and metal. In hybrid systems, the insulation and air sealing systems are usually provided by others as well as specified to suit a particular project design.

SIGNIFICANT ATTRIBUTES

Regardless of the metal building type employed, all of them offer the same range of design and construction attributes:

- Flexibility: Metal building systems typically offer complete design flexibility with long clear-spans possible.
- Time Savings: Metal building systems offer faster design, fabrication, and construction process than conventional construction.
- Cost Savings: Metal building systems have consistently proven themselves to be more economical and affordable when compared to conventional construction, without sacrificing design or performance requirements.
- Sustainability: Working with a metal building manufacturer to design a custom steel structural system with a coordinated set of building enclosure components can meet or exceed high standards for sustainability in a very cost-effective manner.
- Resilience: An emerging focus is on designing and constructing buildings that are resilient, meaning they can not only survive but also bounce back quickly after a natural disaster such as wind, seismic, and flood events—or a man-made disaster, such as a chemical blast. Metal building structural systems can be fully evaluated for such events with the members, connections, and bracing designed specifically for any of the potential hazards of the project location. Since they are custom designed, specifications can include requirements that go beyond the building code to satisfy an owner's commitment to any performance or resiliency goal.

Photo courtesy of MBMA



A total metal building system includes all the components for both the building structure and its enclosure.

Design and Construction Process

Sometimes there is misunderstanding or confusion about who is in control of the parts of a metal building system. In fact, they should be treated no differently than any other building. The architect is fully responsible for the building design specifications working with the building manufacturer and the general contractor. The architect's role still includes defining the owner's project requirements, the applicable code requirements, the size and shape of the building, and the related attributes (length, width, height, roof slope, etc.). The structural system can be laid out (column spacing, beams, etc.) in concert with input from a structural engineer (provided by either the architect or the metal building manufacturer). The specifics of the exterior also remain under the purview of the architect, including the particulars of the building envelope, such as the insulation, air sealing, cladding, and openings (doors, windows, etc.).

The architect and engineer of record usually work in tandem to determine the building's energy code compliance pathway and the LEED certification process with input from the metal building supplier and/or general contractor as appropriate. Based on the design and basic specifications developed by the architect, the building manufacturer then provides the detailed computerized drawings or model, similar to any other structural shop drawings. Once reviewed by all and approved, then the contractor places the order for the system or components which are delivered to the site and installed quite efficiently. Note that the

Photos courtesy of MBMA

The roles and responsibilities of design professionals are the same when creating a green, sustainable, metal building as for other building system types.

SUSTAINABLE SITES PROJECT

Project: Vista Brewing
Location: Driftwood, Texas
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 Challenge: Vista Brewing needed easy and quick access to barrels when making and brewing its varied selection of beers. Further, for the owners of Vista Brewing, being environmentally friendly is one of their core values.

The Solution: A metal building system was chosen for its organizational and functional workspace options. The metal structure's 30-foot ceiling height permitted the team to easily stack the wine barrels used for aging beer.

Sustainability Strategies: An important factor in choosing a metal building was the environmental footprint during construction. The owners 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. In fact, the designers changed the roofline in order to showcase and accommodate the tree canopies toward the rear of the building. Additionally, design decisions were implemented to control energy costs. The design team chose a very high insulation value within the structure, coupled with a metal roof, to aid in keeping out the summer heat. The 30-foot ceilings help with the hot air rising above where the production team is brewing and working daily.

The Results: The owner commented that they are very happy with the ambient temperatures and low energy bills.

communication path between the architect and the metal building manufacturer is often through the general contractor. Successful projects are based on this clear and timely communication, appropriately channeled.

Based on all of the foregoing, we can look more in depth at the sustainable and green building aspects of metal buildings. In the next sections of this course, we will follow the categories for LEED first to discuss the connections between green building design and metal buildings. Following each such discussion, project examples or case studies of metal building projects are provided to illustrate how the green building design principles are achieved.

SUSTAINABLE SITES

All sites are impacted by a building being added to it—the goal is to minimize the adverse effects and maximize the benefits. Metal buildings can help facilitate both of those aims in several ways.

Site Development

Up to 2 credits are available in LEED for addressing sustainability issues in the development of a building site. Toward this end, it is helpful that metal building system components are all shop-fabricated and then erected in a controlled manner on the designated building site. This provides the ability to minimize the need to impact any site areas that are beyond the building perimeter. Further, portions of the metal building package can be sequenced to arrive as needed so that the staging area can be minimized, with reduced site impacts.

Rainwater Management

Up to 3 credits are available in LEED for addressing rainwater in natural and sustainable ways. Metal roofs provide an excellent platform to collect quality rainwater for non-potable uses. Rainwater from metal roofs tends to be cleaner and safer than water collected from other roof types, particularly those that use petroleum products.

Heat Island Effect

LEED provides for up to 2 credits based on the recognition that sunlight striking dark-colored surfaces such as roofs can contribute to "heat islands." Hence, the use of lighter-colored roofs, particularly metal roofs, has become a common sustainability strategy. Research from the U.S. Department of Energy shows that one additional percentage of reflectivity in a

roof coating, on average, will reduce roof temperature by 1 degree. A common calculation used to define a cool roof is the solar reflectance index (SRI) as defined in ASTM E1980: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces. SRI is a method to obtain an index for relative surface temperature with respect to a standard white (SRI = 100) and a standard black (SRI = 0) under standard solar ambient conditions and wind speed.

To determine the SRI of many materials, The Cool Roof Rating Council (CRRC) administers a Product Rating Program in which companies can label roof surface products with radiative property values once radiative roofing tests and aged field tests are conducted by CRCC approved facilities. Metal roofs (i.e., cool roofs) are ideal for reducing heat island effects with various paint coatings to achieve the intended Solar Reflectance Index (SRI) value. A lower surface temperature reduces the heat gain in the structure below. In the hottest months of the year, a standard roof surface can reach 150°F. A metal roof with a solar reflective coating can remain 50°F cooler under the same circumstances. This applies to building roof and parking lot canopies for short term and long-term SRI performance. Further, coatings that have high solar reflectance, used for both roof and wall panels, generate lower environmental temperatures which in turn lower building energy costs.

The coatings used on metal structures can also reduce smog. Catalyzers used in certain coatings use UV light from the sun and humidity from the air to break down harmful nitrogen oxides, known as NOx gases, into harmless salts.

WATER EFFICIENCY

Water use is needed in virtually all occupied buildings. Where that water comes from makes a difference. As already noted, capturing rainwater from a metal roof is a very achievable option for many buildings. That rainwater can then be stored and put to use both for outdoor and indoor non-potable water use.

Outdoor Water Use

Up to 2 credits are available in LEED to reduce potable water use on building exteriors. By developing a rainwater management program, quality, non-potable, captured rainwater may be implemented to reduce municipal water use for landscaping use.

Photos courtesy of MBMA

WATER EFFICIENCY PROJECT

Project: Ed & Myrtle Lou Swindle Agriculture Complex, Warner University
Location: Lake Wales, Florida
Architect: Johnson Cartwright Jarman Architects, P.A.

The Project: This $2-million, 18,000-square-foot structure includes an administration building that serves as the welcome center for prospective students and agricultural community events. It is the connector for all agriculture complex activities and houses faculty offices, a conference room, a work room, and a reception area.

Sustainability Strategies: This LEED Silver agricultural facility employs a rainwater collection system for irrigation, thus offsetting the need for purchased, municipal water. It also uses wind turbines and solar panels to replace the need for purchased energy. The energy saved for water treatment and transfer, as well as the sustainable energy produced on-site, provides significant benefits to the university and the environment.

Indoor Water Use

Since more water is often used indoors, LEED allows for up to 6 credits for demonstrating reductions in indoor water use. Here again, a rainwater management program can also be used to capture quality non-potable rainwater from a metal roof to reduce municipal water use for toilet and urinal flushing, along with some custodial uses.

ENERGY AND ATMOSPHERE

Energy use in buildings has been, and continues to be, one of the primary focus areas for increasing the sustainability of buildings. This includes conservation and efficiency strategies for new and existing buildings with metal buildings able to address all relevant aspects.

Optimized Energy Performance

Since a major component of sustainable green buildings is the responsible use of energy, LEED offers up to 18 credits in this category toward achieving some of those credits. Metal buildings also provide the ability to design the envelope for energy conservation and reduce energy demand. This is done through the proper levels of insulation, mitigation of thermal bridging, and controlling air leakage in opaque wall, floor, and roof areas of building enclosures. It also includes attention to details at fenestration, openings, and penetrations in these opaque areas to address the continuity of building enclosure barriers.

Energy codes provide minimum requirements for insulation in exterior walls and roofs and recognize metal building systems as a distinct construction type. However, manufacturers and architects often exceed those requirements through design decisions that promote higher levels of energy efficiency. Any of a multitude of high-performance insulation options are possible—from mineral fiber batts to rigid boards or even spray-on insulation—all of which can meet or exceed energy conservation requirements. The most commonly used insulation products for metal building systems help control condensation, thus reducing the effects of corrosion to the metal building or degradation of the insulation, all of which helps maintains overall energy performance.

Standard methods to achieve higher insulation levels have been developed for the metal building industry. Instead of using only a single layer of fiberglass

Photos courtesy of MBMA

ENERGY PERFORMANCE PROJECT – NEW CONSTRUCTION

Project: Alamo Beer Company
Location: San Antonio, Texas
Architect: Lake|Flato

Energy Performance: Designed for high performance, the 18,000-square-foot facility operates without air conditioning and boasts a project energy use intensity that's 77 percent lower than similar building types. "You might not think it, but metal building systems are very sustainable," architect Greg Papay says. "That's what I admire most about them—they've been refined to a point where they're economical, efficient and beautiful. They capture all the aspects of what a building should be."

Photos courtesy of MBMA

ENERGY PERFORMANCE PROJECT – RENOVATION

Project: Thunder Road Harley-Davidson
Location: Windsor, Ontario, Canada
Architect: Architectural Design Associates Inc.

The Project: This thriving dealership needed to expand and during their travels throughout North America, owners Chris and Carol O'Neil noted the quality of the Harley-Davidson dealerships that were housed in metal buildings. Now, they have one of their own.

The Design: Their nearly 20,000-square-foot building structure combines a retail showroom and service department under one roof. The open-concept showroom makes it easy to display products and to reconfigure at will.

Energy Results: Despite having 50 percent more space than their previous facility, Thunder Road's heating costs dropped by one-third. "That's a testament to how well-built the structure is," Chris O'Neil says. The metal roof, due to its expandability and weathertight seam, offered additional protection for the dealership's high-value inventory while reducing energy costs. The couple subsequently added solar panels which attached easily to the metal roof and further increased their energy savings.

insulation, it is now routine to use a double layer as recognized in ASHRAE 90.1 section A2.3.2.2: "The first rated R-value of insulation is for insulation installed perpendicular to and draped over purlins. The second rated R-value of insulation is for unfaced insulation installed above the first layer and parallel to the purlins and then compressed when the metal roof panels are attached. A minimum R-3 thermal spacer block between the purlins and the metal roof panels is required unless compliance is shown by the overall assembly U-factor." Other options, such as foam plastic insulation may also be used whether in the form of rigid boards or spray foam in conventional or hybrid insulation manners. In some cases, insulated metal panels (IMPs) are also a very good option. This approach consists of a thermally broken panel with rigid insulation sandwiched between an inner and outer metal face that serve as interior and exterior surfaces.

In terms of coordinating energy criteria with other code requirements such as fire resistance, MBMA recently released six new UL fire-resistance-rated designs for wall-roof joints and intersections in metal buildings. These meet more stringent energy code requirements while maintaining fire safety. The new head-of-wall assemblies still call for a layer of insulation between the metal roof panels and the top of the wall, but allow for additional insulation, glass fiber, or mineral wool, as well as a vapor barrier, as found in filled-cavity insulation systems and liner insulation systems. Overall, more than 20 fire-resistance-rated assemblies are contained in the UL fire resistance directory for metal buildings. They are also available on the Fire Protection page of the MBMA website.

Using the strategies described above, metal building envelopes can be insulated at (or well above) the base-energy codes. Combined with cool roof coatings, metal buildings can fully optimize energy performance as validated through energy models. Further, HVAC systems may be downsized within a thermally efficient building to help reduce purchased energy loads.

Renewable Energy Production

In addition to energy conservation measures, LEED provides up to 3 credits for on-site production of renewable energy such as Solar Photovoltaic (PV) solar thermal systems. Such units attached to a metal roof profile provide an exceptional platform for renewable energy production. PV electric

and solar water-heating systems are more economical than ever before and offer a ready opportunity to generate on-site renewable energy. Metal buildings that use standing-seam metal roofing provide an ideal platform for such systems due to the ease of mounting PV arrays and the longevity of the standing-seam metal roofing system, both of which translate to significant cost savings. Solar panels are installed on a standing-seam metal roof with clips that lock directly onto the seams and are hidden from view. The clips do not require any penetration of the roof, avoiding any potential for water seepage. Since a metal roof generally provides a service life of 60 years or more, outlasting the PV system (with a typical life of 25-30 years), their use avoids roof replacements during the tenure of most PV arrays.

MATERIALS AND RESOURCES

The materials used in any building have an environmental impact throughout their life cycle. LEED and other sustainability programs recognize this in a variety of ways, with metal buildings consistently offering some strong solutions to reducing the impact from the materials used. Four methods are summarized in the following sections.

Building Life-Cycle Impact Reduction

LEED recognizes the value of extending the life of buildings and minimizing material impacts with up to 5 credits available. Constructing an addition onto an existing metal building or dismantling and reusing parts of the building helps achieve the Building and Material Reuse option. For new construction, the Whole Building Life-Cycle Assessment (LCA) option is ideal for metal buildings when using Whole Building LCA software like the Athena Impact Estimator software. MBMA contributed industry-wide life-cycle data with metal building specific capabilities to help design professionals achieve this credit.

The embodied carbon content of building materials has received a lot of appropriate attention recently. That's because the majority of construction-related CO_2 emissions —about 11 percent of the global total—are associated with manufacturing building materials, transporting materials to construction sites, and the actual construction process, according to a U.N. Environment Global Status report. In that light, the most obvious perceived environmental attribute of metal buildings comes from its primary

Photos courtesy of MBMA

RENEWABLE ENERGY NEW CONSTRUCTION PROJECT

Project: Hangar 25, Bob Hope Airport
Location: Burbank, California
Architect: J.R. Miller & Associates

The Project: The $17-million building has 50,630 square feet of hangar space, plus approximately 12,000 square feet of office and meeting area space.

The Design: The hangar is a metal building system including a metal roof and metal wall panels that incorporate a multitude of sustainable features. In the quest for efficiency, the structural members in this metal building system are custom engineered to handle the specific load needs for Hangar 25. This optimizes the steel used in the building which reduces costs.

Energy Systems: A 225-kW photovoltaic (PV) system is mounted to a standard R-panel roof on a rack system that attaches to the purlins. An added benefit of the 1,500 PV panels system is the shading it provides to the roof. This helps keep cooling costs down and, along with the highly reflective white metal roof panels, reduces the heat island effect. The roof is considered a cool roof, with a solar reflectance of 0.70, an infrared emittance of 0.85, and a solar reflective index (SRI) of 85. The solar array produces 110 percent of the power needed to operate the facility and is expected to produce more than 400,000 kWh of energy per year. The electricity savings from the solar array are significant. The building has operating expenses that are approximately 2 cents per square foot, compared to a traditional hangar that operates at about 20 cents per square foot. In addition to building operations, all the equipment for the hangar, including rechargeable tractors, forklifts, and tugs, run off the electricity produced by the solar array. Further, when aircraft receive maintenance, the power to keep all the systems running comes from the solar array. Using the solar power is not only cost-effective, but it also does away with fumes and odors from the diesel and jet fuel that would ordinarily be required.

Other LEED Strategies: Other energy enhancing features include: six large, metal fans suspended from the building's steel frame provide a low-cost system for circulating air; more than 100 translucent panels in the metal roof, keep lighting costs down and more than 95 percent of the regularly used areas of the facility, including the office space, receive natural daylight; the polished, natural concrete floor is chemical-free and estimated to last at least 20 years, and those who work here won't have to worry about toxic compounds. The hangar gained valuable LEED points for its recycled content, with recycled steel used for the primary structural members.

The Results: Hangar 25 is world's first LEED Platinum certified aircraft hangar and achieved the Environmental Management Award from the Airports Council International-North America.

Photos courtesy of MBMA

RENEWABLE ENERGY RETROFIT PROJECT

Project: Word of Life Christian Center
Location: Honolulu, Hawaii

Energy Retrofit Strategy: Utility costs in Hawaii are higher than those in other states in the U.S., so it's wise to install solar panels on large facilities to take advantage of the state's plentiful sunshine. After making minor repairs to their existing 30-year-old standing-seam metal roof, the Word of Life Christian Center installed an 82-kW solar photovoltaic array. Metal roofs typically last over 60 years, so there was plenty of reason to reuse the existing roof since photovoltaic panels have a typical life expectancy of 30 years. The panels were attached with approximately 450 clips that didn't require penetration of the roofing material since metal roofs are manufactured to be solar-ready. The addition of the solar panels required no money down and allowed the congregation to save money by using their own solar power and by selling unused electricity back to their local power provider.

MATERIALS AND RESOURCES PROJECT

Project: Plano Recycling Facility and Learning Center
Location: Plano, Texas
Architect: Anchor Construction

The Project: This 77,000-square-foot, state-of-the-art building serves the recycling needs of more than 510,000 residents and 2,500 commercial customers in North Texas.

Sustainable Strategies: This project achieved a LEED Silver designation from the U.S. Green Building Council. Constructed of steel and other metal, its high percentage of recycled content reduced the environmental impact and the resulting fossil fuels and carbon emissions. From an operations standpoint, it houses advanced sorting equipment and technologies, allowing the facility to process approximately 350 tons of recyclable material per day. The building incorporates optical sorters, next-generation anti-wrap fiber screens, and other leading processing tools. An automated touchscreen control system and tablet-based technologies aid the processes inherent in real-time systems management, monitoring, and data acquisition. The facility also includes a 5,000-square-foot interactive learning center with an observation deck.

material—steel. According to the American Iron and Steel Institute (AISI) and the Canadian Sheet Steel Building Institute (CSSBI), steel is the most recycled material in North America. By specifying recycled steel, which is often processed in an electric arc furnace, the emissions and embodied carbon content of the steel is greatly reduced.

To understand the relative significance of using recycled steel metal buildings, a life-cycle assessment comparison of buildings with different structural and envelope materials was produced independently by the engineering firm of Walter P. Moore & Associates. The resulting report concluded that "Metal buildings showed lower environmental impacts in all six metrics when comparing structural and envelope materials to load bearing masonry walls, concrete tilt-up, and steel framed construction of the same building footprint and functional equivalence." Further, with all metal building components typically delivered simultaneously from the manufacturing plant to the construction site, emissions related to material delivery are vastly reduced over other forms of construction.

Building Product Disclosure and Optimization—Environmental Product Declarations (EPDs)

Environmental Product Declarations (EPDs) are widely recognized as the best way to communicate the environmental

impacts of building products. LEED recognizes and encourages their use, with up to 2 credits available in this category. In support of the creation of these documents, the MBMA funds extensive research related to the environmental impacts of metal building systems. Through collaboration with the Athena Sustainable Materials Institute and UL Environment, MBMA developed an industry-wide LCA report and three industry-wide environmental product declarations (EPDs) for designers to use when specifying MBMA-member products. These are available to architects and others for download at mbma.com.

MBMA also recently released revised environmental product declarations (EPDs) for three specific metal building product categories: primary rigid framing, secondary framing, and metal cladding for roofs and walls. These provide architects, specifiers, designers, and other industry professionals with transparent, third-party documentation of the environmental impacts of products used in metal building systems. MBMA partnered with UL Environment to develop and certify these EPDs which summarize the cradle-to-gate environmental impacts of a metal building system. The EPDs are based on Product Category Rules (PCRs) used to develop a life-cycle analysis (LCA) final report, which is summarized in the EPDs. Significant improvements were noted in the most recent EPDs over the previous ones developed using the same process. For example, the use of recycled steel has improved by 20 percent and the scrap produced has dropped 15 percent. The MBMA industry-wide LCA Final Report and the three MBMA industry-wide EPDs conform to ISO 14044 and ISO 21930, with the cradle-to-gate scope to help earn credits.

Building Product Disclosure and Optimization—Sourcing of Raw Materials

The sourcing of raw materials is a significant concern with up to 2 credits available in LEED to address this. Toward that end, metal building manufacturers' lists may provide the information to meet the Raw Material Source and Extraction Reporting option. The Leadership Extraction Practices option includes the list of traditional single-source attributes, such as recycled content, materials reuse, etc. The recycled content is a strong point for metal building construction. Steel is the only material with the approved default recycled content of 25 percent. Many steel producers and metal building manufacturers publish their true recycled content to increase the percentage for calculation purposes.

Some related points here, include the following:

- Metal buildings are generally manufactured from at least 65% recycled steel, substantially reducing the need for virgin materials excavated from the earth. Then, at the end of a building's life, the raw steel can be 100% recycled to be used in various products, such as cars, appliances, buildings, and bridges.
- Steel's recyclability exceeds other comparable construction materials and its contribution to a circular economy is increasing. Steel products are becoming more lightweight and designed for diverse applications and extended useful life. In particular, metal buildings are more lightweight (use less material) than

Photos courtesy of MBMA

INDOOR ENVIRONMENTAL QUALITY PROJECT

Project: Full Goods
Location: San Antonio, Texas
Architect: Lake|Flato

The Project: Lake|Flato was commissioned to develop an innovative master plan to redesign the Full Goods Warehouse at the historic Pearl Brewery complex in San Antonio, Texas.

The Design Approach: Because the original nature of the building was metal, the design team believe it made sense to use steel structures that lend themselves to the philosophy of the project. It was an industrial brewery site and so they wanted to bring a certain level of grit to it so that it felt authentic. To accomplish this, the original structure of the warehouse was preserved, but it was made more efficient with the addition of a mezzanine level constructed from steel structural systems and metal panels in an effort to blend the old and the new into an extensive, flexible space.

The Sustainability Strategies: Besides the authentic aesthetic, the other benefit of using a metal building system for this project was that the use of steel incorporated the commitment to sustainability. Inside, the building is naturally lit and cooled by large fans and breezeways that take advantage of San Antonio's temperate climate. The total commitment led the project to be LEED Gold certified for its sustainable site development, water conservation, energy efficiency, materials selections, and indoor environmental quality.

The Results: The designer says that there is an array of benefits to using metal buildings, but from an architect's perspective, he sees unique beauty in the structures beyond their utilitarian characteristics. "I just love being able to use metal buildings because they're so beautiful," he says. "I've done a number of designs with them because they provide that grit that is cool and they relate well to so many different types of uses and environments."

Photos courtesy of MBMA

INNOVATION PROJECT

Project: Costco Stores
Location: Nationwide
Architect: MG2

The Context: 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 metal building systems to construct 90 percent of its new warehouse stores.

The Metal Building System Attributes: "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.

other forms of steel construction and as a result have less embodied carbon than many competing forms of construction.

- New steel, made with recycled material, uses as little as 26% of the amount of energy required to manufacture steel from iron and other naturally extracted materials.
- Steel can be continually recycled into new steel products without any deterioration in product quality.
- Net-zero carbon steel, manufactured in the US, provides emissions-free steel products to help architects meet their sustainability goals. It is also important to note that, today, the United States is the cleanest place in the world to make steel, accounting for less than 2 percent of the GHG emissions from the global steel industry. The AISI points out that steel source energy is increasingly from electricity, with more of that electricity coming from renewables than previously.

Construction and Demolition Waste Management

Building construction and demolition generally produces a lot of on-site waste, which is why LEED offers up to 2 credits to reduce and manage it. It is advantageous, then, that all the components of a metal building system are custom designed and efficiently fabricated in an off-site, controlled environment. They are then delivered to the site according to a pre-determined construction schedule. That means there is no extra material sent to the construction site with very little, if any, field cutting required. In fact, metal buildings typically generate more than 50 percent less job-site waste than other construction approaches. In most cases, they have readily achieved the LEED credit for Option 2—Reduction of Total Waste Material—generating no more than 2.5 pounds of waste per square foot of a building's floor area.

INDOOR ENVIRONMENTAL QUALITY

People spend most of their time inside buildings, including metal buildings. The quality of their indoor experience, including impacts on their health and well-being, is directly related to the quality of the indoor environment. In that regard, sustainability and green building have always included a focus on this critical part of building design, including the following aspects.

Low-Emitting Materials

Emissions of volatile organic compounds (VOCs) inside buildings has been documented to be detrimental to human health, both in the short term and long term. Therefore, LEED offers up to 3 credits to reduce or eliminate VOCs and other substances from buildings, particularly as found in painting, adhesives, coatings, etc. Metal building components typically have coatings and paint applied to the steel off-site in a controlled fabrication facility. Therefore, they do not affect the VOC calculations within this credit. More importantly, VOC emissions from painted or primed metal building components are very limited, thus helping to avoid human exposure to these compounds.

Daylight

Daylight has been found to provide significant health benefits, both physical and mental health. Because of the compelling nature of this aspect of green buildings, LEED offers up to 3 credits for buildings that provide natural daylight to occupied areas of buildings. Designing metal buildings to incorporate daylight to help achieve this credit is readily possible with a variety of design approaches using windows, sidelights, and skylights. A common metal building product also includes light-transmitting, translucent panels installed on the metal roof or wall area. Any of these strategies may also include diffusers to enhance the light distribution and light quality.

Looking a little further into this topic, customizable fenestration is an important attribute in the design of metal buildings just as it is for any occupied structure. All buildings need fenestration openings for egress, light, and ventilation. However, providing those openings in a manner that is sustainable is a function of controlling the things that pass through them. While it is important for windows, doors, and skylights to admit light, it is equally important to restrict solar heat gain when

air-conditioning is in use. Conversely, heat loss and air infiltration through fenestration are energy concerns when the building is being heated. Proactively, the fenestration industry has developed products with performance characteristics related to overall thermal U-factors, solar heat gain coefficient (SHGC), visible light transmission (VT), and air infiltration. These commercial products can be readily incorporated into metal buildings, and, in some cases, the metal building manufacturers offer their own customizable products in the form of windows, skylights, and translucent wall and roof panels.

INNOVATION IN DESIGN

Sustainability usually involves innovation—thinking beyond the customary or the norm to achieve the desired outcome or results. LEED can seem rather prescriptive to some, but its intent was never to limit creativity or innovation. As such, there are multiple credits available for innovation and creative ways to achieve more sustainable and well-designed buildings. Some LEED innovation credits rely on showing how a particular design exceeds the minimum requirements to earn a credit. It should be clear by now that metal building systems have advantages that can certainly help in that regard. There are also other ways to incorporate innovation, and the design flexibility, customization, and affordability of metal building systems certainly help in that regard as well. Even if a particular innovation doesn't fit into a category to achieve an additional credit, the net result for the building can still be quite positive to benefit the owner, the users, and the environment.

CONCLUSION

Metal buildings have been shown to be a preferred way to design and construct green and sustainable buildings in all parts of the country. The design is fully flexible, customizable, and economical with metal building systems proving to be applicable to any type of commercial, industrial, or institutional low-rise building. They have also been shown to contribute very significantly to earning credits under the LEED green building rating system. For more information or to see any of the resources described in this course, you can refer to the MBMA website at https://MBMA.com

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