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Specifying the Right Framing Connectors for Deflection

by Chuck Webb, PE, CSI, CDT

All images courtesy ClarkDietrich

COLD-FORMED METAL FRAMING (CFMF) IS ONE OF THE MOST WIDELY USED FRAMING MATERIALS IN COMMERCIAL AND RESIDENTIAL CONSTRUCTION BECAUSE OF ITS ABILITY TO PROVIDE STRENGTH AND STABILITY IN A NUMBER OF CONDITIONS. A WELL-DETAILED FRAMING SYSTEM CAN ACCOMMODATE FORCES IMPOSED ON THE STRUCTURE BY GRAVITY, WIND UPLIFT, AND SEISMIC FORCES. A KEY ELEMENT OF THIS DESIGN IS THE SYSTEM'S ABILITY TO ACCOUNT FOR VERTICAL MOVEMENT OF STRUCTURAL ELEMENTS LIKE FLOOR AND ROOF SYSTEMS BY ALLOWING THEM TO DEFLECT DOWNWARD OR UPWARD WITHOUT IMPOSING AXIAL LOADS TO THE WALL STUD MEMBERS, GYPSUM WALL BOARDS, OR OTHER SUBSTRATES.

When it comes to deflection, the performance of the connections between CFMF and the building structure is critically important, especially in coastal and high-seismic zones where structures face greater risk of movement, stress, and loading from natural events like earthquakes and high-velocity winds.

Compression and extension deflection

Section 1604, “General Design Requirements,” of Chapter 16 of the *International Building Code (IBC)* says structural systems and members shall be designed to have adequate stiffness to limit deflection including roof and floor members. Examples of these members are metal pan deck (fluted deck), composite deck, open web bar joists, steel I-beams, concrete beams and slabs, and precast or hollow-core planks.

Roof members typically move in two directions: downward (compression) or upward (extension). The compression movement of roof elements can be a result of one or a combination of the following:

- **roof live load** – during maintenance by workers, equipment, and/or material; movable objects such as planters; or by the use and occupancy of the roof whether it is a roof garden or assembly area;
- **snow load** – weight of the collected snow on the roof including snow drift;
- **wind load** – the pressure applied by the wind; and
- **dead load** – the weight of materials in construction incorporated into the building.

The upward movement of roof elements is a result of wind suction, where the pressure pulls away from the building, causing the elements to move in an upward direction.

Conversely, floor members typically move in one direction—downward. This is a result from live loads introduced by the use and occupancy of the building, as defined by table 1607.1 of *IBC*, and dead loads. However, if the structure has multiple floors, the downward movement of one level can cause an extension at the head-of-wall above.

When specifying deflection connectors, it is important to consider deflection and standoff distances. Deflection distance refers to the



measure of the maximum vertical distance the primary structure is anticipated to move due to loading. Standoff distance is the space between the secondary and primary frames. This space allows contractors to install the CFS framing in a true line, while the structure of the building may be slightly out-of-plumb from floor to floor.

Head-of-wall deflection joint/gap

Wall framing often bears on the top of the slab of one floor level and frames to the underside of the floor or member(s) above. This is called infill or slab-to-slab framing. Where this occurs, a deflection joint (or gap) is required if the wall framing needs to account for the compression or extension movement of the structure.

A well-designed framing system can accommodate forces imposed on the structure by gravity, wind uplift, and seismic activities.



Several versions of bypass slide clips are available in the market today, each with a specific purpose. Some are offered in both 14 and 12 gauge options.

The deflection joint is the distance between the top of the stud framing to the underside of the substrate above (floor or roof member), as defined by the project's architect or structural engineer. Often, this dimension is given in the project specifications—Division 09 22 16–Non-structural Metal Framing or Division 05 40 00–Cold-formed Metal Framing. It may also be in the contract drawings under the architectural or structural details. The top of the gypsum wall board to the underside of the substrate should also equal this distance.

Head-of-wall attachment methods

There are various framing methods to accommodate vertical movement at the head-of-wall. An option is head-of-wall track products with vertical slots in the track legs. The wall stud framing members are secured to the deflection track utilizing waferhead screws through the center of the vertical slots on both track flanges. This allows the primary structure to compress or extend without



imposing axial loads on the wall studs. Otherwise, the addition of axial loads into the stud framing members could lead to buckling and performance failure of the wall system. Since the wall studs are secure at both flanges, stud rotation is prevented, thereby eliminating the need to add lateral wall bridging 305 mm (12 in.) down from the top of stud.

A common method to account for vertical deflection in head-of-wall applications is a deep leg or oversized runner track. With this method, the top of the stud is held down and the required deflection gap is 'free-floating' in the track cavity. Since the stud is subject to rotation in this application, lateral wall bridging is required 305 mm down from the top of stud. This method allows for larger deflection

A key element of a well-designed framing system is its ability to account for vertical movement of structural elements by allowing them to deflect downward or upward without imposing axial loads to the wall stud members. The use of slotted deflection clips can help achieve this.

gaps, where most slotted connectors are limited to 50 mm (2 in.) total deflection (25-mm [1-in.] compression, 25-mm extension). To calculate the deep leg track flange dimension, one must multiply the deflection gap by two and add 25 mm. For example, the structural engineer gives a required deflection gap of 19 mm ($\frac{3}{4}$ in.)—the deep leg flange should be $(2 \times 19 \text{ mm}) + 25 \text{ mm} = 63 \text{ mm}$ ($2 \frac{1}{2}$ in.) flange. This ensures the top of the stud is not dislodged from the track due to upward movement.

An option to accommodate vertical deflection for infill framing is to use a deflection clip with solid and slotted legs. The solid leg is affixed to the substrate and the slotted one is attached to the stud web. Some products use proprietary screws designed specifically to provide friction-free deflection.

Lastly, accommodating deflection in fire-rated wall applications presents a separate set of challenges. If deflection is required in a fire-rated wall assembly, then the head-of-wall deflection joint must be protected. The aforementioned framing methods can be used in conjunction with third-party, fire-rated products such as fire caulks or mineral wool and sealant. However, there are more labor-friendly options like deflection tracks incorporating an intumescent strip on each track flange that expands in a heat event to protect from heat and flame passage. One benefit of this approach is it allows for deflection of the primary structure while maintaining fire and smoke protection. This means the structure can compress or extend as needed by design and still maintain the integrity of the joint.

Deflection in bypass wall applications

Exterior, structural cold-formed steel framing must often accommodate vertical movement of the primary structure, similar to interior wall systems. The exterior wall framing will either be an infill condition like the aforementioned applications, or it will be a bypass condition where the wall framing members sit outside the slab edge and frame, past the floor or roof level. This is commonly known in the industry as ‘balloon framing.’



To accommodate vertical deflection of the primary structure for bypass applications, a deflection clip that can accommodate vertical movement in compression and extension is required. These clips have an extended leg with vertical slots that attach to the wall stud webs, and a solid leg that is anchored to the structure—either a steel member such as an edge angle or steel I-beam or a concrete member like a slab edge or concrete beam.

Several versions of bypass slide clips are available on the market today, each with a specific purpose. Some are offered in both 14 and 12 gauge options, which are common for steel edge angle conditions, or with an oversized pre-drilled hole in the solid leg for anchor attachments to concrete elements. Others have extended legs with vertical slots for larger wall offsets from the primary structure edge.

Another option is to attach the deflection clip to the underside of a structural element instead of the face. Connectors for these types

The performance of deflection connectors is important in coastal and high-seismic zones where structures face greater risk of movement, stress, and loading from natural events like earthquakes and high-velocity winds.

of applications have horizontal legs that extend from 305 to 610 mm (12 to 24 in.) with vertical slots along the face of the leg. The legs of these clips are intended to attach to the web of the stud members. These types of clips have a second leg that is solid and bent 90 degrees from the vertical, allowing them to attach to the underside of structural steel or concrete elements. However, it should be noted that rotation of the structural element is a possibility in this type of application, making it imperative the structural engineer review and approve this type of connection and ensure the stability of the structure.

The last option for a bypass framing attachment is one that has a ‘tail’ feature on it so it sits flat to the underside of a structural element, or even the top side such as a concrete slab or steel I-beam top flange. This profile has a vertical leg with vertical slots to allow for compression and extension movement. This type of clip can also introduce rotation to the structural element, so the structural engineer of record should review and approve this type of connection, as well.

Other considerations for specifying deflection clips

It is common for CFS framing installers to fabricate clips and connectors in the field. However, there are many benefits to specifying pre-engineered connectors tested to perform exactly as required for each application.

Today’s high-performance buildings demand a certain level of assurance that each element in the structure is going to perform as expected. Pre-manufactured connectors are designed and tested for all allowable load capacities, allowing architects and engineers to ensure calculations are based on how the connector will actually perform. Additionally, these connectors often have third-party data backing up their performance and verifying the connector was manufactured according to applicable standards.

Another major benefit of specifying pre-engineered clips and connectors is their ability to save time and labor on a project by eliminating the need to cut, bend, and fabricate custom-made connectors in the field, which can consume many valuable hours on large commercial

projects. Also, these handmade connectors often lack the pre-punched holes that help installers properly align the fasteners for achieving the intended design load, potentially compromising their performance.

Conclusion

Many projects require the cold-formed metal framing to allow for deflection of the primary structure in compression and/or extension. The movement and amount of movement should be specified by the architect or structural engineer of record. From there, and based on infill or bypass wall conditions, the appropriate framing product can be identified and installed to meet the project needs.

CS

ADDITIONAL INFORMATION

Author



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Key Takeaways

Cold-formed steel is one of the most widely used framing materials in commercial construction because of its ability to provide strength and stability in a number of conditions. A well-designed framing system can accommodate forces imposed on the structure by

gravity, wind uplift, and seismic forces. A key element of this design is the system’s ability to account for vertical movement of structural elements by allowing them to deflect. When it comes to deflection, the performance of the connections holding all framing elements together is critically important, especially in coastal and high-seismic zones where structures face greater risk of movement, stress, and loading from natural events like earthquakes and high-velocity winds.

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Key Words

Division 05	Connections
Cold-formed steel	Framing



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Building a better steel experience.

Metal Panels Dynamically Skin Iowa University Building



by Brad Davison-Ripsey, AIA

Photo © Eric Dean

DURING THE LAST DECADE, THE CONSTRUCTION INDUSTRY HAS SEEN AN EVOLUTION OF FINISHES AND APPLICATIONS. THIS HAS CHANGED THE WAY METAL PANELS ARE BEING DESIGNED—THEY ARE NO LONGER VIEWED JUST AS A DURABLE MEANS TO ENCLOSE A BUILDING. THIS CHANGE IN PERCEPTION CAN BE SEEN IN THE ADOPTION OF A COMPLEX METAL RAINSCREEN SYSTEM COMPRISING INTERLACING PATTERNS TO FORM BEAUTIFUL, COMPLEX FAÇADES.

In June 2008, the University of Iowa experienced massive flooding throughout the campus, which destroyed or heavily damaged many buildings. The original arts building from 1936 was one of the affected structures, along with a handful of others along the banks of the Iowa River. The building experienced severe water damage. Therefore, the university decided to invest in a new facility for visual arts. The school partnered with Steven Holl Architects (SHA) to design the new structure at a new, higher location directly adjacent to the Art Building West SHA had worked on a few years prior.

Though this new building would complete the second half of the so-called art quad on campus, Steven Holl and his team set out to incorporate maximum interaction between all departments of the school—not just art—by creating open, social spaces to spark conversation and creativity.

With this intent in mind, light became a focus early in the design process. The use of light would create a dynamic space able to stimulate those who pass through or walk by. After entertaining more than 30 design schemes for the new structure, the project team finally landed on a square-shaped building carved out for brightness with light courts (terraces) and skylights. All five stories of the facility reside on different planes, shifting in harmony with one another and creating movement within the square footprint. Each of the building's seven cuts of light can be seen throughout the space, from the furniture and door handles to perforated stainless steel panels on the southwest and southeast elevations of the building.

The façade was designed to ensure the proper amount of light flows into and out of the structure. This proved to be a critical factor in the building's construction and successful project execution, as it was designed around the multiple centers of light, both inside and out.

Customized panels

Instead of using traditional, full cutouts for window openings, the design called for two of the elevations to be completely wrapped in perforated metal panels passing over the building's windows to create a dancing light effect as the sun moves throughout the day. The metal panels not only allow light in, but also give the façade texture and depth.



During the day, the façade of the Visual Arts Building at the University of Iowa acts as a sunshade to the hidden windows behind it. This design also provides a light, porous aesthetic touch.

Photo © Angela Sleep Photography



Channel glass and non-perforated metal panels work in harmony on the Visual Arts Building's north elevation.

Photo © Eric Dean

The double-skinned wall system also included a zinc cladding located 178 mm (7 in.) behind the perforated stainless steel panels on the south and west elevations. The 1.5-mm (59-mil) zinc cladding was custom designed. The stainless steel wall panels were 5 mm ($\frac{3}{16}$ in.) thick to accommodate the nearly 13,000 holes in each one. The 16 different shapes for these perforations were derived from the seven cuts of light and skylight.

Installation

Behind the prefabricated rainscreen system, 152 mm (6 in.) of mineral wool insulation and fluid-applied air barrier were installed over the poured-in-place concrete structure. The metal panel system was attached using vertical tracks, strategically placed to accommodate the window placement. Also building information modeling (BIM) was used to finalize the coordination of the panels and their layout across windows. As the metal panels were 5 m (16 ft) wide and 1 m (3.4 ft) tall, the field crew had to set them by crane. Craftspeople onsite were attentive to the vertical track layout during installation, as the layout was critically important for the panels to interface with the windows and terraces.

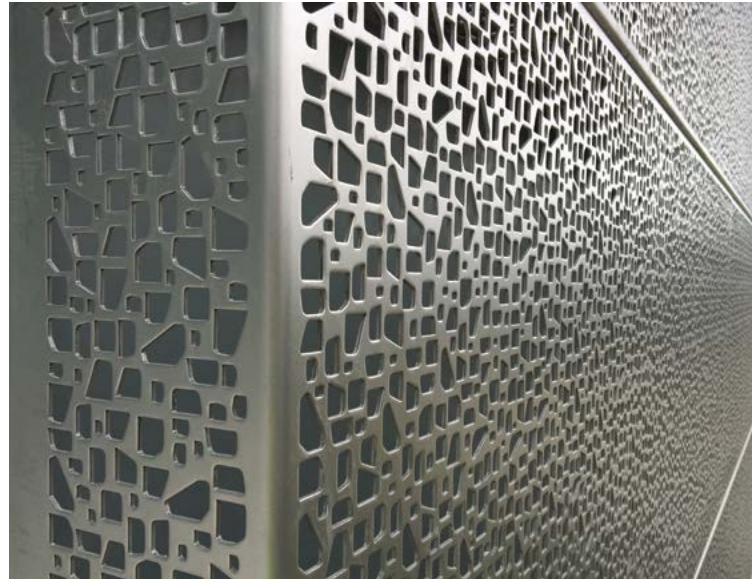
Another important component was aligning the perforations from one metal panel to the next. The pattern repeats across the face of the wall and aligns on the returns at the top and bottom of each panel. To achieve the precision necessary for this alignment, individual computer-aided design (CAD) files were created for each panel and studied in depth. Custom solutions, such as the deflection support bracket and the panel key in front of the large windows, were employed during installation to maintain the integrity of the aesthetics envisioned by the design team.

“You could drop a pencil in one of the holes at the top of the building, and, in theory, it would drop through the same-shaped hole all the way to the bottom,” said project manager Sam Arnold, explaining the level of precision required. This difficult task did not come without extreme attention to detail in every step of planning and installation.



Built in 2006, the Art Building West employs a flat, planar design.

Photo © Andy Ryan



Each panel is perforated with nearly 13,000 holes aligning at the returns from one panel to another.

Photos courtesy Architectural Wall Systems

The use of stainless steel pushed the limits of traditional uses for metal panels and leveraged them as an avenue to strategically let light in and out of the building. This allows occupants to operate with little to no artificial light during the day.



Prefabrication of the channel glass in a controlled environment led to quicker installation.

Learning through mockup and testing

Before installation began, several testing and aesthetic checks were implemented to ensure the system created the desired look. For example, a full-size perforated panel was requested for inspection by all members of the construction team. It was critical for the design team to see and feel the panels before installation. Then, an 8-m (27-ft) wide, 5-m (16-ft) high, 4-m (12-ft) deep mockup was constructed to test the performance of the systems and address any unforeseen challenges the crew might face in the field. The mockup successfully completed the following tests:

- air infiltration per ASTM E283, *Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen*;
- static pressure water resistance per ASTM E331, *Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference*;
- dynamic pressure water resistance per American Architectural Manufacturers Association (AAMA) 501, *Methods of Test for Exterior Wall*; and
- structural performance per ASTM E330, *Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*.



The double-skinned wall system was installed via a vertical track system over mineral wool insulation.

In addition to these standard tests, a custom test procedure was created to measure the deflection of the outer stainless steel panel to determine the extent of the deflection brackets.

Materials working in harmony

A complementary feature to the intricacy of the perforated metal panels was their relationship with the channel glass on the curving surfaces.

Looking back on his initial impressions of the design, Arnold said, “[We] saw some similarities in the channel glass detailing from the original art history building...The layering of multiple façade materials would produce great daylight opportunities as the façade adjusted based on orientation. Overall, the design presented a unique opportunity for design with rainscreen principles.”

The project team elected to preassemble the channel glass to ensure quick installation. The terrace was enclosed in two to three days instead of the usual two- to three-week timeline. With the use of translucent insulation material, the channel glass areas were able to transmit daylight into the building while maintaining a thermal envelope.

Perforated metal panels and the channel glass were used together to achieve a good balance of light for the interior of the building. The push and pull from metal panels to channel glass at the building’s terrace sections emphasizes the movement and shifting of light that creates multiple dimensions to the art university’s building’s footprint.

Conclusion

Since its completion in 2015, the varsity’s Visual Arts Building has received multiple awards for design and craftsmanship including the 2018 Merit Award for Excellence in Craft from the Iowa Chapter of the American Institute of Architects (AIA). The use of stainless steel pushed the limits of traditional uses for metal panels and leveraged them as an avenue to strategically let light in and out of the building. This allows occupants to operate with little to no artificial light during the day.

From day to night, the metal panels completely transform. During the day, the panels carry a heavy, industrial look and disguise the windows

behind them, then appear transparent at night, letting light out through fuzzy squares seen around the building.

The two art buildings are a contrasting, but complementary pair in the art quad of the University of Iowa’s campus. Art Building West boasts a very flat, planar design, while the Visual Arts Building is full of volume and porosity. However, similarities can be seen through the use of channel glass and metal media. Together, the two achieve the balance of commonalities and juxtaposition set forth by Steven Holl’s design and inspire interaction from students across all disciplines by creating a destination and social space for them.

CS

ADDITIONAL INFORMATION

Author

Brad Davison-Rippey, AIA, leads the system design department at Architectural Wall Systems (AWS). He oversees the staff who are dedicated to building projects on paper and virtually with building information modeling (BIM) to ensure a successful installation in the field. Davison-Rippey has been practicing architecture for more than 18 years, eight of which have been with AWS. He can be reached at brippey@archwall.com.

Abstract

Perforated metal panels were employed on the exterior of a new Visual Arts Building at the University of Iowa to bring light into the poured-in concrete structure during the day and outward at night. This allows the occupants to operate with little to no artificial light in the daytime. All five stories of the facility reside on different planes, shifting in harmony with one another and also creating movement within the

square footprint. Each of the building’s seven cuts of light can be seen throughout the space, from the furniture and door handles to perforated stainless steel panels on the southwest and southeast elevations of the building.

MasterFormat No.

07 42 13–Metal Plate Wall Panels
08 45 11–Channel Glass Assemblies

UniFormat No.

B2010.40–Fabricated Exterior Wall Assemblies
B2020–Exterior Windows

Key Words

Divisions 07, 08	Mineral wool insulation
Channel glass	Perforated stainless steel
Exterior wall	Rainscreen
Metal panels	Zinc cladding



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Reclaiming STEEL to Save Big

by Alana Fossa

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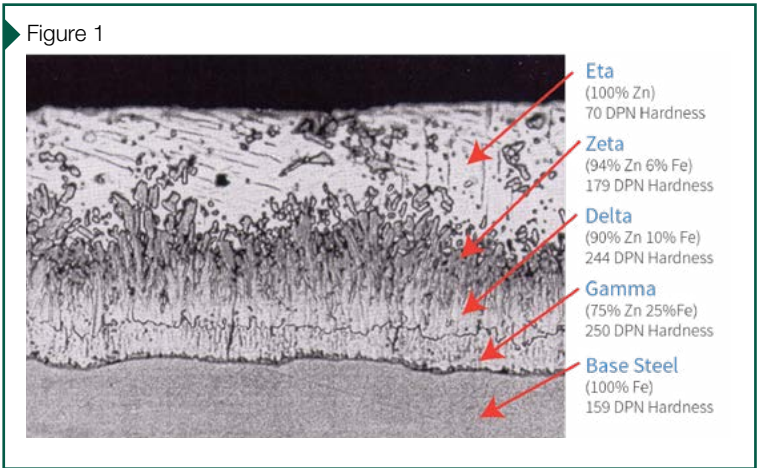
RIGHT FROM COMMERCIAL BUILDINGS AND REHABILITATION PROJECTS TO BRIDGES AND HIGHWAYS, THE RECYCLING AND REUSE OF CONSTRUCTION MATERIALS IS A GREAT WAY TO INCREASE ECONOMIC AND ENVIRONMENTAL VALUE. ALTHOUGH STEEL IS CONSIDERED TO BE A LEADER IN SUSTAINABLE BUILDING MATERIALS, ITS REUSE IS SOMETIMES OVERLOOKED AS IT IS KNOWN TO RUST. IN REALITY, STEEL AND GALVANIZED STEEL CAN BE RECLAIMED WITH MINIMAL REPROCESSING AND BE REINSTATED TO PROVIDE THE SAME STRENGTH, DURABILITY, SUSTAINABILITY, AND PROTECTION AGAIN AND AGAIN. INTEGRATED WITH BOTH ENVIRONMENTAL AND ECONOMIC ADVANTAGES, THERE ARE A WIDE VARIETY OF METHODS TO REUSE STEEL AND GALVANIZED STEEL TO ACHIEVE SUSTAINABLE DESIGNS THAT WILL LAST FOR YEARS.

Steel and zinc: Sustainable building materials

As more architects, engineers, and owners subscribe to the green building movement, an effort to minimize the impact of construction on future generations has become a primary focus for many projects. In line with these goals, the specification of structural steel offers specifiers a high strength-to-weight ratio and low carbon footprint (1.16 tons of carbon dioxide [CO₂] per ton of fabricated hot-rolled steel), thereby establishing steel as a popular building material for sustainable development. Further, all steel waste from production, fabrication, and erection is captured and recycled.¹

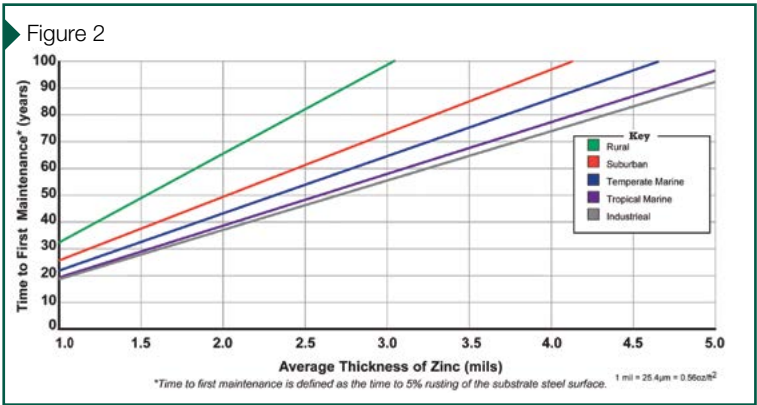
There is an opportunity for additional environmental benefits when steel is hot-dip galvanized for corrosion protection. After fabrication, hot-dip galvanizing (HDG) is a coating process where steel is cleaned and then immersed in a bath of minimum 98 percent pure molten zinc. The result is the formation of a metallurgically bonded zinc coating comprising intermetallic alloy layers covered by a layer of pure molten zinc (Figure 1). In atmospheric environments, this zinc coating provides durable, maintenance- and emission-free protection for 70 years or more in most regions (Figure 2).² Energy consumption and emissions data measured during zinc production, the galvanizing process, and life cycle of steel were used to conduct a life-cycle analysis (LCA) for hot-dip galvanized steel and demonstrate the environmental impact from production to end-of-life (Figure 3, page 19).³ Over the life cycle, the use of HDG is unique because all material and energy inputs and emission outputs are isolated to the production phase because there are no emissions or maintenance after installation.⁴

HDG can not only provide benefits in terms of lower environmental impact during use, but also allows steel to be reused or recycled efficiently for other projects at the end of its life. At end-of-life, both steel and zinc are recycled without waste or the loss of any physical or chemical properties. This means rather than being down-cycled into other or lesser products, zinc and steel can be reused again and again without compromising structural integrity.⁵ Also, steel has the highest



Cross-section of the galvanized steel coating, showing a typical microstructure comprising three zinc-iron alloy layers and a layer of pure metallic zinc.

Images courtesy American Galvanizers Association



Time to first maintenance of hot-dip galvanized (HDG) coatings in atmospheric environments, defined as the time to five percent rusting of the steel.

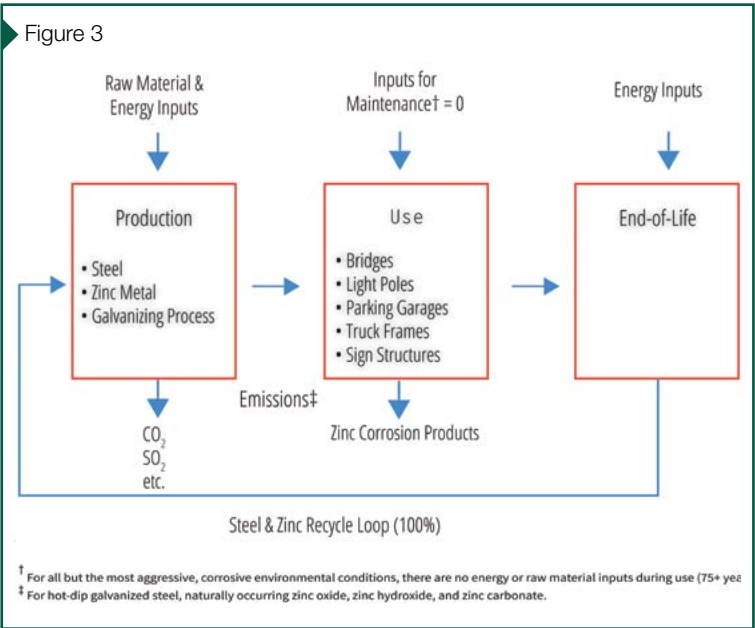
recycled content of any building framing material at 93 percent, and 98 percent of all steel is currently being recycled.⁶ Similarly, zinc has a high reclamation rate of 80 percent in North America and 95 percent in building projects.⁷

Impact for LEED projects

In the building industry, increased interest in using recycled and reused materials is driven by individual environmental awareness in addition to the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) rating system. As proven and sustainable products for commercial building construction, the initial use and reuse of steel can be used to claim credits for LEED projects within the Materials and Resources (MR) category. To assist specifiers document these LEED credits, the American Institute of Steel Construction (AISC) has published separate industry-wide (generic) environmental product declarations (EPDs) for fabricated hot-rolled structural sections, fabricated hollow structural sections, and fabricated plate. Similarly, the American Galvanizers Association (AGA) has EPDs for after-fabrication, hot-dip galvanized, hot-rolled structural sections, hollow structural sections, and plate. Health product declarations (HPDs) are also available based on the type of zinc used by the galvanizer to obtain a building product disclosure optimization (BPDO) credit for selecting products that are extracted and sourced in a responsible manner.

Economic advantages

In addition to the environmental advantages, the reuse of steel provides economic savings to free up funding for new construction. The additional specification of HDG achieves many decades of corrosion protection, and thus eliminates maintenance costs in the future. Reductions in maintenance costs achieved through HDG have proven to be significant over time in comparison to other corrosion protection systems. For example, in the early 1970s an evaluation of bridges in Stark County, Ohio, determined 110 of them were structurally deficient and 50 percent of the budget was spent maintaining paint systems used to protect the bridges from corrosion. In an effort to relieve the budget of these maintenance costs, all decks and beams from the deficient bridges were removed, sandblasted, galvanized, and reinstalled using the original steel components (Figure 4, page 20). Thanks to HDG, these bridges are still rust-free and maintenance-free today. The resultant savings motivated the officials to convert all painted guardrail in the county to galvanized by reusing the steel. By 1987, the



A life-cycle assessment (LCA) of HDG steel reveals no emissions during the use and end-of-life phases.

cost of paint maintenance for the department declined to less than 10 percent. With the potential for great economic savings, specifiers can benefit from similar evaluations for reuse.

Reuse of steel and galvanized steel

As long as the steel has not suffered from severe corrosion, there is a variety of ways the material can be reused and recycled without increasing construction waste or impacting future recyclability. The steel can be reused in place, reinstalled at another location, or reclaimed for fabrication on a new project. Options to reuse the steel include but are not limited to:

- expand or modify existing structure;
- reclaim for a different construction use without reprocessing the material; and

- galvanize, strip, or regalvanize existing steel for return to service or use on new project. Many projects can benefit from the expansion or adaptation of an existing steel structure through cutting, bolting, and welding. For example, when an existing steel building structure is desired for a new purpose, the structural framing may not immediately meet new design criteria without alteration.⁸ The good news is the existing structural framing of a building can be easily expanded or modified to handle new load requirements instead of fully demolishing to build anew. This is the type of flexibility that allows a steel building frame originally designed to house a fire station to be redesigned for the needs of a multi-level restaurant. On the other hand, when steel has exceeded its design life on a project, there are also opportunities to reuse it for the construction of scaffolding, pipe racks, shoring, shelving, or non-structural but interesting visual components.⁹

Steel that was previously bare or painted, but is otherwise fit for purpose, can also be hot-dip galvanized for corrosion protection because the after-fabrication galvanizing process is the same for new and reused steel. To prepare the reused steel for the galvanizing process, existing coating must be removed by abrasive or chemical methods. Next, articles not originally designed for HDG may require minor fabrication steps to ensure proper galvanizing. These steps may include the addition of vent and drainage holes, and cropped corners to allow the flow of pretreatment chemicals and zinc, which ensure full coverage of the parts during immersion in the process tanks and molten zinc bath.¹⁰ When galvanizing reused steel, it is important to note the impact on appearance for projects where aesthetics are of primary concern, such as architecturally exposed structural steel (AESS). The galvanized coating forms at a uniform rate across all surfaces, and will not fill in dimples, roughness, damages, or holes present on the reused steel members. While some architects may prefer the imperfect appearance, these visual aspects may not meet the requirements of all projects.

A rehabilitation project for the Indian Mill truss bridge in Wyandot County, Ohio, demonstrates the ability to easily expand and galvanize an existing painted steel structure (Figure 5, page 21). Originally constructed in 1913, this single-lane vehicular steel truss bridge was deemed functionally obsolete in 2010 and required significant repairs. To preserve the original bridge aesthetic and to expand it, a similar truss was

Figure 4



Bridges from Stark County, Ohio, were removed, sandblasted, galvanized, and reinstalled using the original steel components.

designed to incorporate pieces of the original steel. These components were disassembled, galvanized, and reused in the new construction along with the new galvanized steel members. The result was a fully galvanized bridge that will provide the county and rural community with maintenance-free longevity for another 100 years.

On the other hand, sometimes the steel to be reused on a project has already been galvanized. For galvanized steel that has previously been in service, the components can be reused as is, regalvanized, or painted over. If inspection reveals suitable coating thickness, no further processing may be required prior to reuse. Regalvanizing requires steel to be disassembled, stripped of any remaining coating at the facility, galvanized, and then reassembled at the desired location. This process effectively restores the galvanized steel to its initial condition in a very short time. Painting over the existing galvanizing can be achieved in the field, and is most suitable for parts that cannot be removed from service or where a shorter extension in coating life is needed.

Regalvanizing was a successful choice for the reuse of guardrail panels, originally galvanized in 1955, for the M-102 Bridge Rail Reconstruction Project (Detroit, Michigan). For 50 years of Michigan weather, traffic mishaps, road grime, and salts, HDG provided maintenance-free protection from corrosion, but highway traffic over time damaged 20 percent of the panels. Under a 'Keep It Green' initiative supported by the Michigan Department of Transportation (MDOT), the old but undamaged guardrail was stripped of the remaining galvanizing, regalvanized, and

returned to service. Since only 20 percent of the existing steel required replacement, MDOT saved more than half of the budget allocated for this project. In addition to freeing up funds for future projects, the reuse of HDG will provide the M-102 Bridge Rail reconstruction project maintenance-free longevity for over 50 years.

Conclusion

Although the above examples demonstrate the many ways steel can be reused efficiently and cost-effectively with minimal or no processing, additional opportunities may be revealed on further evaluation of existing steel projects. Additionally, different steel articles from a variety of industries are also well-suited for reuse, including balcony railings, security barriers, fencing, highway products, architectural panels, sculptures, and recreation equipment. As sustainability becomes a larger part of specifying and engineering, the use of materials like steel and zinc ensures designs stand the test of time while improving the quality of life for future generations. Reusing steel and specifying HDG for corrosion protection can provide additional opportunities to make any project more sustainable.

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Notes

- ¹ Read *More than Recycled Content: The Sustainable Characteristics of Structural Steel* by the American Institute of Steel Construction (AISC).
- ² Consult *Performance of Hot-Dip Galvanized Steel Products in the Atmosphere, Soil, Water, Concrete, and More* by the American Galvanizers Association (AGA).
- ³ Refer to *Hot-dip Galvanizing for Sustainable Design* by AGA.
- ⁴ See Note 3.
- ⁵ Read *Life-Cycle Assessment study for hot-dip galvanized balcony system compared with painted balcony system* by S. Vares, K. Tattari, and T. Hakkinen.
- ⁶ See Note 1.
- ⁷ Consult *Zinc: A Sustainable Material Essential for Modern Life* by the International Zinc Association (IZA).
- ⁸ See Note 1.
- ⁹ See Note 1.
- ¹⁰ Refer to “The Design of Products to be Hot-dip Galvanized After Fabrication” by AGA.

Figure 5



Galvanized steel guardrails can be easily reused with minimal or no processing.

Photo courtesy iStock by Getty Images

ADDITIONAL INFORMATION

Author

Alana Fossa is the senior corrosion engineer for the American Galvanizers Association (AGA). Fossa provides assistance to architects, engineers, fabricators, owners, and other specifiers regarding technical issues and the processing of hot-dip galvanized steel (HDG). She also manages AGA studies and research on performance, application, and processing of HDG steel. Fossa can be reached via e-mail at afossa@galvanizeit.org.

Key Takeaways

Galvanized steel can be recycled and reused efficiently and cost-effectively in many ways with minimal or no processing. Different steel articles from a variety of industries are also well-suited for reuse, including balcony railings, security barriers, fencing, highway products, architectural panels, sculptures, and recreation equipment. As sustainability becomes a larger part of

specifying and engineering, the use of materials like steel and zinc can help ensure designs stand the test of time while improving the quality of life for future generations.

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- 05 00 00–Metals
- 09 90 00–Painting and Coating

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- B10–Superstructure
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