Cold-formed steel has been widely used in buildings, automobiles, equipment, home and office furniture, utility poles, storage racks, grain bins, highway products, drainage facilities, and bridges. Its popularity can be attributed to ease of mass production and prefabrication, uniform quality, lightweight designs, economy in transportation and handling, and quick and simple erection or installation.

In building construction, cold-formed steel products can be classified into three categories: members, panels, and prefabricated assemblies. Typical cold-formed steel members such as studs, track, purlins, girts and angles are mainly used for carrying loads while panels and decks constitute useful surfaces such as floors, roofs and walls, in addition to resisting the in-plane and out-of-plane surface loads. Prefabricated cold-formed steel assemblies include roof trusses, panelized walls or floors, and other prefabricated structural assemblies. Approximately 40% of the total steel used in building construction is cold-formed steel. Cold-formed steel possesses a significant market share because of its advantages over other construction materials and the industry-wide support provided by various organizations that promote cold-formed steel research and products, including codes and standards development that is spearheaded by the American Iron and Steel Institute (AISI).

This article presents the profile of cold-formed steel in building construction through a historical
review of the development of AISI Cold-Formed Steel Specification and Standards, discusses the major cold-formed steel applications in building construction, and introduces organizations that play important roles in the cold-formed steel industry.

CODES & STANDARDS DEVELOPMENT - A HISTORICAL REVIEW

Cold-formed steel applications can be traced back as early as the 1850s in both the United States and Great Britain. In the late 1920s and early 1930s cold-formed steel entered the building construction arena with products manufactured by a handful of fabricators. Although these products were successful in performance, they faced difficulties with acceptance for two reasons: (1) there was no standard design methodology available, and (2) cold-formed steel was not included in the building codes at that time. Many of the cold-formed steel applications were unable to be used due to the lack of design methodology and product recognition.

To face this challenge, AISI convened a technical committee in 1938, known as the Committee on Building Code, with the mission of developing a specification for the design of cold-formed steel structures. Research work was conducted at Cornell University, led by Professor George Winter. Eight years later, in 1946, the first Specification for the Design of Light Gage Steel Structural Members was published, and in 1949, the first Design Manual was available for use by design engineers. After the publication of the second edition in 1956, the Specification was formally
adopted by the building code body, opening the door towards acceptance of cold-formed steel products. To increase the market share of cold-formed steel, AISI has been continually providing research funding to broaden the design coverage, improve the design technology, and cultivate a cold-formed steel community.

With the establishment of the North American Free Trade Agreement (NAFTA) in 1990, it became clear that codes and standards would be at the frontline to eliminate the trade barrier and promote the usage in steel in the North America. In 1995, AISI initiated the development of a unified cold-formed steel specification among NAFTA countries. After ten years of mutual efforts, the first edition of the North American Specification for the Design of Cold-Formed Steel Structural Members was published in 2001. This document was immediately adopted by the 2003 International Building Code and was recognized by the American National Standards Institute (ANSI) as the National Standard in the United States, by the Canadian Standards Association (CSA) in Canada, and by Camara Nacional de la Industria del Hierro y del Acero (CANACERO) in Mexico. This unified Specification raises cold-formed steel design technology to the same level among all NAFTA countries, allowing faster introduction of new technologies and opening up the marketplace for a wide variety of cold-formed steel products and derivatives, such as steel framing and steel decks, as well as design aids and educational
In the early 1990s, as the residential construction industry expanded and lumber prices continued to escalate, the steel industry recognized a new potential market for cold-formed steel applications. A Residential Advisory Group was formed in 1991 to explore the avenue for penetrating this potential market. In the mid-1990s, the first edition of the Prescriptive Method for One and Two Family Dwellings was published and was adopted into CABO One and Two Family Dwelling Code. In 1996, the Residential Advisory Group was reorganized into the North American Steel Framing Alliance. In 1998, it was renamed the Steel Framing Alliance and expanded its market to cover the light commercial market as well. Also in 1998, in its role as an ANSI-accredited standards development organization, AISI launched the Committee on Framing Standards with the mission to "To eliminate regulatory barriers and increase the reliability and cost competitiveness of cold-formed steel framing in residential and light commercial building construction through improved design and installation standards." As a result, additional ANSI-approved design standards, such as Cold-Formed Steel Framing - General Provisions, -Truss Design and Header Design, were developed and published in 2001. These Standards as well as the expanded and updated Prescriptive Method, have been adopted by the 2003 International Building Code, and have been recognized by ANSI as National Standards. In 2004 these standards were updated, and new ANSI-approved standards on Cold-
Formed Steel Framing - Lateral Design and - Wall Stud Design were completed.

A detailed summary of Specification and Standard development by AISI is provided in Appendix I.

ORGANIZATIONS RELATED TO COLD-FORMED STEEL

To expand the cold-formed steel market, steel manufacturers and suppliers have formed several organizations to improve and promote cold-formed steel products, to provide services to the user group, and to expand manufacturers' product lines. These organizations include:

American Iron and Steel Institute (AISI): The American Iron and Steel Institute's history spans almost 100 years. AISI plays a pivotal role in expanding and growing the markets for steel applications. It engages in a wide variety of collective and collaborative activities, and is organized into five major areas: Market Development, Communications, Manufacturing and Technology, Public Policy, and Statistics. As a leader in the cold-formed steel industry, AISI plays an important role in developing and expanding the cold-formed steel market. Over the last half century, AISI has developed and maintained the Specification for the Design of Cold-Formed Steel Structural Members, the fundamental technical document for the cold-formed steel industry. In the past ten years, a series of cold-formed steel framing Standards have been developed. These Standards have established a
solid foundation for the cold-formed steel framing industry. In addition, AISI has published and maintained a number of cold-formed steel design manuals and design guides.

**Metal Building Manufacturers Association** (MBMA): MBMA was formed by metal building manufacturers and suppliers in 1956. MBMA members represent 95% of the total metal building systems built in the United States.

To ensure good quality of metal building systems, MBMA requires all of its member companies to be certified through the AISC-Metal Building Quality Certification Program. In addition, MBMA periodically updates its *Metal Building System Manual* and *Metal Roofing System Design Manual* to assist architects and engineers in selecting metal building systems.

With advanced computer design tools, metal building systems have been expanded from simple building configurations such as warehouses, and factory buildings to applications with varying architectural appearances found in churches, schools, shopping centers, and office buildings. Metal buildings and roofing systems are increasingly being recognized as reliable, aesthetically pleasing, and cost-effective building alternatives.

**Steel Deck Institute** (SDI): Founded in 1939 by the manufacturers of steel decks and associated products, the Steel Deck Institute has played an important role in providing uniform
industrial standards for engineering, manufacturing and field installation of steel decks. Representing 85% of the steel decks produced in the United States, SDI member companies produce cold-formed steel decks with various configurations for different types of applications. Technical information published by SDI includes the *SDI Design Manual for Composite Decks, Form Decks and Roof Decks; Roof Deck Construction Handbook; Diaphragm Design Manual;* and *SDI Manual of Construction with Steel Deck.*

**Steel Stud Manufacturers Association** (SSMA): SSMA was formed in 1999 through a merger of the Metal Lath and Steel Framing Association Division of National Association of Architectural Metal Manufacturers and the Metal Stud Manufacturers Association. The products produced by SSMA member companies include studs, tracks, and steel framing accessories such as cold-rolled channels and flat straps. In 2001, SSMA published its first product catalog using unified designation for both stud and track sections, which greatly simplified product identification for both contractors and design professionals. SSMA also publishes technical notes and CAD Details on cold-formed steel framing.

**Steel Framing Alliance** (SFA): SFA (formerly the North American Steel Framing Alliance) was established in 1998 to enable and encourage the practical and widespread use of cold-formed steel framing in the residential market. Since then, it has expanded its scope to commercial and institutional markets, as well.
SFA is a leading organization for promoting steel studs and related products by providing builders and engineers with cost-effective alternatives. At the technical front, SFA has supported many research and development initiatives, and has published a series of design guides on roof trusses, shear walls, fasteners, headers, fire-resistance ratings, and durability for cold-formed steel framing.

**Metal Construction Association** (MCA): MCA was formed in 1983 by entities engaged in manufacturing, engineering, selling and installing metal products. Its mission is to expand the usage of metal in construction through marketing, innovation, and education. MCA organizes the annual event called Metalcon, which provides a showcase for manufacturers and a learning opportunity for consumers and design professionals. In addition, MCA organizes a metal roofing certification program to promote the widespread use of appropriate metal roofing products that have met the designated quality standards. The organization also publishes a series of metal wall and roof design and selection guides.

**Rack Manufacturers Institute** (RMI): RMI was formed in 1958 by rack manufacturer companies, and is currently affiliated with the Material Handling Industry. The member companies of RMI produce cold-formed steel industry racks that are classified as either stationary or portable racks. Different from other cold-formed steel members, storage rack members contain slots.
(openings) in order for connecting members flexibly. In addition of considering the Cold-Formed Steel Specification, storage racks are designed to follow the Specifications developed by RMI, such as, Specification for the Design and Utilization of Industrial Portable Storage Rack; Specification for the Design, Testing and Utilization of Industrial Steel Storage; Specification for the Use of Industrial and Commercial Steel Storage Racks-Manual of the Safety Practices/A Code of Safety Practices.

**Metal Roofing Alliance** (MRA): MRA is a coalition of metal roofing manufacturers, paint suppliers and coaters, dealers, metal industry associations, and roofing contractors. The mission of MRA is to promote metal roofing products by showing both consumers and installers the outstanding value and the superior longevity that a metal roof provides. MRA uses Internet as a viable tool to provide information, resources, and contacts for consumers.

**Wei-Wen Yu Center for Cold-Formed Steel Structures** (CCFSS): Established at the University of Missouri-Rolla (UMR) in 1990 under the leadership of Professor Wei-Wen Yu and the sponsorship of the American Iron and Steel Institute, the Center provides integrated services related to cold-formed steel research and education. CCFSS organizes a biennial International Specialty Conference on Cold-Formed Steel Structures, which showcases the worldwide state-of-the-art practices in cold-formed steel research and technology. Many innovative ideas
and design provisions presented through the International Specialty Conferences have been adopted by design specifications and standards. CCFSS also organizes a biennial cold-formed steel design short course and offers online design courses, which provide design professionals, researchers and college students in-depth cold-formed steel design knowledge. In addition, the Center maintains a technical library, that collects worldwide cold-formed steel related research publications and research documents. This information can be searched via the Center's website at www.umr.edu/~ccfss. The Center's newsletters and technical bulletins have become the voice of the cold-formed steel community. Currently, the Center is cosponsored by AISI, MBMA, MCA, RMI, SDI, SSMA, and UMR.

**Light-Gauge Steel Engineers Association** (LGSEA): LGSEA's members include design engineers, manufacturers, and builders and contractors in cold-formed steel construction. The organization conducts educational seminars and develops a series of technical notes to assist design engineers by disseminating design technology for cold-formed steel construction.

A summary of technical documents and standards published by each organization is provided in Table 1.
Cold-formed steel products are shaped at ambient temperatures from steel sheet, strip plate or flat bars by roll-forming machines, press brakes or bending brake operations. They can be produced in large quantity and at high speed with consistent quality. A typical automated rolling machine can run at a speed range of 75-400 feet per minute, and the products can be as small as a three-quarter inch wide cold-rolled channel section to as big as a thirty-six inch wide roof deck section. In addition, cold-formed steel possesses many advantages over other construction materials:

1. **Lightweight** - Cold-formed steel components weigh approximately 35% to 50% less than their wood counterparts, which means easy handling during construction and transportation.

2. **High-strength and stiffness** - As a result of the cold-forming process, cold-formed steel possesses one of the highest strength-to-weight ratios of any building material. This high strength and stiffness advantage means better design flexibility, wider spans and better material usage.

3. **Fast and easy erection and installation** - Building components made of cold-formed steel can be fabricated with high accuracy in a plant and then assembled on job sites, which greatly increases erection efficiency and ensures construction quality.

4. **Dimensionally stable material** - Cold-formed steel
does not expand or contract with moisture content. In addition, it does not split or warp as time goes by. Therefore, it is dimensionally stable. Cracked gypsum sheathed walls, nail head popping and other common problems with wood-framed structures can be virtually eliminated in buildings with cold-formed steel stud walls.

5. **No formwork needed** - The use of cold-formed steel decks eliminates the formwork for pouring concrete floor. In addition, composite action between the steel deck and concrete increases floor strength and stiffness.

6. **Durable material** - Cold-formed steel is durable because it is termite-proof and rot-proof. In addition, galvanized cold-formed steel products can provide long-term resistance to corrosion.

7. **Economy in transportation and handling** - Lightweight cold-formed members or panels are easy to handle and to transport. In addition, they can be nested and bundled, reducing the required shipping and storage space.

8. **Non-combustible material** - Steel is a non-combustible material and will not contribute fuel to the spread of a fire. This can result in better fire resistance and lower insurance premiums.

9. **Recyclable nature** - Steel is North America No. 1 recycled construction material, with a minimum 25% recycled content. Steel products used in
construction are infinitely recyclable, with no degradation in structural properties. It can be recycled and reused. Steel-framed housing dramatically reduces the amount of trees consumed for residential construction, thus conserving one of nature's most precious resources.

APPLICATION OF COLD-FORMED STEEL

In building construction, cold-formed steel products are mainly used as structural members, diaphragms and coverings for roofs, walls and floors. There are varieties of cold-formed shapes available as structural members, which include open sections, closed sections and built-up sections. Cee-, zee-, double channel I-sections, hat, and angle sections are open sections while box sections and pipes are closed sections. The built-up members are formed by connecting two or more cold-formed steel members together, such as an I-section member built up by connecting two channel sections back-to-back. These structural shapes can be used in buildings as eave struts, purlins, girts, studs, headers, floor joists, braces and other building components. Various shapes are also available for wall, floor, and roof diaphragms and coverings.

Metal Building Construction

In pre-engineered metal buildings, the entire building structure is made from steel products, and approximately 40-60% of the total steel used is cold-formed steel. A typical metal building system consists of primary rigid frames, secondary
members, cladding, and bracing. The primary rigid frames are usually built up using welded plates with sizes optimized to satisfy the design requirements. The secondary members, such as purlins and girts, support the roof and wall coverings and provide lateral stability to the primary rigid frame members. The cold-formed metal roof and wall panels are often used as building claddings. They transfer the loads (such as wind and snow) to the secondary members and provide the integrity of the whole building. Straps or rods are often used as bracing members that maintain the building stability in the direction perpendicular to the primary rigid frames. They are also often used in end-walls or the end wall stability. Based on the statistics published by MBMA, the average annual sale of metal buildings is 2.3 billion dollars and the average annual steel shipment between 1997 and 2002 was 1.8 million tons.

Wall Construction

Cold-formed steel products are used for wall coverings and wall framing. ·

- **Wall Covering.** Wall panels are widely used as wall covering for metal buildings and office buildings. With technology improvement, wall panels can be made with a variety of shapes and textures, such as embossed, sand-finished metals, to meet structural and architectural requirements. Insulated wall panels can greatly simplify the construction process and
achieve significant cost savings.

- **Wall Framing.** In a metal building, C- or Z-shaped cold-formed steel girts are often used to provide lateral support to the metal wall panels. They are normally connected to the rigid frame at each end and are suspended from the roof eave purlins for vertical support. Cold-formed steel stud wall framing has been widely used in commercial buildings for both exterior and interior wall construction. For exterior applications, steel stud wall framing is often used as a backup system for brick veneer, stucco, and exterior insulating finishing systems (EIFS). For interior applications, steel stud wall framing is used to support the partition walls, shaft walls, ceilings, and duct enclosures. Stud wall framing is a wall system with studs connected to top and bottom tracks and braced with cold-rolled channel bridging or flat strap bracing. The stud wall system can be used to carry the floor load (load bearing wall), to divide building space (partition wall), to resist the lateral load such as wind or seismic load (curtain wall), or to provide lateral stability for the building (shear wall). In recent years, stud wall framing has seen a significant increase of its usage in residential and light commercial load-bearing construction.

**Floor Construction**
In floor construction, floor decks, steel joists (studs) and trusses are often used as floor coverings, diaphragms and floor framing, respectively.

- **Floor Deck.** Cold-formed steel decks are widely used in commercial and institutional building construction. They are made by forming cold-formed steel sheet into corrugated profiles, which greatly increases the bending capacity of the sheet steel and results in a very high strength to weight ratio. One of the great advantages of using steel decking in building construction is that the steel deck can function as a working platform and the concrete form that carries construction loads and concrete weight during the construction, and as a permanent part of load resistance system in service. There are two types of floor decks: form deck and composite deck. While both types are widely used in building construction, the composite decks usually provide means such as embossments to interlock the deck to the concrete so that higher shear resistance can be achieved. The composite decks usually possess higher strength and are capable of achieving a longer span. Multi-function steel decks, such as a cellular deck, can carry electrical wires and communication cables, as well as heating and air conditioning ducts.
• **Floor Framing.** Cold-formed steel can also be used as a part of sub-floor structures. They usually consist of C-shaped cold-formed joists or cold-formed steel trusses spaced at 16" or 24" on center and braced with diagonal or horizontal bridging at 8- to 10-feet on center. Either concrete or plywood floors can be installed on top of the cold-formed steel sub-floor.

The cold-formed sub-floor structures are used in light commercial structures, such as apartments and educational buildings, as well as single-family homes.

**Roof Construction**

• **Roof Panels.** Cold-formed steel roof panels function as structural components, resisting wind uplift and snow load, and maintaining the integrity of the building under lateral wind and seismic loads. They also fulfill appealing architectural requirements. The roof panels can be fastened to the purlins as in a through-fastened roof system or be connected to purlins with concealed sliding clips as in a standing seam roof system. The standing seam roof system can accommodate the roof panel movement due to temperature changes, which makes standing seam roof panels a great weather-resistant product. The standing seam roof panels are not only
used in new buildings, but are also widely used in the renovation and restoration of existing buildings.

Cold-formed steel roof decks can also serve as a part of the roof substructure, resisting roof diaphragm forces and supporting roofs with insulation and waterproofing membrane. Steel roof decks are usually 1½" or 3" deep, depending on the span requirement.

● Roof Framing. Cold-formed steel can also serve as the roof substructure in the form of roof purlins or roof trusses. In a metal building, Z-shaped and C-shaped roof purlins are usually used to support the roof panels and to transfer the roof wind and snow loads to the primary frames, while providing lateral stability to the primary frame members.

Cold-formed steel trusses have gained a significant market share in recent years. They can be made from regular C-section studs or from other proprietary shapes. Cold-formed steel trusses provide the same span capabilities and design flexibilities as wood trusses, yet they are lighter and more dimensionally stable than wood trusses. Most of the cold-formed steel roof trusses are pre-engineered and prefabricated with the help of computer software, which makes it possible to accommodate various roof configurations. This design flexibility makes cold-formed
Cold-formed steel will continue to be a viable material in building construction because of its unique characteristics and advantages. However, to maintain and increase market share, the steel industry must focus long term on enhancing design, improving manufacturing process and innovating construction technology.

**New Research and Development.**

To keep cold-formed steel design at the cutting-edge of technology, and to be competitive in the codes and standards arena, research work continues to be carried out through AISI committees, associations, and research institutes. The following are some of the highlights of recent research and standards development:

- **Direct Strength Design.** This is a new design procedure that has been adopted by the North American Cold-Formed Steel Specification as an alternative method to the traditional effective design approach. This design method does not require effective width calculations or iteration, but instead uses gross properties and the elastic buckling behavior of the cross-section to predict the member strength. With the assistance of computer software, this design procedure will be applicable to
cold-formed steel prismatic members with virtually any cross section configuration and will result in a more reliable and realistic design. Continued research work will be carried out to expand this design procedure to perforated members such as studs with web openings or rack structural members with patterned cutouts.

- **Seismic Design.** To facilitate cold-formed steel design in high seismic areas, new seismic design provisions, called Standard for Cold-Formed Steel Framing - Lateral Design, has been developed by the AISI Committee on Framing Standards (COFS). A design standard for cold-formed steel members and structures will be developed by the AISI Committee on Specifications (COS).

- **Wind Load Effects on Metal Roofing.** A series of wind tunnel tests and electromagnetic uplift simulations have been carried out by MBMA with co-sponsorship by AISI, MCA and Factory Mutual Global (FM). The objective of this research is to study how metal roofs respond to instantaneous wind load and determine a correlation factor which can be applied to roof panel uniform static air pressure tests while taking wind load dynamic effects into consideration.

**Building Performance**

Over the years, the North American
steel industry has committed to improving building performance through improving the performance of cold-formed steel products. Some examples include:

- **Cool Roofing.** Formed by AISI, MBMA, MCA, the National Coil Coaters Association (NCCA) and Zinc Aluminum Coaters Association (ZAC), the Cool Metal Roofing Coalition sponsored research to evaluate the energy efficiency of metal roofs. The objective of this research is to formulate and validate design tools for predicting metal roof energy efficiency during the cooling and heating seasons. The metal panels, each with different coatings, will be compared with each other and with asphalt shingle roofs for different geographic regions to determine their energy efficiency. Department of Energy computer models will be used to show annual energy savings of metal roofing products. In addition, the Cool Metal Roofing Coalition also provides technical information and educational materials and promotes metal roofing as a "green" building product due to its durability, recyclability and lightweight.

- **Corrosion Performance of Steel Framing.** Sponsored by the International Lead and Zinc Research Organization (ILZRO), a five-year study of steel framing viability under different climatic conditions has been carried out by the National Association of Home Builders
The on-site monitoring of steel framing was carried out at Miami, FL; Leonardtown, MD; Long Beach Island, NJ; and Hamilton, Ontario in Canada. The test results indicated that for cold-formed steel with minimum coating weight (G60), the estimated life expectancies ranged from 220 to more than 1,100 years with an average of 650 years for all the samples at all the locations. Thus, the research has approved that coated metal studs are long-lasting and corrosion resistant.

- **Fire Endurance and Acoustic Performance of Steel Framing.** A design guide, that collects a series of fire endurance and sound transmission data for residential and light commercial steel framing wall and floor systems, has been developed by the joint efforts of the Steel Framing Alliance (SFA) and the Canadian Steel Construction Council (CSCC). In addition, a Residential Steel Framing Builder's Guide for Fire and Acoustic Details has been recently developed by the National Association of Home Builders (NAHB) Research Center, Inc. and sponsored by The U.S. Department of Housing and Urban Development (HUD) and Steel Framing Alliance (SFA). These documents provide valuable information for design engineers and architects in selecting steel framing walls and floor systems.
Construction Safety

To address the ironworkers' concern about traction on lubricated steel decking and roofing surfaces, the OSHA/SENRAC Steel Coalition was established with its member associations of AISI, MBMA, MCA, SDI, NCCA, and Steel Joist Institute (SJI) in 1996. After more than eight years research and experimentation, a Voluntary Lubricant Compliance Program (VLCP) was developed which recommends that participants use highly evaporative lubricants during manufacturing roof and deck products. This VLCP provides an innovative and responsible approach to mitigating potential risks of slip and fall accidents on steel decking and roofing.

Manufacturing and Construction

Metal buildings and cold-formed products have evolved over the years. A streamlined price estimating, designing and manufacturing process has greatly increased the productivity and product quality of metal building construction. In addition, the advanced computerized design tools also provide flexibility so that metal buildings can be designed to meet architectural requirements.

Cold-formed steel framing is a fast-growing industry. To meet the demand for more steel framing construction workers, SFA is developing a series of "How To" educational materials for frame workers, plumbers and electricians. To encourage builders to use cold-formed steel framing, many manufacturers provide customized
price estimates and framing design services. In addition, many panelized wall and floor products are being developed by manufacturers to speed up and simplify the construction process. As a result of steel industry's efforts, the building construction is benefiting from new design, manufacturing and construction technologies.

SUMMARY

Cold-formed steel has become a competitive building material in the last two decades as a result of industry-wide efforts. To ensure sustained market growth for the cold-formed steel in building construction, AISI will continue to play an important role to increase collaboration between different organizations, to improve the design specification, and to enhance the image and awareness of cold-formed steel. The American Iron and Steel Institute has been and will remain at the forefront of developing codes and standards to pave the way for cold-formed steel to enter a new era.

REFERENCES

1. George Winter (1959), Development of Cold-Formed Light Gage Steel Structures, a paper presented at the Pittsburgh Regional Technical Meeting of the American Iron and Steel Institute, 1959.
2. Wei-Wen Yu, Don S. Wolford, and Albert L. Johnson (1996), Golden Anniversary of the AISI Specification, Recent Research and Developments in Cold-Formed Steel Design and Construction, Proceedings of the 13th International Specialty Conference on Cold-Formed
7. American Iron and Steel Institute, slides show of A Look at Cold-Formed Steel Structures.
8. Larry Williams (2003), Steel Framing: A Look Back Brings Forward Motion.
9. Related Industry Websites:
   - American Iron and Steel Institute: www.steel.org
   - Metal Building Manufacturers Association: www.mbma.com
   - Steel Deck Institute: www.sdi.org
   - Steel Stud Manufacturers Association: www.ssma.com
   - Steel Framing Alliance: www.steelframingalliance.com
   - Wei-Wen Yu Center for Cold-Formed Steel Structures: www.umr.edu/~ccfss
   - Light-Gauge Steel Engineers Association: www.lgsea.org
   - Metal Construction Association: www.
TABLE 1 - TECHNICAL DOCUMENTS ON COLD-FORMED STEEL DESIGN AND CONSTRUCTION

**AISI**

1. North American Specification for the Design of Cold-Formed Steel Structural Members and the Commentary
2. Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings
   - General Provisions
   - Truss Design
   - Header Design
   - Lateral Design
   - Wall Stud Design
3. Cold-Formed Steel Design Manual
4. Cold-Formed Steel Framing Design Guide
5. Steel Stud Brick Veneer Design Guide
6. A Guide for Designing with Standing Seam Roof Panels
7. A Design Guide for Standing Seam Roof Panels

**MBMA**

1. Metal Building System Manual
3. Various Brochures
SDI
1. Design Manual for Composite Decks, Form Decks and Roof Decks
2. Roof Deck Construction Handbook
3. Diaphragm Design Manual
4. SDI Manual of Construction with Steel Deck
5. Standard Practice Details

LGSEA
1. Acoustic Insulation and Sound Transmission in Cold-Formed Steel construction - Technical Note 360
2. Specifying Pre-Engineered Cold-Formed Steel Floor and Roof Trusses - Technical Note 551f
3. Clinched (Integral) Fastening of Cold-Formed Steel - Technical Note 560c
4. Cold-Formed Steel Joists - Technical Note 552
5. Design Considerations for Flexural and Lateral-Torsional Bracing - Technical Note 559
6. Design Guide: Construction Bracing of Cold-Formed Steel Trusses - Technical Note 551d
7. Design Guide: Permanent Bracing of Cold-Formed Steel Trusses - Technical Note 551e
8. Design Values for Vertical and Horizontal Lateral Load Systems - Technical Note 550
9. Diaphragm Design with Pneumatically Driven Pins - Technical Note 561c
10. Fastener Corrosion - Technical Note 560b-5
11. Field Installation Guide for Cold-Formed Steel Roof Trusses
12. Fire-Rated Assemblies for Cold-Formed Steel Construction - Technical Note 420
13. Introduction to Curtain Wall Design Using Cold-Formed Steel - Technical Note 542
14. Screw Fastener Selection for Light Gauge Steel Framing - Technical Note 565c
15. Shear Transfer at Top Plate: Drag Strut Design - Technical Note 556a-4
17. Welding Cold-Formed Steel - Technical Note 560-b1

MCA

1. Ecological Benefits of Metal Roofing
2. Guide to Steel Sheet Substrates
3. Insulating Values: Factory Engineered Insulated Panels
4. Lightning and Metal Roofing
5. Metal Roof Coating Maintenance
6. Metal Panel Field Repainting
7. Oil Canning
8. Recycled Content of Metal Roofing and Siding Panels
9. Structural Loading: Factory Engineered Insulated Panels

SSMA

1. SSMA Product Technical Information
2. Cold-Formed Steel Details
3. Technical Notes:
   - Single Deflection Track Selection
   - Unsheathed Flange Bracing
   - Track Within A Track Deflection
   - Interior Non-Structural 30 Mil Framed Walls
   - Metric Conversion - SSMA Tables

SFA

1. Design Guide for Cold-Formed Steel Beams with Web Penetrations - Design Guide #1
2. Monotonic Tests of Cold-Formed Steel Shear Walls with Openings - Design Guide #6
3. Builders' Steel Stud Guide
4. Shear Wall Design Guide - Design Guide #2
5. Fire-Resistance Ratings of Load-Bearing Steel Stud Walls
6. Residential Steel Beam and Column Load/ Span Tables - Design Guide #3
7. Fasteners for Residential Steel Framing - Design Guide #7
9. Durability of Cold-Formed Steel Framing
11. L-Header Field Guide - Design Guide #8

RMI

1. Specification for the Design, Testing and Utilization of Industrial Steel Storage Racks
3. Industrial Steel Storage Racks Manual

APPENDIX 1

CHRONICLE SUMMARY OF COLD-FORMED STEEL SPECIFICATION AND COLD-FORMED STEEL FRAMING STANDARDS

<table>
<thead>
<tr>
<th>Year Published</th>
<th>Significances</th>
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<tr>
<td>1946</td>
<td>The first edition of the Specification for the Design of Light Gage Steel Structural Members was published.</td>
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<tr>
<td></td>
<td>The first edition of the Light Gage Steel Design Manual was published.</td>
</tr>
<tr>
<td>1949</td>
<td>The Design Manual with the Specification was published, and the Specification was adopted by the building code officials.</td>
</tr>
<tr>
<td>1956</td>
<td>The basic safety factor was reduced from 1.85 to 1.65 in the Specification.</td>
</tr>
<tr>
<td>1960 &amp;1961</td>
<td></td>
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</tbody>
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1962
Strength increase due to cold work of forming was recognized.

1968
Compression member lateral-torsional buckling consideration was added.

1980
Specification scope was extended to cover cold-formed steel up-to one inch in thickness, and was expanded to include plate and bar steels, as well as sheet steels.

1986
The unified approach was adopted for determining the cold-formed member strength in considering local buckling.

1991
The first edition of LRFD Specification was published. The AISI Advisory Group was renamed to Committee on Specifications for the Design of Cold-Formed Steel Structural Members.

1996
The first edition of the combined ASD and LRFD Specification was published.

2001
The first edition of the North American Specification was published.

1996
The first edition of the Prescriptive Method for Residential Cold-Formed Steel Framing was published and was adopted by IRC 2000.

1997
The second edition of the Prescriptive Method for Residential Cold-Formed Steel Framing was published and was adopted by IRC 2000.
The following standards were first published:

1. Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings
2. Standard for Cold-Formed Steel Framing - General Provisions
3. Standard for Cold-Formed Steel Framing - Truss Design
4. Standard for Cold-Formed Steel Framing - Header Design

The following standards were first published:

1. Standard for Cold-Formed Steel Framing - Lateral Design
2. Standard for Cold-Formed Steel Framing - Wall Stud Design