Planning the Future of North American Cold-Formed Steel Design Standards

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Abstract

Growth in cold-formed steel structures has long been tied to developing and advancing the engineering standards that govern their use in construction. The American Iron and Steel Institute (AISI) has taken a leadership role in this activity in North America since 1946. Conventional standards providing closed-formed solutions to member capacity, such as the recently completed suite of AISI Standards in 2015 and 2016. These standards have reached an impressive level of maturity given the complexity of designing entire (building) structural systems out of steel that is rarely greater than 2mm thick. However, the demands on the structural engineer designing cold-formed steel have evolved. System performance, resilience, and sustainability all present new challenges, while changing processes in construction and the integration of simulation tools in design alter engineering workflows and open up new opportunities. Cold-formed steel standards need to evolve to meet these demands and leverage new workflows. The Strategic Planning Committee of the AISI Standards Council facilitated a process that defined areas of focus (vision statements) for the AISI specification writing committees and then facilitated a process to generate prioritized issues for the subcommittees to address. Taken together the lists provide a snapshot of the needed work to evolve cold-formed steel standards, and in turn enable next-generation cold-formed steel structural systems. This paper provides a description of the strategic planning process and its significant outcomes, which will guide the efforts of AISI standards development over the next code development cycle and beyond.

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Introduction

The American Iron and Steel Institute (AISI) has long had a role in cold-formed steel (CFS) standards development, beginning with the sponsorship of research at Cornell University under Professor George Winter and the publication of the first AISI Specification in 1946. The work was initiated because of difficulties faced in the acceptance and the development of CFS construction. Due to its unique thin-walled response there were no provisions for CFS in the U.S. building codes prior to the 1946 AISI Specification (Yu et al., 1996).

Since those early beginnings, AISI has engaged a committed group of professionals through the AISI Committee on Specifications (COS) to expand the body of knowledge and enhance the CFS Specification. In 1999, AISI became an ANSI-accredited standards developer which elevated the Specification to be recognized as an American National Standard. In 2001, the COS developed a unified North American Specification, working closely with the steel institutes in Canada and Mexico which facilitated the Specification, already referenced in the US model building codes, to be approved in Canada by Canadian Standards Association and referenced in the National Building Code, and endorsed in Mexico by CANACERO. In 2007, all the AISI standards were given a numeric designation; e.g., the 2007 edition of the North American Specification for the Design of Cold-Formed Steel Structural Members was designated AISI S100-07. Today, AISI S100-16 (see Table 1) is the latest incarnation of the CFS standard for structural members, and the research underlying this standard is the basis for much of the standards used in Australia and New Zealand and, increasingly, in Central and South America.

In 1997, the AISI Committee on Framing Standards (COFS) was established to develop a family of design and installation standards to supplement the AISI S100 Specification, eliminate regulatory barriers, and increase the reliability and cost competitiveness of cold-formed steel framing in building construction. The evolution of these standards has been summarized (Schafer et al. 2015). Today the COFS suite of Standards, as summarized in Table 1, covers the design of structural and non-structural CFS framing, including seismic design; the practice of CFS framing; and supports one-and two-family dwelling CFS framing applications with a prescriptive method. AISI has also expanded its scope in recent years to more explicitly include profiled steel panels and supports a related diaphragm design standard.

Table 1. Latest Suite of AISI Standards: 2015/2016 Editions

Identifier	Title	Committee
AISI S100-16	North American Specification for the Design of Cold-Formed Steel Structural Members	COS
AISI S202-15	Code of Standard Practice for Cold-Formed Steel Structural Framing	COFS
AISI S220-15	North American Standard for Cold-Formed Steel Framing - Nonstructural Members	COFS
AISI S230-15	Standard for Cold-Formed Steel Framing - Prescriptive Method for One- and Two-Family Dwellings	COFS
AISI S240-15	North American Standard for Cold-Formed Steel Structural Framing	COFS
AISI S310-16	North American Standard for the Design of Profiled Diaphragm Panels	COS
AISI S400-15	North American Standard for Seismic Design of Cold-Formed Steel Structural Systems	COFS

The stated mission of AISI Standards Development is to improve the performance of cold-formed steel in structures through the development and use of improved analysis methods and design specifications. Over the course of developing standards consistent barriers hindering this mission have been identified. There has been a lack of unified industry purpose due to the cold-formed steel industry being characterized by distinct trade associations focused on particular cold-formed steel products and each participating in the process for their own specific reasons. This presents challenges with respect to coordination when associations' agendas are not aligned and to motivation when there are gaps between associations' scopes. There has also been a lack of research funding, which thwarts the primary goal to facilitate competitive designs and comprehensive design methodologies for cold-formed steel. In addition, inadequate technology transfer hinders awareness, adoption and widespread use of the state-of-the-art design provisions for cold-formed steel.

Along with these industry-specific barriers CFS standards also must keep pace with the evolution in performance for competing solutions; new technology in manufacturing, construction, and engineering design; and changing and broadening of societal demands for structural performance.

Strategic Planning Process

The Strategic Planning Committee of the AISI Standards Council facilitated a process that defined vision statements for the COS and COFS committees and then turned these vision statements into operational strategies for the subcommittees responsible for creating the next editions of the AISI Standards.

The COS established as its focus for the 2017-2022 development cycle to *leverage analysis* to advance cold-formed steel structural efficiency and in the long-term, to *enable performance-based design* (PBD). The notion of leveraging analysis and the phrase performance-based design are both complex and the Strategic Planning Committee guided the process of their exploration by having subcommittee Chairs answer a series of strategic questions to seed the discussion:

- What is a/are significant barrier(s) to the success of cold-formed steel construction within the purview of your subcommittee?
- How is (or what are the types of) simulation currently used within the scope of your subcommittee?
- What opportunities (if any) exist for leveraging simulation within the scope of your subcommittee?
- What does the phrase “performance-based design” imply to you?
- Key questions about the strategic direction that our subcommittee needs answered to make the best progress include:

Similarly, the COFS established as its focus for the 2017-2022 development cycle to improve the *ease of use* of the AISI framing standards, support and encourage *full system design*, and enable cold-formed steel framing growth in *midrise*. A similar set of questions were addressed by its subcommittee chairs:

- What is a/are significant barrier(s) to the success of cold-formed steel framing within the purview of your subcommittee?
- From your perspective what key item(s) might ease the use of the framing standards within the purview of your subcommittee
- How might issues outside the scope of the existing framing standards such as acoustic, thermal/energy, as well as fire, blast etc. impact the solutions provided in the areas related to your subcommittee?
- Is simulation enabled as a solution to issues under the purview of your subcommittee, if not, what are the barriers as you see them?
- Key questions about the strategic direction that our subcommittee needs answered to make the best progress include:

The subcommittee discussions related to these questions were detailed and consumed an entire round of in-person meetings in the winter of 2017 for both the COS and COFS. Detailed notes were taken and the result was an idea rich series of observations and potential steps as well as barriers and identified needs for greater knowledge.

Working over several months in the Spring of 2017 the Strategic Planning Committee organized the discussions, eliminated redundancies, and provided a realization for each observation coming from the subcommittees in the form of a potential work item (Schafer et al., 2017). For many subcommittees 30-50 possible items were not uncommon. A strategy was developed for ranking the possible items as summarized in Table 2, and as follows:

- *Impact*. Define as H, M or L (high, medium or low). The key metric is impact on tonnage, which is influenced by such factors as improvement in cost competitiveness, improvement in reliability, elimination of regulatory barrier, fostering of innovation and new product development and/or applications, increase in number of users/specifiers, etc.
- *Level of Effort*. Define as 1, 2, 3 or 4 (low-to-high), as follows:
  - 1 = easy / volunteer effort sufficient
  - 2 = moderately easy / needs modest funds for research/contractor
  - 3 = moderately hard / needs significant stakeholder engagement/funding
  - 4 = hard / needs significant external involvement/funding
- *Priority*. Define as green, yellow, orange or red, as follows:
  - Green (H1 and M1) = delegate to subcommittees
  - Yellow (H2 to M3) = take to stakeholders (for buy-in and resources) with subcommittees monitoring
  - Orange (H4 and M4) = take to Cold-Formed Steel Research Consortium (CFSRC) and/or others with Standards Council monitoring
  - Red (L1 to L4) = do nothing

Table 2
Scheme for Prioritizing Key Issues

Impact	Level of Effort			
	1	2	3	4
H	Green	Yellow	Yellow	Orange
M	Green	Yellow	Yellow	Orange
L	Red	Red	Red	Red

At the summer 2017 COS and COFS meetings the subcommittees reviewed and amended the compiled lists, and finalized the impact and level of effort priorities to all the items. The following was noted:

- H1 or M1 items should have an action plan (task group, etc.).
- H2 or M2 items should have a champion(s) to draft a statement of work.
- H3 or H4 items should have a champion (s), which could be the chair or any member, to draft a statement of work and additional background as needed.
- For all other items, the prioritization provided by the subcommittee should be utilized to determine a resource allocation plan, with work items potentially to follow.

Following the summer 2017 COS and COFS meetings, subcommittee chairs identified the “top 5” items for their subcommittees to work on, and the Strategic Planning Committee then met to organize the output of the process for use at the winter 2018 meetings. These final lists are discussed in more detail below. At the winter 2018 meetings, subcommittees established an action item for each of their “top 5” items. These items will then be moved to the agenda for the summer 2018 meetings with champions and task groups assigned, as needed. With this process the Strategic Planning Committee hopes that the rather ephemeral vision statements, drafted in response to a series of needs and longer-term objectives, can enable actionable steps forward to advance the standards.

Committee on Specifications and its Subcommittees

The COS established as its focus for 2017-2022 to leverage analysis to advance cold-formed steel structural efficiency and in the long-term, to enable performance-based design (PBD). An outcome of the efforts to update the complete suite of AISI design standards in 2015 and 2016 was a realignment of the documents and committee structure, which provides a robust foundation for this effort (Schafer et al., 2015).

It was recognized that the key to leveraging analysis was defining system performance; i.e., the combined performance of the entire structure (the whole building) across all its desired functions (structural response under service and extreme loads; non-structural response for acoustic, thermal, energy, and more). Simulation was seen as a tool, often computational, that provides a means to reliably predict performance for a desired attribute. Cold-formed steel framing is a system, not just individual members (Figure 1). The final system is a building.

The same can be said for metal building systems, and similar concepts can be applied to other cold-formed steel systems; such as racks.

Figure 1: Cold-Formed Steel Framing

However, it was also recognized that the AISI standards provide limited system benefits and in special cases only, such as box headers in cold-formed steel framing where empirical formulas define the beneficial effects of the assembly on nominal strengths within restricted ranges of parameters that were verified by tests (Figure 2). Missing from the standards are methods to predict the full range of strength and stiffness in order to truly define system behavior.

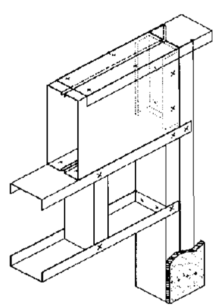

Figure 2: Box Header Assembly

The opportunity to be realized was illustrated in the recent CFS-NEES effort (Schafer et al., 2014), which provided the necessary building blocks for developing nonlinear time history models of buildings framed from cold-formed steel. The experiments demonstrated the large difference between idealized engineering models of the seismic lateral force resisting system and the superior performance of the full building system. The tested building was at least 18 times stiffer than what would have been predicted if only the shear walls were considered (Figure 3). Significant work remains to bring the findings to design practice, which is both ongoing and an area of future need.

Figure 3: CFS-NEES Building

The COS efforts start with structural system benefits because the focus and expertise of the committee has traditionally been on structural and the potential for improvements are large and clear. However, simulation efforts across other performance aspects are expanding; i.e., financial, construction, energy, acoustic, vibration, fire and more, which all create additional views of the system. Optimization for multiple attributes is enabled by having all the simulations and provides the potential to provide radically improved buildings.

The AISI Cold-Formed Steel *Analysis Task Group* has as its objectives to (1) support development and maintenance of analysis-based provisions that enable system reliability, enable performance-based design evaluation, and expand engineering capabilities for optimizing and specifying CFS; and (2) enable CFS use in current software. Serving both the COS and COFS, this task group identified the following high priority items:

- Enable second order elastic analysis
- Parallel AISC 360 App. 1 provisions for design by advanced analysis
- Establish industry “vocabulary” for analysis-based design

With responsibility for the provisions in Chapter J of AISI S100, the COS *Subcommittee on Connections and Joints* (CF-3) first identified seven major areas of interest (with typically 5-10 potential work items in each area):

- maintain and improve strength limit state predictions for connections,
- improve (strength) reliability application for connection/joint strength,

- encourage innovation in the application of fastening technology,
- clear barriers to use of proprietary (i.e., non-standard) solutions,
- improve and expand suite of AISI test standards and guidance,
- encourage and expand use of simulation of CFS connections/joints, and
- expand connection predictions to full range (pre, peak, and post-peak) for evaluating performance of systems.

After ranking and discussion a small subset of work items were then selected:

- Improve reliability application for connection/joint strength (M1/H3)
- Encourage innovation in fastening technology (M2/H3)
- Improve/expand suite of connection test standards/guidance (L1/M2)
- Update, validate and confirm screw fastener predictions (M1/2)
- Develop SAE bolt design provisions (M3)
- Improve transverse fillet weld predictions (M2)
- Investigate block shear vs. tear-out and new provisions (M1)
- Transfer research findings of load bearing clip angle project into applicable design provisions (M1)

With responsibility for the provisions in Chapter I of AISI S100, the COS *Subcommittee on Assemblies and Systems* (CF-4) first identified nine major areas of interest (with typically 5-10 potential work items in each area):

- improve strength design method for built-up/composite members,
- determine whether/how to achieve "convergence" on how various CFS systems are handled,
- coordinate with CFS stakeholders and their standards; serve as liaison and clearinghouse for the systems referenced in Chapter I,
- catalog and monitor CFS assemblies and systems under CF-4 consideration,
- organize and goal set for metal building wall and roof systems,
- develop CFS system provisions (guidance) that leverage/support structural simulation of CFS systems or assemblies and reduce testing,
- encourage and develop supporting provisions for (non-structural) simulation of CFS assemblies,
- develop and propagate a consistent methodology for incorporating system reliability, and
- serve as performance-based design conduit.

After ranking and discussion a small subset of work items were then selected:

- Develop general strength method for all-steel built-up members (H2)
- Develop general strength method for composite concrete members (H4)
- Coordinate with CFS stakeholders and their standards; serve as liaison and clearinghouse for the systems that it supports/references (H1)

- Monitor the structural impact of non-structural simulation - fire, acoustic, thermal, etc. (M1)
- Develop/propagate method for incorporating system reliability (H4)
- Serve as incubator for performance-based design for CFS systems (M4)

With responsibility for the provisions in Chapter K of AISI S100, the COS *Subcommittee on Test Based Design* (CF-6) first identified five major areas of interest (with typically 5-10 potential work items in each area):

- evolve and improve AISI test standards,
- identify ways to ease and speed up product evaluation and approval,
- support simulation as alternative path for limit states design,
- support and develop assembly-based testing/simulation methods, and
- support test or simulation of non-structural performance objectives; e.g., fire, acoustic, thermal

After ranking and discussion a small subset of work items were then selected:

- Develop "prototype" performance-based test standard (H1)
- Review limit states considered in design and catalog the corresponding test-based paths (H1)
- Consider alternative methods for "packaging" test standards (H1)
- Identify ways to ease and speed up product evaluation/approval (H1)
- Review/adopt best test practices from other industries' standards (H1)

With responsibility for the provisions in Chapters C and H of AISI S100, the COS *Subcommittee on Stability and Combined Actions* (CF-22) first identified three major areas of interest (with typically 5-10 potential work items in each area):

- develop improved system stability (geometric nonlinear) analysis methods,
- improve/expand bracing provisions, and
- improve/expand design of members under combined actions.

After ranking and discussion a small subset of work items were then selected:

- Implement brace force/stiffness accumulation provisions (H2)
- Partner with stakeholders for practical/effective bracing solutions (M2)
- Clarify torsional stability and torsional bracing (M3)
- Implement new DSM beam-column design provisions (H1)
- Improve efficiency for assessing combined actions (H2/3)
- Monitor and leverage system stability analysis methods of AISC (H1)
- Coordinate with rack standard advances (M1)

With responsibility for provisions throughout AISI S100, the COS *Subcommittee on Member Design* (CF-24) first identified four major areas of interest (with typically 5-10 potential work items in each area):

- maintain and improve strength limit state predictions for members,
- improve (strength) reliability application for member strength,
- encourage innovation in the application of materials and manufacturing technology, and
- develop CFS member provisions (guidance) that leverage/support simulation of CFS systems.

After ranking and discussion a small subset of work items were then selected:

- Maintain/support elastic buckling analysis (H/M1)
- Provide clarity in member design objectives; define consequence of existing strength limit states (H/M1)
- Foster deeper engagement w/current stakeholders' innovation (H/M1)
- Explore use of higher strength grades and complex sections (H/M1)
- Update reliability standards based on available knowledge (H/M1)
- Define member response under elevated temperature gradients (H/M1)
- Establish bending provisions for non-symmetric sections (H/M2)
- Resolve EWM vs. DSM differences (deck) and long-term path (H/M2)
- Develop and validate a design method for torsion (H3/4)

With responsibility for provisions in Chapters A, B, L and M of AISI S100, the COS *Subcommittee on General Provisions* (CF-31) first identified five major areas of interest (with typically 5-10 potential work items in each area):

- maintain and improve existing provisions,
- support introduction of system analysis and system reliability,
- enable AISI S100 to provide multiple performance objectives,
- improve and expand provisions that support innovation in steel material choice, and
- revisit 95% thickness rule.

After ranking and discussion a small subset of work items were then selected:

- Ponding provisions (M2)
- Advanced High-Strength Steel (AHSS) performance (H3)
- Provisions for the evaluation of existing structures (M1-M2)
- Fatigue provisions for newer steels (M1)
- Streamline safety and resistance factors (H2/3)
- Material variability and M-factors (M1/2)
- Re-evaluate grade 80 F_y knockdown methodology (M3)

With responsibility for provisions in AISI S310, the COS *Subcommittee on Diaphragm Design* (CF-33) first identified five major areas of interest (with typically 5-10 potential work items in each area):

- maintain and improve the existing standard,
- insure/enable the use of S310 in all appropriate system standards,
- support and develop the use of S310 for seismic design,
- develop a long term path for S310 standard, and
- streamline adoption of proprietary fasteners for use in steel deck in building designs.

After ranking and discussion a small subset of work items were then selected:

- Implement new provisions for deck with concrete (H2)
- Enable the use of AISI S310 in all applicable standards (H1)
- Develop a long term path for AISI S310 (H1/3)
- Review and improve definition of "diaphragm" (M1)
- Develop AISI S310 (or other standard) for seismic design (H4)
- Develop design requirements for diaphragms supported by wood (M1)
- Implement system reliability methods for deck diaphragms (H3)
- Rational analysis provisions (M1)
- Continue to revise and improve editorial choices (M1)

Committee on Framing Standards and its Subcommittees

The COFS established as its focus for 2017-2022 to improve the ease of use of the AISI framing standards, support and encourage full system design, and enable cold-formed steel framing growth in midrise.

Compared to other materials, cold-formed steel design has traditionally been more complex because of its unique characteristics (e.g., slenderness of cross sections, range of material grades and ductility, and the great variety of combinations of cross sections and end-use applications); and the desire of manufacturers of high volume products to maximize performance. This is further exasperated by the general lack of education on cold-formed steel design compared with more traditional materials.

While still establishing its goals and work plans for the 2016-2022 cycle, the COFS Simplification Task Group is considering ways to best integrate the provisions of AISI S100 into the various AISI framing standards, simplify the required analytical methods, improve efficiencies and incorporate system effects in the most concise, clear manner.

Cold-formed steel framing has attributes that make it quite suitable for low- and mid-rise and even a viable framing alternative in the construction of high-rise buildings. The results of a 2016 engineering feasibility study from the Steel Framing Industry Association (SFIA) suggests that the structural integrity of cold-formed steel theoretically could enable architects and designers to create CFS-framed buildings as high as 40 stories or more. The feasibility analysis was conducted by Pat Ford, P.E., principal of the engineering firm Matsen Ford Design, headquartered in Milwaukee, with guidance from the SFIA Technical Committee. The results of the study have been presented to industry leadership, including members of the COFS. The project has been named Matsen Tower (Figure 4) in honor of Ford's late business partner, John P. Matsen, P.E. who also was a leader in the industry's technical community and to whom the first edition of AISI S240 is dedicated.

Figure 4: Matsen Tower

However, cold-formed steel framing growth in midrise is not fully enabled due to limitations in design codes and standards. A study by Cold-Formed Steel Research Consortium (CFSRC) assessed current cold-formed steel framing standards for mid-rise applications through a unified archetype building frame work, which shed light on the potentials and limitations of the current practice (Torabian et al., 2016). The study concluded that incorporating system effects in the analysis and design of mid-rise buildings in addition to high capacity shear walls that need high capacity chord studs, hold-downs, and anchors is needed to bring the efficiency of complete cold-formed steel construction to mid-rise construction.

Additionally, building codes are increasingly imposing requirements for non-structural attributes, such as energy efficiency and acoustic performance. Compliance of cold-formed steel systems with fire, sound and thermal requirements is typically demonstrated through testing, but such testing is costly and time consuming. Development of analysis-based methods for such performance aspects is also desirable and achievable. It was determined that AISI standards should include analysis-based methods for such nonstructural performance aspects as energy efficiency and acoustic performance. For similar reasons, AISI standards should include analysis-based methods for such structural performance aspects as fire.

With responsibility for provisions in AISI S220 and AISI S240, the COFS *Framing Design Subcommittee* first identified four major areas of interest (with typically 5-10 potential work items in each area):

- complexity,
- structural framing design,
- connection details, and
- building system design.

After ranking and discussion a small subset of work items were then selected:

- Bracing / sheathing and resolution on accumulated forces (H2/3)
- Reliability for repetitive member systems (H2)
- Bearing on concrete (H3)
- Composite C-shape joists (H2)
- Thermal / fire / acoustical breaks vs. structural connections (H2/3)
- AISI S100-16 review for COFS use (H2)
- Trusses in mid-rise (e.g. transfer girders) (H1)
- Enabling ledger framing in mid-rise (H2)
- Greater than 24 in. framing spacing (H1)
- Realizing clip angle research (H1)
- Clarity in connection design objectives (H1)
- Floor serviceability (H1/2)
- Mixed construction (H1/2)
- Nonstructural system design issues (H/M1)

With responsibility for provisions in AISI S240 and AISI S400, the COFS *Lateral Design Subcommittee* first identified four major areas of interest (with typically 5-10 potential work items in each area):

- Improving S400 implementation across standards (codes and standards related efforts),
- more robust (higher strength and ductility) and cost effective LFRSs,
- building system lateral design, and
- education.

After ranking and discussion a small subset of work items were then selected:

- Supplement CFS NHERI with companion diaphragm project (H4)
- Continue development of mid-ply shear wall system (H3)
- Monitor AISC Direct Analysis Method and Seismic Design project (H3)
- Expected strength factor Ω_E for different SFRS systems (H2)
- Coupled shear walls (useful Type II approach) (M2)
- ASCE 41 and the seismic retrofit opportunity (H1/M3)
- Corrugated shear walls (e.g., mini-storage) (H1)

With responsibility for AISI S202, as well as provisions in AISI S220 and AISI S240 for general requirements and quality, the COFS *Standard Practices Subcommittee* first identified two major areas of interest (with typically 5-10 potential work items in each area):

- AISI S202 - Code of Standard Practice, and
- AISI framing standards.

After ranking and discussion a small subset of work items were then selected:

- Coordination of cladding and finish systems in AISI S202 (H1/3)
- Design responsibilities for 3D digital models in AISI S202 (M2)
- Recognize CFS manufacturer certification programs in AISI S202 (H1)
- Coordination with metal buildings in AISI S202 (L2/3)
- Integrate steel deck into CFS-framed structures in AISI S240 (M3)
- Imperfection and residual stresses to be used in advanced analysis (M3)
- Design responsibilities for modular construction in AISI S202 (H3)
- QC/QA for panelized and modular construction in AISI S240 (H2/3)
- Feedback on use of QC/QA provisions in AISI S240 Chapter D (M1)
- Eliminate 24” o.c. repetitive framing limit in AISI S240 (M3)

With responsibility for AISI S230, the COFS *Prescriptive Methods Subcommittee* identified the following high priority items:

- Update AISI S230-15 to ASCE 7-16 (H2)
- Eliminate building size limits and expand wall bracing options (H1/2)

- Add PAF and expansion anchor tables and charts (H1)
- Update AISI S230 Commentary (H2)
- Add Flow charts (H2)

Education Committee

The Education Committee established as its focus for 2017-2022 to monitor industry education efforts and ensure that adequate educational products are available to support each AISI standard, and where needs are not met, advocate for additional resources to support industry education efforts.

With responsibility for AISI design guides and manuals, the Education Committee identified the following high priority items:

- Determine education plan for each AISI standard (H1)
- Develop new AISI design guides; i.e., one for each standard (H2/M3)
- Consider new packaging options for AISI standards (M1)
- Educate users on new numbering scheme for AISI standards (H1)
- Address items from the technical committees/subcommittees (H1/M3)

The AISI Education Subcommittee and its steel industry partners work closely with the Wei-Wen Yu Center for Cold-Formed Steel Structures (CCFSS). Established in 1990 and named for its founder, the CCFSS strives to encourage and promote the use of cold-formed steel construction through technical service, engineering education, research, and professional activity. Its digital library serves as an industry resource and its bi-annual Specialty Conference and 3-day Short Course are highly regarded industry assets. Its director, Dr. Roger A. LaBoube, assists in answering “hot line” questions on a daily basis and in providing numerous educational seminars and webinars year round.

Additionally, the AISI Education Subcommittee and its steel industry partners support and encourage the efforts of the Cold-Formed Steel Engineers Association (CFSEI). The CFSEI is made up of hundreds of structural engineers and other design professionals with the goal of finding a better way to produce safe and efficient designs for commercial and residential structures with cold-formed steel. The CFSEI series of Technical Notes continues to grow and covers many of the design challenges encountered, helping to bridge the gap between the building codes, the standards, and design. The bi-monthly CFSEI webinars and annual CFSEI Expo are excellent educational events, with the Expo also affording significant networking opportunities.

Resourcing the Plan(s)

Research and development is the fuel of the codes and standards development engine. Our goal is not merely to do research, but to do research that is driven by market needs and our marketing objectives. We rely on industry from the steel industry, but we continue to pursue funding from external sources.

The AISI facilitates the Steel Industry Code Forum to improve communication and provide a forum for collaboration among key industry partner associations on codes, standards and other technical issues. There are currently 19 associations active in the Forum (Figure 5). Relationships developed and strengthened through the Forum allow the associations to work effectively towards common objectives at code hearings and other critical venues, but also provide a mechanism for collaboration towards resourcing projects of strategic importance to the industry.

Figure 5: AISI Steel Industry Code Forum

However, the steel industry recognizes that the pursuit of high-risk, transformative research initiatives that have the potential to significantly advance the ability of steel structures to meet society's evolving needs requires a more advanced approach. Steel construction research and development must maximally leverage outside opportunities to provide necessary resources. In response, AISI aided in the formation of and now works closely with the Cold-Formed Steel Research Consortium (CFSRC). A Charter for the CFSRC was established at the Johns Hopkins University in May 2013 based on the principles defined by its mission, vision, and core values. The CFSRC has a growing list of the academic institutions engaged, which affords significant potential, which the steel industry is just beginning to exercise; i.e., sharing facilities, staff and students across institutions and pursuing in a more systematic way the kinds of moneys needed for game changing research.

Conclusions

Cold-formed steel enjoys wide use in a variety of structures. The family of engineering specifications produced by the American Iron and Steel Institute

(AISI), through the hard work of its staff and volunteers, provide critical guidance and information for the design of these unique thin-walled members. The evolution of these standards from considering members to considering systems, and the changing landscape in construction, analysis, and design place unique demands on the members working to update and evolve cold-formed steel engineering specifications. Detailed herein are the results of a comprehensive strategic planning exercise to develop a vision and actionable plan for the committees and subcommittees that produce AISI engineering specifications. Around the themes of leveraging analysis, performance-based design, system design, and ease of use each subcommittee developed a list of major areas of interest. These interest areas, in the broadest sense, represent an up to date summary of the research needs for cold-formed steel. In addition, each committee prioritized an action plan – providing a window into the activities that will directly lead to the next editions of the AISI specifications. There is a popular adage often attributed to Benjamin Franklin, the father of time management, "*Failing to plan is planning to fail.*" The Strategic Planning Committee of the AISI Standards Council has facilitated a process that will guide the efforts of AISI standards development over the next cycle and beyond. Coupled with the expertise and energy of the members and staff of the committees, there is good reason to expect that AISI will continue to enable the improved performance and design of cold-formed steel in structures through 2022 and beyond.

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