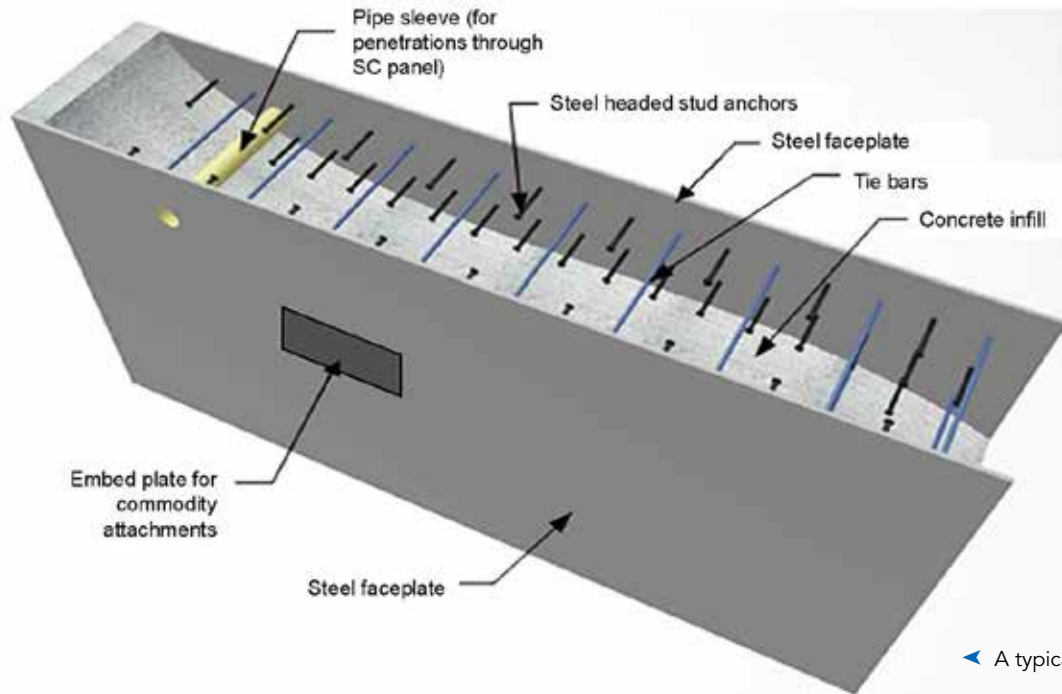


steelwise

## NUCLEAR OPTION

BY SAAHASTARANSHU R. BHARDWAJ  
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AISC's newest design guide covers modular steel-plate composite walls in nuclear facilities.



◀ A typical SC wall.

**AN INCREASED INTEREST** in improving the resilience and sustainability of nuclear facilities has subsequently increased attention towards optimizing their construction.

An emerging option for such optimization is steel-plate composite (SC) construction. This modular technology leads to shorter construction schedules and provides a robust design for seismic, blast and impact loads.

Here's how it works: Concrete walls are reinforced with two steel faceplates attached to the concrete using steel anchors, such as steel headed stud anchors, and connected to each other using steel tie bars. The steel faceplates serve as formwork during concrete placement, and through composite action enabled by shear connectors they also serve as equivalent reinforcing steel during the service life of the structure, thus eliminating the need for internal steel reinforcing bars. Ties provide structural integrity, prevent delamination of plain concrete and serve as shear reinforcement.

And now SC is the focus of a new publication: AISC Design Guide 32: *Design of Modular Steel-Plate Composite Walls for Safety-Related Nuclear Facilities*. In 2015, AISC published the design provisions for SC walls (Appendix N9) in safety related-nuclear facilities as a part of Supplement No. 1 (s1) to the 2012 *Specification for Safety-Related Steel Structures for Nuclear Facilities* (ANSI/AISC N690-12), available at [www.aisc.org/standards](http://www.aisc.org/standards), and the newly published



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▲ Tie bar and stud layout.



▲ An SC module being transported at a job site.

design guide is intended for use in conjunction with this spec. Now available at [www.aisc.org/dg](http://www.aisc.org/dg), it:

- ▶ Addresses SC walls that meet the requirements of Appendix N9
- ▶ Provides supplementary recommendations for the design of modular SC structures using the provisions of Appendix N9
- ▶ Discusses the design of SC wall connections including design philosophies and typical connection details
- ▶ Presents illustrations explaining the tolerance requirements for construction and fabrication of SC walls

While Design Guide 32 provides primary procedural steps required for the design of SC structures, nuclear construction also needs to satisfy other regulatory and environmental requirements, which may affect the design procedure, as well as project-specific scenarios that need to be considered in the design.

## Layout

The guide is organized into 14 chapters along with an appendix. Chapter 1 presents background and introductory information for the SC wall system, its advantages and limitations, and summarizes the layout and applicability of AISC N690s1. Chapter 2 discusses design guide scope and layout. The minimum requirements that an SC wall needs to meet for the provisions of Appendix N9 to be applicable are discussed in Chapter 3. The guide then discusses the detailing requirements for SC walls in Chapters 4 through 6. These detailing requirements are provided to address specific SC limit states such as faceplate local buckling. The requirements include faceplate slenderness requirements and steel anchor and tie detailing. Guidelines for modeling and analysis of SC walls

are presented in Chapter 7, and the determination and basis of individual design strength equations in follow in Chapter 8, with Chapters 9 and 10 covering demand interaction. Connection design is covered in detail in Chapter 11, where different connection philosophies, force transfer mechanisms and types are presented, along with illustrations, and Chapter 12 provides guidance on impact and impulsive loading.

## Example

Implementation of the AISC N690s1 provisions is illustrated using a detailed design example presented in Appendix A in the guide. An SC wall from a compartment of a typical safety-related nuclear facility is selected, and all aspects of the design are discussed. The example discusses the rationale for selecting the preliminary details of the structure, and a discussion on the materials selected with their basis is also presented. Representative design demands are considered for the design of the example SC wall, which doesn't include any attachments or openings.

While the example presents the methodology for designing modular SC walls, the designer should consider the constructability aspect of these walls during the analysis and detailing phases of the design. For example, the size of the prefabricated module should be established based on transportation capabilities. It is also necessary to consider the erection and fabrication loads, concrete casting pressure and demands on ties and ribs prior to casting. Therefore, designers need to be cognizant of the fabrication and erection procedures and sequence to ensure the design can be implemented without any issues. Appendix N9 to AISC N690s1 provides fabrication and erection tolerances that need to be met for the provisions of the appendix to be applicable. These toler-



- ▲ Lifting and erecting SC modules.
- Design procedure for SC walls, based on AISC N690s1 provisions.

ances are discussed in Chapter 13 of the guide, while Chapter 14 deals with quality assurance and quality control requirements. The flow chart on the opposite page illustrates the design procedure for SC walls, based on AISC N690s1 provisions.

The development and publication of ANSI/AISC N690s1 and AISC Design Guide 32 provide the first U.S. standard for design and construction of SC wall structures. Together, these two publications will facilitate the use of modular composite construction in nuclear facilities, making these facilities more resilient and constructable. ■

