MODULAR CONNECTION TECHNOLOGIES FOR SC WALLS OF SMRs

NEET-1: Advanced Methods of Manufacturing

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INTRODUCTION

- Steel-plate composite (SC) structures have been used to expedite construction of the third generation of nuclear power plants.
- Consider AP1000® and US-APWR®, both of which use SC walls for the primary and secondary shield walls within the containment internal structures (CIS).
- AP1000® uses an SC shield building to provide aircraft impact resistance and radiation shielding

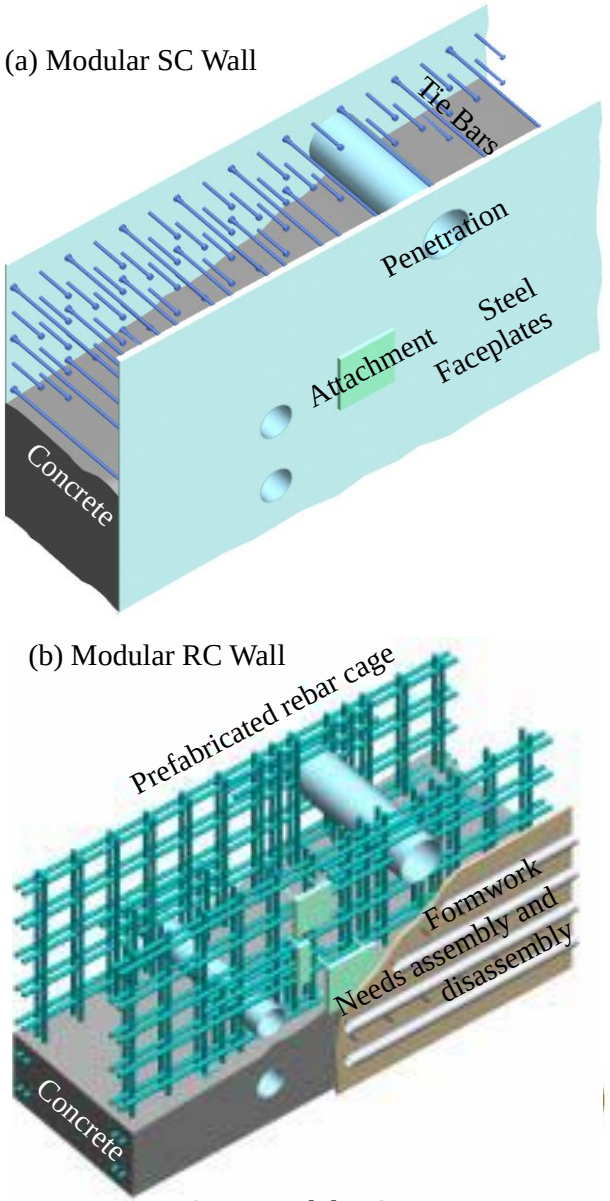


Figure 1. SMR Modular Construction

MOTIVATION

- The challenge for SC walls was that there is no governing design code or standard in the US that can be used for their design, inspection, and review
- This has been a significant challenge for the NRC reviewers and extended the licensing schedule for nuclear power plants using SC walls.
- Connections between SC-to-SC walls and SC-to-RC walls or slabs have been particular challenging because:
  i. There are no clear performance requirements specified by any code or standard, and
  ii. There are no pre-qualified or pre-developed and tested connections for engineers to select from

PROJECT OBJECTIVES

- The overall goal of the project is to develop design details, benchmarked numerical models, and experimental results concerning SC wall connections to other SC walls, RC slabs, and the concrete basemat.

1. Develop modular SC wall connection strategies, and evaluate their structural behavior for use in SMRs.
2. Develop and benchmark numerical models that can be used to investigate the structural behavior, performance and failure of SC wall connections.
3. Conduct experimental investigations to verify SC wall connection performance.
4. Develop standardized connection details and design guidelines to expedite the design, review, licensing, and construction processes for SMRs.

TASK 1. MODULAR CONNECTION STRATEGIES

- Develop different connection strategies and details for:

  (1) SC wall-to-wall connection in T-configurations, L-configurations, and elbow configurations,

  (2) SC wall-to-concrete basemat anchorage connections, and

  (3) Reinforced concrete floor slab-to-SC wall connections

TASK 2. COMPUTATIONAL SIMULATIONS

- Develop and benchmark detailed 3D finite element models to predict behavior of connections up to failure

- Explicitly account for
  i. Complex behavior of concrete materials in compression, tension, and shear,
  ii. Behavior of steel materials in the inelastic range up to fracture,
  iii. Interaction behavior between the steel and concrete components, and
  iv. Behavior and failure of different types of connector elements

TASK 3: EXPERIMENTAL EVALUATION

- The objective of the experimental investigations is to establish the performance, strength, ductility, and failure mode of SC wall-to-wall connections, SC wall-to-basemat connections, and RC slab-to-SC wall connections.

- The experimental investigations will be conducted at reduced (1:2 to 1:3) scale to optimize safety and economy, while capturing the salient features of fabrication, construction, and materials.

Task 4. Design Guidelines

- Development of design guidelines and recommendations for standardized SC wall connections to achieve good seismic performance
- Dissemination through publications, codes and design guides etc.

- Schedule

	Year 1		Year 2		Year 3	
Task 1: Development of Modular Connections						
Task 2: Computational Simulation and Benchmarking						
Task 3: Experimental Investigations						
Task 4: Design Guidelines and Standardization						

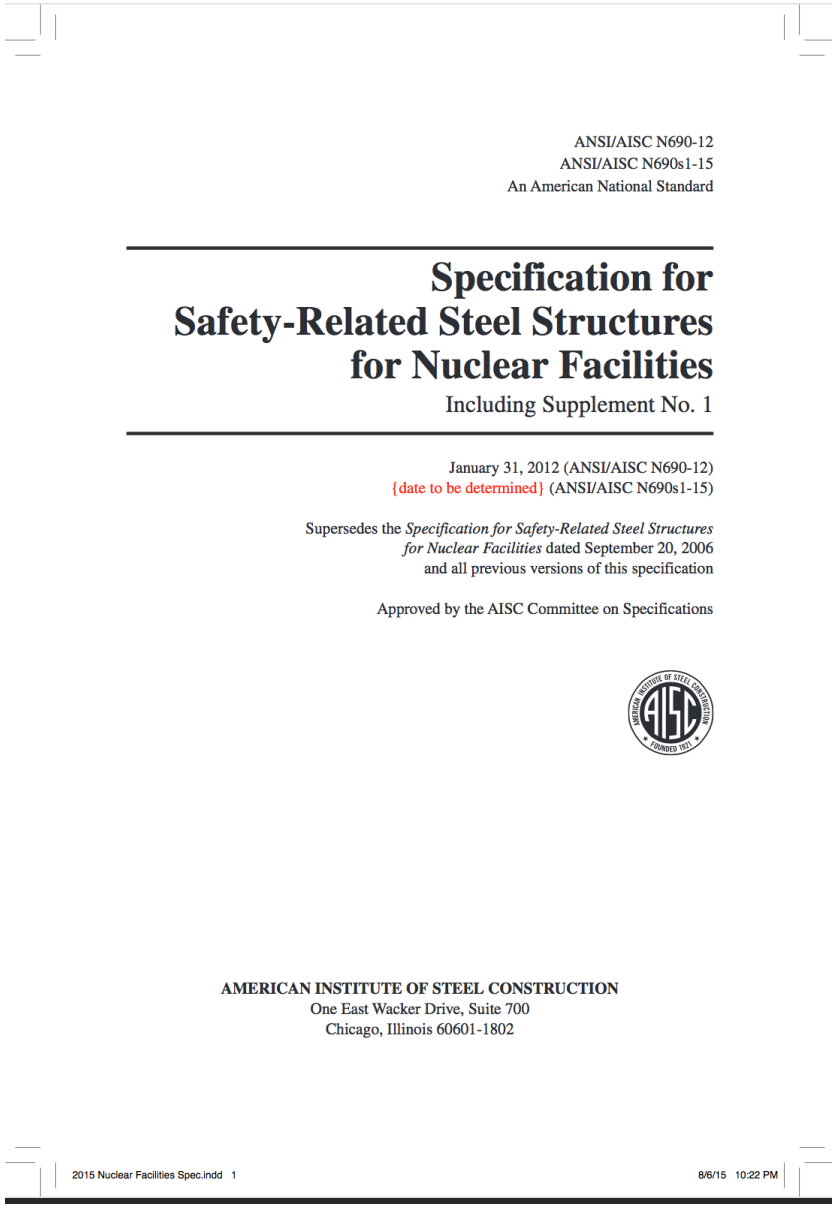
RELEVANCE

- The project will significantly improve the efficiency and economy of SMRs by developing, evaluating, and standardizing modular connection strategies for the SC walls structures being considered for most SMR applications.

INDUSTRY PARTNERS

- Westinghouse Electric Co. → Mr. Tod Baker
- AISC

SIGNIFICANT OUTCOME / CONTRIBUTION



ANSI/AISC N690-12
ANSI/AISC N690s1-15
An American National Standard

Specification for Safety-Related Steel Structures for Nuclear Facilities

Including Supplement No. 1

January 31, 2012 (ANSI/AISC N690-12)
{date to be determined} (ANSI/AISC N690s1-15)

Supersedes the *Specification for Safety-Related Steel Structures for Nuclear Facilities* dated September 20, 2006 and all previous versions of this specification

Approved by the AISC Committee on Specifications

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2015 Nuclear Facilities Spec.indd 1 8/6/15 10:22 PM

SIGNIFICANT OUTCOME / CONTRIBUTION

Specification for Safety-Related Steel Structures for Nuclear Facilities, January 31, 2012
incl. Supplement No. 1, {date to be determined}
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