

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

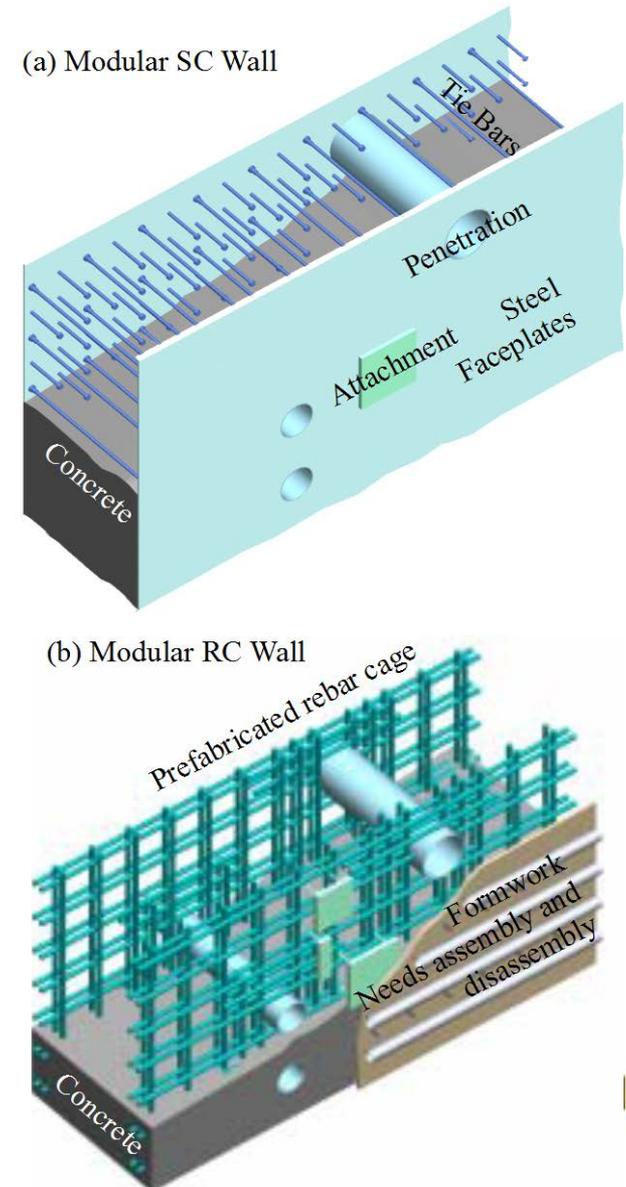


Figure 1. SMR Modular Construction

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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APPENDIX N9. STEEL-PLATE COMPOSITE (SC) WALLS.	67
N9.1. Design Requirements	67
1. General Provisions	67
2. Design Basis	68
2a. Required Strength	68
2b. Design for Stability	69
3. Faceplate Slenderness Requirement	69
4. Requirements for Composite Action	69
4a. Classification of Steel Anchors	69
4b. Spacing of Steel Anchors	70
5. Tie Requirements.	71
5a. Classification of Ties	71
5b. Required Tensile Strength for Ties	71

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

6.	Design for Impactive and Impulsive Loads.....	72
6a.	Dynamic Increase Factors.....	72
6b.	Ductility Ratios.....	72
6c.	Response Determination.....	73
7.	Design and Detailing Around Openings.....	74
7a.	Design and Detailing Requirements Around Small Openings.....	74
7b.	Design and Detailing Requirements Around Large Openings.....	75
7c.	Bank of Small Openings.....	75
N9.2.	Analysis Requirements.....	76
1.	General Provisions.....	76
2.	Effective Stiffness for Analysis.....	76
3.	Geometric and Material Properties for Finite Element Analysis.....	78
4.	Analyses Involving Accident Thermal Conditions.....	79
5.	Determination of Required Strengths.....	79
N9.3.	Design of SC Walls.....	80
1.	Uniaxial Tensile Strength.....	80
2.	Compressive Strength.....	80
3.	Out-of-Plane Flexural Strength.....	81
4.	In-Plane Shear Strength.....	81
5.	Out-of-Plane Shear Strength.....	82
6.	Strength Under Combined Forces.....	83
6a.	Out-of-Plane Shear Forces.....	83
6b.	In-Plane Membrane Forces and Out-of-Plane Moments.....	84
7.	Strength of Composite Linear Members in Combination with SC Walls.....	87
N9.4.	Design of SC Wall Connections.....	87
1.	General Provisions.....	87
2.	Required Strength.....	87
3.	Available Strength.....	88



SIGNIFICAN

N5.2. Material Properties	111
6. Bolts	111
APPENDIX N9. STEEL-PLATE COMPOSITE (SC) WALLS	112
N9.1. Design Requirements	113
1. General Provisions	113
2. Design Basis	120
2a. Required Strength	121
2b. Design for Stability	121
3. Faceplate Slenderness Requirement	122
4. Requirements for Composite Action	123
4a. Classification of Steel Anchors	123
4b. Spacing of Steel Anchors	124
5. Tie Requirements	126
5a. Classification of Ties	130
5b. Required Tensile Strength for Ties	130
6. Design for Impactive and Impulsive Loads	133
6b. Ductility Ratios	133
6c. Response Determination	133
7. Design and Detailing Around Openings	136
7a. Design and Detailing Requirements Around Small Openings	137
7b. Design and Detailing Requirements Around Large Openings	140
N9.2. Analysis Requirements	141
1. General Provisions	141
2. Effective Stiffness for Analysis	141
3. Geometric and Material Properties for Finite Element Analysis	147
4. Analyses Involving Accident Thermal Conditions	147
5. Determination of Required Strengths	148
N9.3. Design of SC Walls	150
1. Uniaxial Tensile Strength	151
2. Compressive Strength	151
3. Out-of-Plane Flexural Strength	153
4. In-Plane Shear Strength	154
5. Out-of-Plane Shear Strength	156
6. Strength Under Combined Forces	158
6a. Out-of-Plane Shear Forces	158
6b. In-Plane Membrane Forces and Out-of-Plane Moments	160
N9.4. Design of SC Wall Connections	163
1. General Provisions	163
2. Required Strength	166
3. Available Strength	167
REFERENCES	169

