

# 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

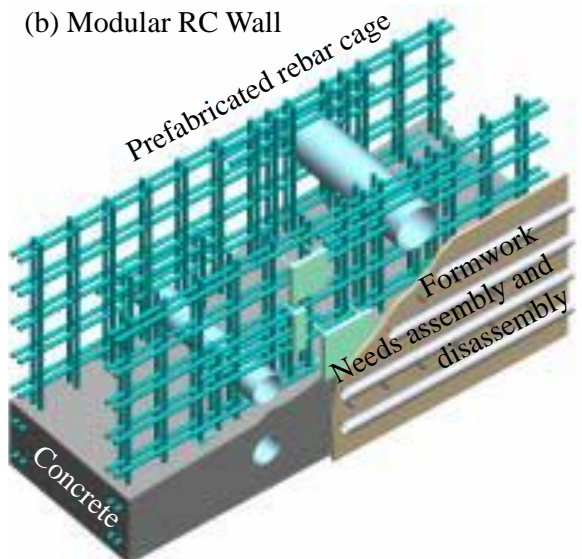
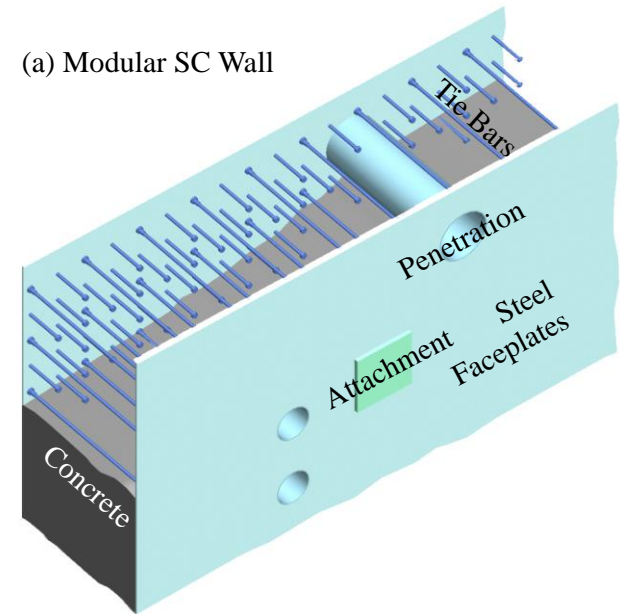


Figure 1. SMR Modular Construction

# 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

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## Specification for Safety-Related Steel Structures for Nuclear Facilities

Including Supplement No. 1

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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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# SIGNIFICANT OUTCOME / CONTRIBUTION

<b>APPENDIX N9. STEEL-PLATE COMPOSITE (SC) WALLS.</b> . . . . .	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

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*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

TABLE OF CONTENTS

xi

N5.2. Material Properties .....	111
6. Bolts .....	111
<b>APPENDIX N9. STEEL-PLATE COMPOSITE (SC) WALLS .....</b>	<b>112</b>
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
<b>REFERENCES .....</b>	<b>169</b>

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