# Prefabricated High-Strength Rebar Systems with High-Performance Concrete for Accelerated Construction of Nuclear Concrete Structures

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**Program**: Advanced Methods for Manufacturing (NEET-1)

**ABSTRACT:**

This project involves innovative research that offers the promise of dramatically reduced field construction times and fabrication costs for reinforced concrete (RC) nuclear structures through: 1) high-strength steel deformed reinforcing bars (rebar); 2) prefabricated rebar assemblies with headed anchors; and 3) high-performance concrete. The focus is on shear walls, their connections/joints, and around large penetrations/embedments because they are the most common lateral load-resisting members in non-containment nuclear structures. Specific research goals are to: A) develop transparent limit/cost-benefit frameworks; B) develop an optimization methodology for design; C) conduct experimental evaluations of structural members, member-to-member/foundation joints, splices, anchorages, and penetrations; D) develop validated numerical simulation models; E) develop validated design procedures/tools/criteria; and F) develop field procedures that are consistent with current methods. The experiments to be used for the validation of the design methods and simulation models include testing of: 1) high-strength materials; 2) headed rebar details (e.g., anchorages); 3) shear-wall-to-foundation joints under pure shear; and 4) multi-story shear walls under service, thermal, and seismic loads (combined shear and flexure).

High-strength rebar with high-strength concrete can result in a higher-performing composite, reduce the total rebar volume, and simplify rebar cages. Prefabricated headed rebar cages can reduce construction times and the tight quality controls of prefabrication can deliver a more reliable product. Further, reduced congestion can allow better field inspection and easier concrete placement. Combined, these innovations have the potential to dramatically accelerate construction schedules and reduce fabrication costs while also facilitating more reliable quality control of nuclear structures. By building on existing materials research, the proposed technologies have the potential to be utilized in the near-term, with results directly applicable to impact the relevant design codes. These goals and outcomes are directly in line with the NEET-1 program goals to "*accelerate innovations that reduce the cost and schedule of constructing new nuclear plants and make fabrication of nuclear power plant components faster, cheaper, and more reliable.*" This research is of national interest as cost savings in construction of nuclear structures can lead to lower electricity costs. The project is also highly relevant to the NEET-1 goal to "*develop new/revised nuclear industry codes and standards that enable the utilization of newly developed technologies*."

The project will synergize the expertise and resources of four researchers across academia, a national laboratory, and industry, and will also educate two Ph.D. students and undergraduate students. The research will be led by the University of Notre Dame, with support in numerical modeling from Sandia National Laboratories and nuclear industry insight and practical design/detail guidance from AECOM. The research results will be distributed through two Ph.D. dissertations, journal articles, conferences, committee meetings, reports, and an industry workshop. Main deliverables will be experimentally validated, generalized design methods and criteria, analysis tools, and manufacturing/construction procedures. A Design Procedure Document (with full-scale shear wall design example), a white paper, and design recommendations for relevant code updates will be other major deliverables.