



TIP 317: Seismic Hardening of High Voltage Transformers: Anchorage Strength and Base Isolation Platform Design

Context

This research project addresses the seismic hardening of high voltage power transforms using the current industry standard of anchoring directly to the foundation, and the newly developed BPA base isolation application. Depending on the transformer, BPA will be using both options throughout its power grid.

When seismically hardening or anchoring transformers, the resulting anchor forces can be very large as a result of the mass of the equipment, which ranges from 200,000 lb to 700,000 lb depending on the voltage rating (between 115kV to 500kV). The foundation pads and reinforcing details also vary from existing installations as well as for standard detail of new construction.

Description

The project seeks to obtain fundamental understanding of high-voltage equipment anchor bolt designs, and structurally reliable and economic base isolation platform options. The work will be completed in two components.

Component 1, Concrete anchorage: Selected concrete anchorage systems will be fabricated in the Portland State University Structural Laboratory. These units will undergo structural testing to determine the ultimate capacity. A number of tests will be performed to obtain significant statistical data. From the test results design parameters will be selected that are appropriate for HV substation transformer, and possibly other substation equipment.

Component 2, Base Isolation Platforms: Collect and reevaluate lessons learned during BPA's transformer installation. Selected one or two isolation platform systems to be fabricated and tested at Portland State University Laboratory. These units will be structurally tested to determine the ultimate capacity and for constructability.

Why It Matters

The potential benefits of these research project components are the ability of BPA to implement seismic hardening of high voltage power transformers safely and with verifiable structural reliability. The outcome of this project will protect BPA's most important asset, high-voltage power transformers.

Goals and Objectives

The objectives of project component 1 are to:

- Conduct a design review of commonly used anchor sizes and grades as well as commonly occurring foundation pad details at BPA,
- Develop an anchorage test matrix based the design review,
- Conduct full scale tests on the anchor combinations and compare the test results to the design values used by BPA and the industry standard ACI 318D,
- Develop appropriate design parameters to determine a reliable anchor capacity.

The objectives of project component 2 are to:

- Document lessons learned from BPA's experience and identify future requirements for transformer platforms,
- Develop design concepts for a concrete and all steel option,
- Perform tests on the selected options to demonstrate the structural reliability and the margin of capacity for installation and long term performance.

Deliverables

Deliverables for each project component are:

- Component 1: A design standard for high-voltage substation equipment anchor bolts.
- Component 2: Reliable and optimum transformer base isolation platforms (concrete and steel).

A project close-out meeting will be held at the BPA. Key findings from the project and final deliverables will be presented. Recommendations for future research to address any gaps identified during the project

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Project Start Date: October 1, 2014

Project End Date: September 30, 2015

Reports & References (Optional)

Links (Optional)

Participating Organizations

Portland State University, Portland OR

Funding

Total Project Cost: \$

BPA FY2015 Budget: \$470,000

For More Information Contact:

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