



Development of Design Procedures for Concrete Adhesive Anchors

Research Objectives

- Provide simplified design guidance for adhesive anchor use on WisDOT projects
- Provide design guidance and examples for adhesive anchors used for concrete parapet replacement on WisDOT projects

Research Benefits

- New guidance on the use of adhesive anchors in multiple applications that allows for increased use in WisDOT projects

Background

Concrete adhesive anchors are used in new and retrofitted transportation structures by WisDOT and other departments of transportation (DOTs). Adhesive anchors can be reinforcing bars or threaded rods installed in holes drilled in concrete and anchored with a polymeric adhesive. Current applications of adhesive anchors by WisDOT include backwall, pacing block and wing replacements (upper and lower sections), and abutment and pier extensions. The use of adhesive anchors for sustained loads in overhead applications has been prohibited by many state DOTs, including WisDOT. This project focused on providing simplified design guidance for adhesive anchor use on WisDOT projects. The project also resulted in providing design guidance and examples for adhesive anchors used for concrete parapet replacement on WisDOT projects, which is currently not allowed for wingwall replacement and for abutment extension.

Methodology

The project consisted of a literature review, written survey of state DOTs, design examples for adhesive anchors in three different applications, laboratory testing of wingwalls simulating an upper wingwall replacement, review of WisDOT policy, and recommendations based on findings.

Results

The literature review found the American Association of State Transportation Officials (AASHTO) and the American Concrete Institute (ACI) specify that adhesive anchors must be designed, detailed and installed using the provisions of ACI 318-14, Ch. 17, except for two modifications regarding adhesive anchors under impact loading and sustained tension. Sustained tensile loading is addressed in both ACI 318 and AASHTO specifications by including a sustained load factor. State DOTs specify if and when adhesive anchors can be used in sustained load applications.

Few adhesive manufacturers have information regarding bond strength of coated reinforcing bars. ACI 318 provides lower-bound default values for anchors meeting the qualification requirements of ACI 355.4 where the product-specific characteristic bond stress is not known. These default values are much smaller than those of products in the WisDOT-approved product list; therefore, using them would generally result in designs that are too conservative.

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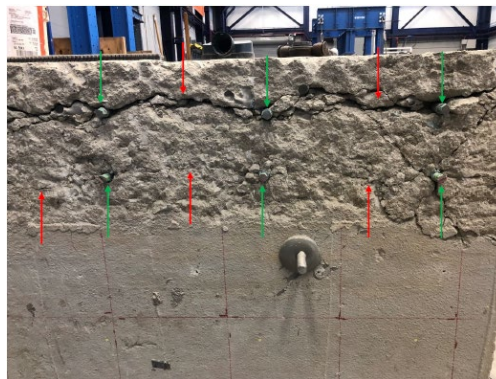
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“This research provides current guidance and recommendations for improving WisDOT’s utilization of concrete adhesive anchors in transportation structures.”
– James Luebke,
WisDOT

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Final report is available at:
[WisDOT Research website](#)



Test Sample B2. Green arrows point to the reinforcement anchors. Red arrows point to cracks between a row of anchors.

Testing was conducted to simulate an upper wingwall replacement on top of an existing lower wingwall to determine performance of epoxy coated reinforcing bars adhesively anchored into the lower wingwall and cast into the upper wingwall. A total of two test samples were fabricated to represent an upper wingwall replacement on a lower wingwall. The performance of both walls was similar in that the ultimate load values and cold-joint opening displacement and load reinforcing bar strain characteristics were similar. Calculations were made based on ACI design equations to determine the anticipated failure mode of the adhesively anchored reinforcement in the lower wingwall. The failure modes considered were concrete breakout, reinforcing steel yield and fracture, and adhesive bond failure. The controlling calculated design strength failure mode was concrete breakout. The tests of the wingwalls indicated the ACI design procedure results in a design that is conservative for this application.

Recommendations for implementation

The researchers recommended WisDOT consider the following:

- Allow adhesive anchors in parapets with strict adherence to manufacturer installation instructions and design procedures following AASHTO and ACI specifications with AASHTO-designed anchor capacity limited by anchor spacing.
- Allow adhesive anchor use in sustained tensile loading applications.
- Allow adhesive anchors in overhead or upwardly inclined installation applications.
- Allow alternative design approaches to utilize high bond strength products.
- Change installation procedure requirements in the WisDOT Standard Specification to follow the manufacturers’ published installation instructions and allow adhesive anchors in abutment wingwall replacement.
- Allow adhesive anchors for concrete parapet replacement.

This brief summarizes Project 0092-21-01,
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