Research Problem Statement

ODOT Research Section
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I. TITLE

17-023 Effect of ASTM A706 Grade 80 Reinforcement on Shear Friction Applications

II. PROBLEM

Current bridge provisions limit the contribution of the reinforcing steel in concrete shear interface design to a yield strength of 60 ksi [420 MPa]. Because of this, the higher yield strength of high strength steel (HSS) reinforcing bars cannot currently be utilized in design. To date, only a limited number of tests have been performed to characterize the shear friction resistance of members containing HSS and results from these tests indicate that using the full HSS reinforcing bar yield strength could overestimate the shear interface capacity of the specimens. However, shear friction design using HSS reinforcement at its yield strength, if shown viable, could provide constructability benefits.

The Oregon Department of Transportation (ODOT) and Region X University Transportation Center (PacTrans) supported a project (SPR 762) on the effect of HSS reinforcement on concrete-concrete shear interface behavior. In this project, four sets of five push-off test specimen types were tested for a total of 20 specimens. The experimental design included specimens with varying reinforcing steel ratios (0.42% and 0.64%), bar sizes (#4 [#13M] and #5 [#16M]), and steel grades (ASTM A706 Grade 60 [420] and Grade 80 [550]). All push-off specimens were designed to have similar interface shear resistance using current design equations. Results from this testing program indicate that while the peak strength capacity of the specimens reinforced with Grade 80 #5 bars was greater than that of the Grade 60 #5 bars, a similar increase was not observed in the #4 specimens where negligible differences were observed in the peak strength. However, the use of HSS reinforcement increased the post-peak sustained loads. The mixed observations in terms of the increasing strength in the specimens with #4 and #5 reinforcement can be explained with the fact that the interface reinforcement for the #4 specimens did not reach yielding strains. However, two different varying conditions, the reinforcement bar size and the spacing between the bars may have played a role in this difference. To clarify this point, and to gain a better understanding of the effects of HSS reinforcement for shear friction applications, further research is still needed, especially concerning other test variables not considered in SPR 762, including for example, concrete strength, interface roughness, rebar spacing, rebar grade, among others.

III. PROPOSED RESEARCH, DEVELOPMENT, OR TECHNICAL TRANSFER ACTIVITY

The main objective of the proposed research is to validate existing design equations or to develop new design equations, supported by a comprehensive experimental testing program, for use of ASTM A706 Grade 80 high strength reinforcing steel in shear friction applications. The tests to be performed will be push-off tests, following procedures and knowledge gained by the proposers during a testing program recently completed at the large scale Structural Engineering Laboratory at Oregon State University.

This research as a minimum should include the following tasks:

- Task 1: Literature review summarizing work currently being done by other SHAs on high-strength steel; if available, identify current design methodologies for using high-strength steel in shear interface applications.
- Task 2: Based on the literature review findings, develop an experimental program to test the performance shear interfaces using Grade 80 reinforcement meeting ASTM A706 specifications. The team's current thinking is to test three (3) specimens for each set of parameters that affect the shear capacity of interfaces containing Grade 80 steel reinforcement, such as concrete strength (2 levels), interface roughness (3 levels), rebar spacing (2 levels), and rebar grade (2 levels). In total, it is envisioned that 3x2x3x2x2 = 72 specimens will be tested.
- Task 3: Perform the experimental testing program developed in Task 2.
- Task 4: Develop a final report that documents findings and provides recommendations to ODOT on the use of Grade 80 reinforcement meeting ASTM A706 specifications.

IV. POTENTIAL BENEFITS

High-strength steel bars in reinforced concrete elements can provide the following benefits: less congestion of the reinforcement cages resulting in improved constructability (easier bar and concrete placement), reduced shipping costs, reduced construction costs, improved structural performance post-cracking, and reduced environmental impact.

V. IMPLEMENTATION

If the research outcome shows Grade 80 reinforcement meets performance requirements for shear friction applications, the product of this research will include analytical equations and procedures that will allow engineers to rationally design structures using Grade 80 reinforcement. If it is determined that Grade 80 reinforcement cannot be used at its full yield strength, issues will be identified and the researchers will provide clear reasoning to support the findings. If results indicate that the steel can provide added value, after validation by ODOT bridge engineers, modifications to the ODOT Bridge Design and Drafting Manual will be recommended so that Grade 80 steel at full yield strength can be used within ODOT. In addition, with support of the ODOT bridge engineers, results will be presented to AASHTO T-10 committees, among others.

VI. CONTACT INFORMATION

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