ABSTRACT

Reinforced concrete elements are vulnerable to sliding against each other when shear forces are transmitted between them. Shear-friction is the mechanism by which shear is transferred between concrete surfaces. It develops by aggregate interlock between the concrete interfaces while reinforcement crossing the shear interface or normal force due to external loads contributes to the shear resistance. Current design provisions used in the United States (ACI 318-19, AASHTO LRFD (2020), and the *PCI Design Handbook* (2017)) include design expression for shear-friction capacity. However, the value of the reinforcement yield strength input into the expressions is limited to a maximum of 60 ksi. Furthermore, the concrete strength is not incorporated into the primary design expressions. These limits cause the potential contribution of high-strength reinforcement and high-strength concrete in shear-friction applications from being considered. Therefore, a research program was developed to investigate the possibility of improving current shear-friction design practice and addressing these current limits.

Specifically, an experimental program was conducted to evaluate the influence of high-strength reinforcement and high-strength concrete on shear-friction strength. In addition, a statistical analysis was performed using a comprehensive shear-frication database comprised of past tests available in the literature. The experimental program consisted of two phases. Phase I included 24 push-off specimens to study the influence of the yield strength of the interface reinforcement (Grade 60 and Grade 100) and the number and size of interface reinforcing bars (6-No.4 and 4-No. 5 bars) with three different interface conditions (rough, smooth, and shear-key). Phase II included 20 push-off specimens with rough interfaces to investigate the influence of the yield strength of the interface reinforcement (Grade 60 and Grade 100) and concrete strength (target strengths of 4000 psi and 8000 psi). The influence of these two variables was observed over a range of reinforcement ratios (ρ = 0.55%, 0.83%, 1.11%, and 1.38%).

The test results showed that the overall shear-friction strength was the greatest for rough interface specimens, followed by specimens detailed with shear keys. The smooth interface specimens had the lowest strengths. The results of both phases of the experimental program indicated that the use of high-strength reinforcement did not improve shear-friction capacity.

Furthermore, the results from the Phase II tests showed that increasing the concrete compressive strength led to increased shear-friction capacity. The test results from the experimental program were analyzed and compared with current design provisions, which demonstrated room for improvement of current design practice.

Following the experimental program, a comprehensive shear-friction database was analyzed, and multilinear regression was used to create a model to predict shear-friction strength. Factors were then applied to the model to provide acceptable design expressions for shear-friction strength (less than 5% unconservative estimates). The database was used to evaluate the factored model and current design provisions.

The research outcomes, especially the expressions for shear-friction strength that were developed and that include consideration of the concrete compression strength, along with the shear-friction tests demonstrating the lack of strength gain with the use of Grade 100 reinforcement, provide valuable information for the concrete community to help direct efforts toward improving current shear-friction design practice.