SHEAR PERFORMANCE OF REINFORCED SHEAR KEYS IN JOINTS OF PRECAST SEGMENTAL BRIDGES

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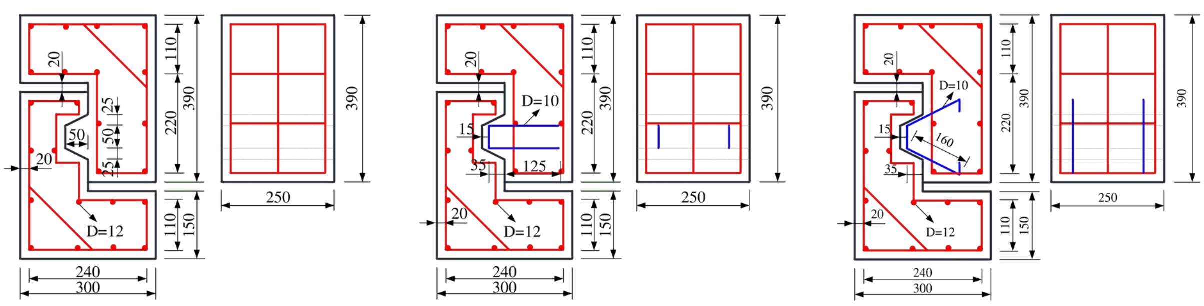
Extended Abstract

Precast segmental structures have been widely adopted in bridge engineering because of their advantages, including high construction quality, rapid erection, and minimal disruption to traffic. However, since no continuous reinforcement is provided between adjacent segments, the joints become the weakest part of the structure, resulting in lower shear capacity compared with cast-in-place structures. Therefore, improving the shear performance of joints in precast segmental structures is of great importance.

In this study, a reinforced shear key incorporating rebars was developed to enhance both shear capacity and construction efficiency. As shown in Fig. 1, three castellated key joints were designed, including two conventional joints and four reinforced joints, to conduct push-off tests. The effects of rebar configuration (U-shaped or K-shaped) on the shear behavior of the joints were experimentally investigated. Joints D-PC is commonly used in engineering construction (Fig. 1a). The shear key in joints D-RU, D-RK, are strengthened with two 10 mm-diameter U-shaped or K-shaped steel bars, with a reinforcement ratio of 1.2% at the key base.



(a) Joint D-PC (b) Joint D-RU (b) Joint D-RK

Fig. 1 Elevation and cross-section view of joints

To investigate the crack propagation, failure modes and key loads of the innovative epoxy joint, push-off tests was conducted. Fig. 2 present the testing setup and instrumentation layout of the monotonous push-off test, respectively. The horizontal pressure and vertical load were measured by L1 and L2. The vertical loading displacement of the specimen was computed based on the average value derived from measurements D1 and D2. Before loading, constant pressure was applied by A1, the compressive stress value of each joint was 1.5 MPa and the corresponding horizontal force was 75 kN. A displacement control mode was adopted, with a loading increment 0.1 mm. The push-off test was stopped until the specimen was damaged.

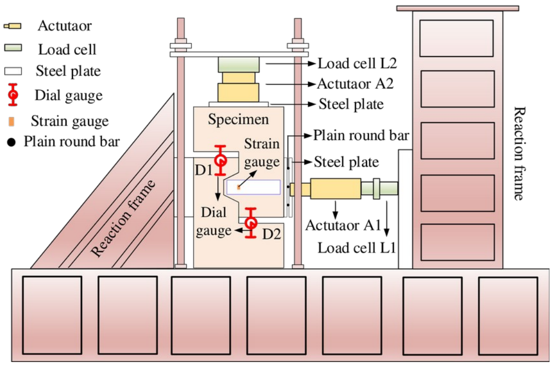
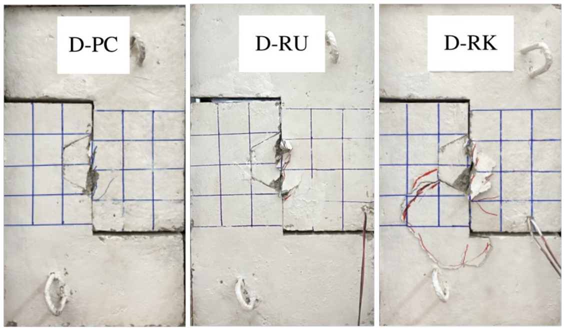
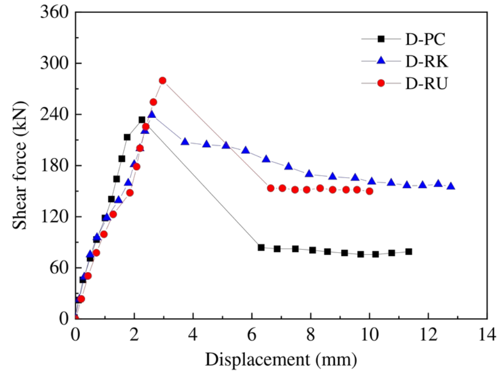


Fig. 2 Push-off test

The experimental results are shown in Fig. 3. For all specimens, cracking initially occurred at the lower corner of the shear key and propagated along the shear plane at an angle of approximately 40-50° to the horizontal direction. As the applied load increased, the initial crack extended, and several short diagonal cracks developed at the root of the shear key. In particular, for specimen D-RK, cracks also appeared in the female segment when the diagonal cracks nearly covered the entire root region of the shear key. When the vertical load reached the ultimate value, cracks at the root of the shear key coalesced, causing the concrete key to separate from the male segment with a brittle failure sound. Consequently, the shear force dropped rapidly; however, the decrease in the reinforced joints was less abrupt than that of joint D-PC because of the contribution of the embedded reinforcement. As loading displacement continued to increase, cracks in the female segment propagated toward the bottom of the joint. The ultimate loads of joints D-RK and D-RU were approximately twice that of joint D-PC. The enhanced load-carrying capacity was attributed not only to frictional resistance but also to the contribution of the reinforcing bars within the shear key. However, the shear strength of joint D-RK was only 5.9 kN higher than that of joint D-PC, whereas the ultimate load of joint D-RK increased by 19.7% compared with that of joint D-PC. This may be because the reinforcing bars in the shear key were not oriented perpendicular to the diagonal cracks and therefore could not effectively contribute to the improvement of shear strength.



a) Crack development



b) load-displacement curves

Fig. 2 Experimental results

Keywords*: Precast segmental bridge; joint; reinforced shear key, Push-off test; Shear strength*